Radio Regulations

Articles

Edition of 2024

1

Radio Regulations

Articles

1

Edition of 2024

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Note by the Secretariat

This revision of the Radio Regulations, complementing the Constitution and the Convention of the International Telecommunication Union, incorporates the decisions of the World Radiocommunication Conferences of 1995 (WRC-95), 1997 (WRC-97), 2000 (WRC-2000), 2003 (WRC-03), 2007 (WRC-07), 2012 (WRC-12), 2015 (WRC-15), 2019 (WRC-19) and 2023 (WRC-23). The majority of the provisions of these Regulations shall enter into force as from 1 January 2025; the remaining provisions shall apply as from the special dates of application indicated in Article **59** of the revised Radio Regulations.

In preparing the Radio Regulations, Edition of 2024, the Secretariat corrected the typographical errors that were drawn to the attention of WRC-23 and which were approved by WRC-23.

This edition uses the same numbering scheme as the 2001 edition of the Radio Regulations, notably:

With respect to *Article numbers*, this edition follows the standard sequential numbering. The Article numbers are not followed by any abbreviation (such as "(WRC-97)", "(WRC-2000)", "(WRC-03)", "(WRC-07)", "(WRC-12)", "(WRC-15)", "(WRC-19)" or "(WRC-23)"). Consequently, any reference to an Article, in any of the provisions of these Radio Regulations (e.g. in No. **13.1** of Article **13**), in the texts of the Appendices as contained in Volume 2 of this edition (e.g. in § 1 of Appendix **2**), in the texts of the Resolutions included in Volume 3 of this edition (e.g. in Resolution **1 (Rev.WRC-97)**), and in the texts of the Recommendations included in Volume 3 of this edition (e.g. in Recommendation **8**), is considered as a reference to the text of the concerned Article which appears in this edition, unless otherwise specified.

With respect to *provision numbers in Articles*, this edition continues to use composite numbers indicating the number of the Article and the provision number within that Article (e.g. No. 9.2B means provision No. 2B of Article **9**). The abbreviation "(WRC-23)", "(WRC-19)", "(WRC-15)", "(WRC-12)", "(WRC-07)", "(WRC-03)", "(WRC-2000)" or "(WRC-97)" at the end of such a provision means that the relevant provision was modified or added by WRC-23, by WRC-19, by WRC-15, by WRC-12, by WRC-07, by WRC-03, by WRC-2000 or by WRC-97, as applicable. The absence of an abbreviation at the end of the provision means that the provision is identical with the provision of the simplified Radio Regulations as approved by WRC-95, and whose complete text was contained in Document 2 of WRC-97.

With respect to *Appendix numbers*, this edition follows the standard sequential numbering, with the addition of the appropriate abbreviation after the Appendix number (such as "(WRC-97)", "(WRC-2000)", "(WRC-03)", "(WRC-07)", "(WRC-12)", "(WRC-15)", "(WRC-19)" or "(WRC-23)"), where applicable. As a rule, any reference to an Appendix, in any of the provisions of these Radio Regulations, in the texts of the Appendices as contained in Volume 2 of this edition, in the texts of the Resolutions and of the Recommendations included in Volume 3 of this edition, is presented in the standard manner (e.g. "Appendix **30 (Rev.WRC-23)**") if not explicitly described in the text (e.g. Appendix **4** as modified by WRC-23). In the texts of Appendices that were partially modified by WRC-23, the provisions that were modified by WRC-23 are indicated with the abbreviation "(WRC-23)" at the end of the concerned text. If an Appendix is referenced without any abbreviation after the Appendix number, in the texts of this edition (e.g. in No. **13.1**), or without other description, such reference is considered as a reference to the text of the concerned Appendix which appears in this edition.

Within the text of the Radio Regulations, the symbol, ↑, has been used to represent quantities associated with an uplink. Similarly, the symbol, ↓, has been used to represent quantities associated with a downlink.

Abbreviations have generally been used for the names of world administrative radio conferences and world radiocommunication conferences. These abbreviations are shown below.

Abbreviation	Conference
WARC Mar	World Administrative Radio Conference to Deal with Matters Relating to the Maritime Mobile Service (Geneva, 1967)
WARC-71	World Administrative Radio Conference for Space Telecommunications (Geneva, 1971)
WMARC-74	World Maritime Administrative Radio Conference (Geneva, 1974)
WARC SAT-77	World Broadcasting-Satellite Administrative Radio Conference (Geneva, 1977)
WARC-Aer2	World Administrative Radio Conference on the Aeronautical Mobile (R) Service (Geneva, 1978)
WARC-79	World Administrative Radio Conference (Geneva, 1979)
WARC Mob-83	World Administrative Radio Conference for the Mobile Services (Geneva, 1983)
WARC HFBC-84	World Administrative Radio Conference for the Planning of the HF Bands Allocated to the Broadcasting Service (Geneva, 1984)
WARC Orb-85	World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilising It (First Session – Geneva, 1985)
WARC HFBC-87	World Administrative Radio Conference for the Planning of the HF Bands Allocated to the Broadcasting Service (Geneva, 1987)
WARC Mob-87	World Administrative Radio Conference for the Mobile Services (Geneva, 1987)
WARC Orb-88	World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilising It (Second Session – Geneva, 1988)
WARC-92	World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (Malaga-Torremolinos, 1992)
WRC-95	World Radiocommunication Conference (Geneva, 1995)
WRC-97	World Radiocommunication Conference (Geneva, 1997)
WRC-2000	World Radiocommunication Conference (Istanbul, 2000)
WRC-03	World Radiocommunication Conference (Geneva, 2003)
WRC-07	World Radiocommunication Conference (Geneva, 2007)
WRC-12	World Radiocommunication Conference (Geneva, 2012)
WRC-15	World Radiocommunication Conference (Geneva, 2015)
WRC-19	World Radiocommunication Conference (Sharm El-Sheikh, 2019)
WRC-23	World Radiocommunication Conference (Dubai, 2023)
WRC-27	World Radiocommunication Conference, 2027[1]

[1] The date of this conference has not been finalized.

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RADIO REGULATIONS

Preamble

0.1 These Regulations are founded on the following principles:

0.2 Members* shall endeavour to limit the number of frequencies and the spectrum used to the minimum essential to provide in a satisfactory manner the necessary services. To that end, they shall endeavour to apply the latest technical advances as soon as possible (No. 195 of the Constitution of the International Telecommunication Union (Geneva, 1992)).

0.3 In using frequency bands for radio services, Members shall bear in mind that radio frequencies and any associated orbits, including the geostationary-satellite orbit are limited natural resources and that they must be used rationally, efficiently and economically, in conformity with the provisions of these Regulations, so that countries or groups of countries may have equitable access to those orbits and frequencies, taking into account the special needs of the developing countries and the geographical situation of particular countries (No. 196 of the Constitution).

0.4 All stations, whatever their purpose, must be established and operated in such a manner as not to cause harmful interference to the radio services or communications of other Members or of recognized operating agencies, or of other duly authorized operating agencies which carry on a radio service, and which operate in accordance with the provisions of these Regulations (No. 197 of the Constitution).

0.5 With a view to fulfilling the purposes of the International Telecommunication Union set out in Article 1 of the Constitution, these Regulations have the following objectives:

0.6 to facilitate equitable access to and rational use of the natural resources of the radio-frequency spectrum and the geostationary-satellite orbit;

0.7 to ensure the availability and protection from harmful interference of the frequencies provided for distress and safety purposes;

0.8 to assist in the prevention and resolution of cases of harmful interference between the radio services of different administrations;

0.9 to facilitate the efficient and effective operation of all radiocommunication services;

0.10 to provide for and, where necessary, regulate new applications of radiocommunication technology.

0.11 The application of the provisions of these Regulations by the International Telecommunication Union does not imply the expression of any opinion whatsoever on the part of the Union concerning the sovereignty or the legal status of any country, territory or geographical area.

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* *Note by the Secretariat:* Provision No. 195 (PP-02) uses the term “Member States”.

CHAPTER I

Terminology and technical characteristics

ARTICLE 1

Terms and definitions

Introduction

1.1 For the purposes of these Regulations, the following terms shall have the meanings defined below. These terms and definitions do not, however, necessarily apply for other purposes. Definitions identical to those contained in the Annex to the Constitution or the Annex to the Convention of the International Telecommunication Union (Geneva, 1992) are marked "(CS)" or "(CV)" respectively.

NOTE – If, in the text of a definition below, a term is printed in italics, this means that the term itself is defined in this Article.

Section I – General terms

1.2 *administration:* Any governmental department or service responsible for discharging the obligations undertaken in the Constitution of the International Telecommunication Union, in the Convention of the International Telecommunication Union and in the Administrative Regulations (CS 1002).

1.3 *telecommunication:* Any transmission, *emission* or reception of signs, signals, writings, images and sounds or intelligence of any nature by wire, *radio*, optical or other electromagnetic systems (CS).

1.4 *radio:* A general term applied to the use of *radio waves*.

1.5 *radio waves* or *hertzian waves:* Electromagnetic waves of frequencies arbitrarily lower than 3 000 GHz, propagated in space without artificial guide.

1.6 *radiocommunication: Telecommunication* by means of *radio waves* (CS) (CV).

1.7 *terrestrial radiocommunication:* Any *radiocommunication* other than *space radiocommunication* or *radio astronomy.*

1.8 *space radiocommunication:* Any *radiocommunication* involving the use of one or more *space stations* or the use of one or more *reflecting satellites* or other objects in space.

1.9 *radiodetermination:* The determination of the position, velocity and/or other characteristics of an object, or the obtaining of information relating to these parameters, by means of the propagation properties of *radio waves*.

1.10 *radionavigation: Radiodetermination* used for the purposes of navigation, including obstruction warning.

1.11 *radiolocation: Radiodetermination* used for purposes other than those of *radionavigation*.

1.12 *radio direction-finding: Radiodetermination* using the reception of *radio waves* for the purpose of determining the direction of a *station* or object.

1.13 *radio astronomy:* Astronomy based on the reception of *radio waves* of cosmic origin.

1.14 *Coordinated Universal Time (UTC):* Time scale, based on the second (SI), as described in Resolution **655 (Rev.WRC-23)**. (WRC-23)

1.15 *industrial, scientific and medical (ISM) applications* (of radio frequency energy): Operation of equipment or appliances designed to generate and use locally radio frequency energy for industrial, scientific, medical, domestic or similar purposes, excluding applications in the field of *telecommunications*.

Section II – Specific terms related to frequency management

1.16 *allocation* (of a frequency band): Entry in the Table of Frequency Allocations of a given frequency band for the purpose of its use by one or more terrestrial or space *radiocommunication services* or the *radio astronomy service* under specified conditions. This term shall also be applied to the frequency band concerned.

1.17 *allotment* (of a radio frequency or radio frequency channel): Entry of a designated frequency channel in an agreed plan, adopted by a competent conference, for use by one or more *administrations* for a terrestrial or space *radiocommunication service* in one or more identified countries or geographical areas and under specified conditions.

1.18 *assignment* (of a radio frequency or radio frequency channel): Authorization given by an *administration* for a radio *station* to use a radio frequency or radio frequency channel under specified conditions.

Section III – Radio services

1.19 *radiocommunication service:* A service as defined in this Section involving the transmission, *emission* and/or reception of *radio waves* for specific *telecommunication* purposes.

In these Regulations, unless otherwise stated, any radiocommunication service relates to *terrestrial radiocommunication*.

1.20 *fixed service: A radiocommunication service* between specified fixed points.

1.21 *fixed-satellite service:* A *radiocommunication service* between *earth stations* at given positions, when one or more *satellites* are used; the given position may be a specified fixed point or any fixed point within specified areas; in some cases this service includes satellite-to-satellite links, which may also be operated in the *inter-satellite service*; the fixed-satellite service may also include *feeder links* for other *space radiocommunication services*.

1.22 *inter-satellite service:* A *radiocommunication service* providing links between artificial *satellites*.

1.23 *space operation service:* A *radiocommunication service* concerned exclusively with the operation of *spacecraft*, in particular *space tracking, space telemetry* and *space telecommand*.

These functions will normally be provided within the service in which the *space station* is operating.

1.24 *mobile service:* A *radiocommunication service* between *mobile* and *land stations*, or between *mobile stations* (CV).

1.25 *mobile-satellite service:* A *radiocommunication service:*

– between *mobile earth stations* and one or more *space stations*, or between *space stations* used by this service; or

– between *mobile earth stations* by means of one or more *space stations*.

This service may also include *feeder links* necessary for its operation.

1.26 *land mobile service:* A *mobile service* between *base stations* and *land mobile stations*, or between *land mobile stations*.

1.27 *land mobile-satellite service:* A *mobile-satellite service* in which *mobile earth stations* are located on land.

1.28 *maritime mobile service:* A *mobile service* between *coast stations* and *ship stations*, or between *ship stations*, or between associated *on-board communication stations*; *survival craft stations* and *emergency position-indicating radiobeacon stations* may also participate in this service.

1.29 *maritime mobile-satellite service:* A *mobile-satellite service* in which *mobile earth stations* are located on board ships; *survival craft stations* and *emergency position-indicating radiobeacon stations* may also participate in this service.

1.30 *port operations service:* A *maritime mobile service* in or near a port, between *coast stations* and *ship stations*, or between *ship stations*, in which messages are restricted to those relating to the operational handling, the movement and the safety of ships and, in emergency, to the safety of persons.

Messages which are of a *public correspondence* nature shall be excluded from this service.

1.31 *ship movement service:* A *safety service* in the *maritime mobile service* other than a *port operations service*, between *coast stations* and *ship stations*, or between *ship stations*, in which messages are restricted to those relating to the movement of ships.

Messages which are of a *public correspondence* nature shall be excluded from this service.

1.32 *aeronautical mobile service:* A *mobile service* between *aeronautical stations* and *aircraft stations*, or between *aircraft stations*, in which *survival craft stations* may participate; *emergency position-indicating radiobeacon stations* may also participate in this service on designated distress and emergency frequencies.

1.33 *aeronautical mobile (R)* service:* An *aeronautical mobile service* reserved for communications relating to safety and regularity of flight, primarily along national or international civil air routes.

1.34 *aeronautical mobile (OR)** service:* An *aeronautical mobile service* intended for communications, including those relating to flight coordination, primarily outside national or international civil air routes.

1.35 *aeronautical mobile-satellite service:* A *mobile-satellite service* in which *mobile earth stations* are located on board aircraft; *survival craft stations* and *emergency position-indicating radiobeacon stations* may also participate in this service.

1.36 *aeronautical mobile-satellite (R)* service:* An *aeronautical mobile-satellite service* reserved for communications relating to safety and regularity of flights, primarily along national or international civil air routes.

1.37 *aeronautical mobile-satellite (OR)** service:* An *aeronautical mobile-satellite service* intended for communications, including those relating to flight coordination, primarily outside national and international civil air routes.

1.38 *broadcasting service:* A *radiocommunication service* in which the transmissions are intended for direct reception by the general public. This service may include sound transmissions, *television* transmissions or other types of transmission (CS).

1.39 *broadcasting-satellite service:* A *radiocommunication service* in which signals transmitted or retransmitted by *space stations* are intended for direct reception by the general public.

In the broadcasting-satellite service, the term "direct reception" shall encompass both *individual reception* and *community reception*.

1.40 *radiodetermination service:* A *radiocommunication service* for the purpose of *radiodetermination*.

1.41 *radiodetermination-satellite service: A radiocommunication service* for the purpose of *radiodetermination* involving the use of one or more *space stations*.

This service may also include *feeder links* necessary for its own operation.

1.42 *radionavigation service:* A *radiodetermination service* for the purpose of *radionavigation*.

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* (R): route.

** (OR): off-route.

1.43 *radionavigation-satellite service:* A *radiodetermination-satellite service* used for the purpose of *radionavigation*.

This service may also include *feeder links* necessary for its operation.

1.44 *maritime radionavigation service:* A *radionavigation service* intended for the benefit and for the safe operation of ships.

1.45 *maritime radionavigation-satellite service:* A *radionavigation-satellite service* in which *earth stations* are located on board ships.

1.46 *aeronautical radionavigation service:* A *radionavigation service* intended for the benefit and for the safe operation of aircraft.

1.47 *aeronautical radionavigation-satellite service:* A *radionavigation-satellite service* in which *earth stations* are located on board aircraft.

1.48 *radiolocation service:* A *radiodetermination service* for the purpose of *radiolocation*.

1.49 *radiolocation-satellite service:* A *radiodetermination-satellite service* used for the purpose of *radiolocation*.

This service may also include the *feeder links* necessary for its operation.

1.50 *meteorological aids service:* A *radiocommunication service* used for meteorological, including hydrological, observations and exploration.

1.51 *Earth exploration-satellite service:* A *radiocommunication service* between *earth stations* and one or more *space stations*, which may include links between *space stations*, in which:

– information relating to the characteristics of the Earth and its natural phenomena, including data relating to the state of the environment, is obtained from *active sensors* or *passive sensors* on Earth *satellites*;

– similar information is collected from airborne or Earth-based platforms;

– such information may be distributed to *earth stations* within the system concerned;

– platform interrogation may be included.

This service may also include *feeder links* necessary for its operation.

1.52 *meteorological-satellite service:* An *earth exploration-satellite service* for meteorological purposes.

1.53 *standard frequency and time signal service:* A *radiocommunication service* for scientific, technical and other purposes, providing the transmission of specified frequencies, time signals, or both, of stated high precision, intended for general reception.

1.54 *standard frequency and time signal-satellite service:* A *radiocommunication service* using *space stations* on earth *satellites* for the same purposes as those of the *standard frequency and time signal service*.

This service may also include *feeder links* necessary for its operation.

1.55 *space research service:* A *radiocommunication service* in which *spacecraft* or other objects in space are used for scientific or technological research purposes.

1.56 *amateur service:* A *radiocommunication service* for the purpose of self-training, intercommunication and technical investigations carried out by amateurs, that is, by duly authorized persons interested in radio technique solely with a personal aim and without pecuniary interest.

1.57 *amateur-satellite service:* A *radiocommunication service* using *space stations* on earth *satellites* for the same purposes as those of the *amateur service*.

1.58 *radio astronomy service:* A service involving the use of *radio astronomy*.

1.59 *safety service:* Any *radiocommunication service* used permanently or temporarily for the safeguarding of human life and property.

1.60 *special service:* A *radiocommunication service*, not otherwise defined in this Section, carried on exclusively for specific needs of general utility, and not open to *public correspondence*.

Section IV – Radio stations and systems

1.61 *station:* One or more transmitters or receivers or a combination of transmitters and receivers, including the accessory equipment, necessary at one location for carrying on a *radiocommunication service*, or the *radio astronomy service*.

Each station shall be classified by the service in which it operates permanently or temporarily.

1.62 *terrestrial station:* A *station* effecting *terrestrial radiocommunication*.

In these Regulations, unless otherwise stated, any *station* is a terrestrial station.

1.63 *earth station:* A *station* located either on the Earth's surface or within the major portion of the Earth's atmosphere and intended for communication:

– with one or more *space stations*; or

– with one or more *stations* of the same kind by means of one or more *reflecting satellites* or other objects in space.

1.64 *space station:* A *station* located on an object which is beyond, is intended to go beyond, or has been beyond, the major portion of the Earth's atmosphere.

1.65 *survival craft station:* A *mobile station* in the *maritime mobile service* or the *aeronautical mobile service* intended solely for survival purposes and located on any lifeboat, life-raft or other survival equipment.

1.66 *fixed station:* A *station* in the *fixed service*.

1.66A *high altitude platform station:* A *station* located on an object at an altitude of 20 to 50 km and at a specified, nominal, fixed point relative to the Earth.

1.67 *mobile station:* A *station* in the *mobile service* intended to be used while in motion or during halts at unspecified points.

1.68 *mobile earth station:* An *earth station* in the *mobile-satellite service* intended to be used while in motion or during halts at unspecified points.

1.69 *land station:* A *station* in the *mobile service* not intended to be used while in motion.

1.70 *land earth station:* An *earth station* in the *fixed-satellite service* or, in some cases, in the *mobile-satellite service,* located at a specified fixed point or within a specified area on land to provide a *feeder link* for the *mobile-satellite service*.

1.71 *base station:* A *land station* in the *land mobile service*.

1.72 *base earth station:* An *earth station* in the *fixed-satellite service* or, in some cases, in the *land mobile-satellite service,* located at a specified fixed point or within a specified area on land to provide a *feeder link* for the *land mobile-satellite service*.

1.73 *land mobile station:* A *mobile station* in the *land mobile service* capable of surface movement within the geographical limits of a country or continent.

1.74 *land mobile earth station:* A *mobile earth station* in the *land mobile-satellite service* capable of surface movement within the geographical limits of a country or continent.

1.75 *coast station:* A *land station* in the *maritime mobile service*.

1.76 *coast earth station:* An *earth station* in the *fixed-satellite service* or, in some cases, in the *maritime mobile-satellite service*, located at a specified fixed point on land to provide a *feeder link* for the *maritime mobile-satellite service*.

1.77 *ship station:* A *mobile station* in the *maritime mobile service* located on board a vessel which is not permanently moored, other than a *survival craft station*.

1.78 *ship earth station:* A *mobile earth station* in the *maritime mobile-satellite service* located on board ship.

1.79 *on-board communication station:* A low-powered *mobile station* in the *maritime mobile service* intended for use for internal communications on board a ship, or between a ship and its lifeboats and life-rafts during lifeboat drills or operations, or for communication within a group of vessels being towed or pushed, as well as for line handling and mooring instructions.

1.80 *port station:* A *coast station* in the *port operations service*.

1.81 *aeronautical station:* A *land station* in the *aeronautical mobile service*.

In certain instances, an aeronautical station may be located, for example, on board ship or on a platform at sea.

1.82 *aeronautical earth station:* An *earth station* in the *fixed-satellite service*, or, in some cases, in the *aeronautical mobile-satellite service*, located at a specified fixed point on land to provide a *feeder link* for the *aeronautical mobile-satellite service*.

1.83 *aircraft station:* A *mobile station* in the *aeronautical mobile service*, other than a *survival craft station*, located on board an aircraft.

1.84 *aircraft earth station:* A *mobile earth station* in the *aeronautical mobile-satellite service* located on board an aircraft.

1.85 *broadcasting station:* A *station* in the *broadcasting service*.

1.86 *radiodetermination station:* A *station* in the *radiodetermination service*.

1.87 *radionavigation mobile station:* A *station* in the *radionavigation service* intended to be used while in motion or during halts at unspecified points.

1.88 *radionavigation land station:* A *station* in the *radionavigation service* not intended to be used while in motion.

1.89 *radiolocation mobile station:* A *station* in the *radiolocation service* intended to be used while in motion or during halts at unspecified points.

1.90 *radiolocation land station:* A *station* in the *radiolocation service* not intended to be used while in motion.

1.91 *radio direction-finding station:* A *radiodetermination station* using *radio direction-finding*.

1.92 *radiobeacon station:* A *station* in the *radionavigation service* the *emissions* of which are intended to enable a *mobile station* to determine its bearing or direction in relation to the radiobeacon station.

1.93 *emergency position-indicating radiobeacon station:* A *station* in the *mobile service* the *emissions* of which are intended to facilitate search and rescue operations.

1.94 *satellite emergency position-indicating radiobeacon:* An *earth station* in the *mobile-satellite service* the *emissions* of which are intended to facilitate search and rescue operations.

1.95 *standard frequency and time signal station:* A *station* in the *standard frequency and time signal service*.

1.96 *amateur station:* A *station* in the *amateur service*.

1.97 *radio astronomy station:* A *station* in the *radio astronomy service*.

1.98 *experimental station:* A *station* utilizing *radio waves* in experiments with a view to the development of science or technique.

This definition does not include *amateur stations.*

1.99 *ship's emergency transmitter:* A ship's transmitter to be used exclusively on a distress frequency for distress, urgency or safety purposes.

1.100 *radar:* A *radiodetermination* system based on the comparison of reference signals with radio signals reflected, or retransmitted, from the position to be determined.

1.101 *primary radar:* A *radiodetermination* system based on the comparison of reference signals with radio signals reflected from the position to be determined.

1.102 *secondary radar:* A *radiodetermination* system based on the comparison of reference signals with radio signals retransmitted from the position to be determined.

1.103 *radar beacon (racon):* A transmitter-receiver associated with a fixed navigational mark which, when triggered by a *radar*, automatically returns a distinctive signal which can appear on the display of the triggering *radar*, providing range, bearing and identification information.

1.104 *instrument landing system (ILS):* A *radionavigation* system which provides aircraft with horizontal and vertical guidance just before and during landing and, at certain fixed points, indicates the distance to the reference point of landing.

1.105 *instrument landing system localizer:* A system of horizontal guidance embodied in the *instrument landing system* which indicates the horizontal deviation of the aircraft from its optimum path of descent along the axis of the runway.

1.106 *instrument landing system glide path:* A system of vertical guidance embodied in the *instrument landing system* which indicates the vertical deviation of the aircraft from its optimum path of descent.

1.107 *marker beacon:* A transmitter in the *aeronautical radionavigation service* which radiates vertically a distinctive pattern for providing position information to aircraft.

1.108 *radio altimeter: Radionavigation* equipment, on board an aircraft or *spacecraft,* used to determine the height of the aircraft or the *spacecraft* above the Earth's surface or another surface.

1.108A *meteorological aids land station:* A *station* in the *meteorological aids service* not intended to be used while in motion. (WRC-15)

1.108B *meteorological aids mobile station:* A *station* in the *meteorological aids service* intended to be used while in motion or during halts at unspecified points. (WRC-15)

1.109 *radiosonde:* An automatic radio transmitter in the *meteorological aids service* usually carried on an aircraft, free balloon, kite or parachute, and which transmits meteorological data.

1.109A *adaptive system:* A *radiocommunication* system which varies its radio characteristics according to channel quality.

1.110 *space system:* Any group of cooperating *earth stations* and/or *space stations* employing *space radiocommunication* for specific purposes.

1.111 *satellite system:* A *space system* using one or more artificial earth *satellites*.

1.112 *satellite network:* A *satellite system* or a part of a *satellite system*, consisting of only one *satellite* and the cooperating *earth stations*.

1.113 *satellite link:* A radio link between a transmitting *earth station* and a receiving *earth station* through one *satellite*.

A satellite link comprises one up-link and one down-link.

1.114 *multi-satellite link:* A radio link between a transmitting *earth station* and a receiving *earth station* through two or more *satellites*, without any intermediate *earth station*.

A multi-satellite link comprises one up-link, one or more satellite-to-satellite links and one down-link.

1.115 *feeder link:* A radio link from an *earth station* at a given location to a *space station*, or vice versa, conveying information for a *space radiocommunication service* other than for the *fixed-satellite service*. The given location may be at a specified fixed point, or at any fixed point within specified areas.

Section V – Operational terms

1.116 *public correspondence:* Any *telecommunication* which the offices and *stations* must, by reason of their being at the disposal of the public, accept for transmission (CS).

1.117 *telegraphy*[1]: A form of *telecommunication* in which the transmitted information is intended to be recorded on arrival as a graphic document; the transmitted information may sometimes be presented in an alternative form or may be stored for subsequent use (CS 1016).

1.118 *telegram:* Written matter intended to be transmitted by *telegraphy* for delivery to the addressee. This term also includes *radiotelegrams* unless otherwise specified (CS).

In this definition the term *telegraphy* has the same general meaning as defined in the Convention.

1.119 *radiotelegram:* A *telegram*, originating in or intended for a *mobile station* or a *mobile earth station* transmitted on all or part of its route over the *radiocommunication* channels of the *mobile service* or of the *mobile-satellite service*.

1.120 *radiotelex call:* A telex call, originating in or intended for a *mobile station* or a *mobile earth station*, transmitted on all or part of its route over the *radiocommunication* channels of the *mobile service* or the *mobile-satellite service*.

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[1] **1.117.1** A graphic document records information in a permanent form and is capable of being filed and consulted; it may take the form of written or printed matter or of a fixed image.

1.121 *frequency-shift telegraphy: Telegraphy* by frequency modulation in which the telegraph signal shifts the frequency of the carrier between predetermined values.

1.122 *facsimile:* A form of *telegraphy* for the transmission of fixed images, with or without half-tones, with a view to their reproduction in a permanent form.

1.123 *telephony:* A form of *telecommunication* primarily intended for the exchange of information in the form of speech (CS 1017).

1.124 *radiotelephone call:* A telephone call, originating in or intended for a *mobile station* or a *mobile earth station*, transmitted on all or part of its route over the *radiocommunication* channels of the *mobile service* or of the *mobile-satellite service*.

1.125 *simplex operation:* Operating method in which transmission is made possible alternately in each direction of a *telecommunication* channel, for example, by means of manual control[2].

1.126 *duplex operation:* Operating method in which transmission is possible simultaneously in both directions of a *telecommunication* channel[2].

1.127 *semi-duplex operation:* A method which is *simplex operation* at one end of the circuit and *duplex operation* at the other.[2]

1.128 *television:* A form of *telecommunication* for the transmission of transient images of fixed or moving objects.

1.129 *individual reception* (in the broadcasting-satellite service): The reception of *emissions* from a *space station* in the *broadcasting-satellite service* by simple domestic installations and in particular those possessing small antennas.

1.130 *community reception* (in the broadcasting-satellite service): The reception of *emissions* from a *space station* in the *broadcasting-satellite service* by receiving equipment, which in some cases may be complex and have antennas larger than those used for *individual reception*, and intended for use:

– by a group of the general public at one location; or

– through a distribution system covering a limited area.

1.131 *telemetry:* The use of *telecommunication* for automatically indicating or recording measurements at a distance from the measuring instrument.

1.132 *radiotelemetry: Telemetry* by means of *radio waves*.

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[2] **1.125.1**, **1.126.1** and **1.127.1** In general, *duplex operation* and *semi-duplex operation* require two frequencies in *radiocommunication*; *simplex operation* may use either one or two.

1.133 *space telemetry:* The use of *telemetry* for the transmission from a *space station* of results of measurements made in a *spacecraft*, including those relating to the functioning of the *spacecraft*.

1.134 *telecommand:* The use of *telecommunication* for the transmission of signals to initiate, modify or terminate functions of equipment at a distance.

1.135 *space telecommand:* The use of *radiocommunication* for the transmission of signals to a *space station* to initiate, modify or terminate functions of equipment on an associated space object, including the *space station*.

1.136 *space tracking:* Determination of the *orbit*, velocity or instantaneous position of an object in space by means of *radiodetermination*, excluding *primary radar*, for the purpose of following the movement of the object.

Section VI – Characteristics of emissions and radio equipment

1.137 *radiation:* The outward flow of energy from any source in the form of *radio waves*.

1.138 *emission: Radiation* produced, or the production of *radiation*, by a radio transmitting *station*.

For example, the energy radiated by the local oscillator of a radio receiver would not be an emission but a *radiation*.

1.139 *class of emission:* The set of characteristics of an *emission*, designated by standard symbols, e.g. type of modulation of the main carrier, modulating signal, type of information to be transmitted, and also, if appropriate, any additional signal characteristics.

1.140 *single-sideband emission:* An amplitude modulated *emission* with one sideband only.

1.141 *full carrier single-sideband emission:* A *single-sideband emission* without reduction of the carrier.

1.142 *reduced carrier single-sideband emission:* A *single-sideband emission* in which the degree of carrier suppression enables the carrier to be reconstituted and to be used for demodulation.

1.143 *suppressed carrier single-sideband emission:* A *single-sideband emission* in which the carrier is virtually suppressed and not intended to be used for demodulation.

1.144 *out-of-band emission**: *Emission* on a frequency or frequencies immediately outside the *necessary bandwidth* which results from the modulation process, but excluding *spurious emissions*.

1.145 *spurious emission**: *Emission* on a frequency or frequencies which are outside the *necessary bandwidth* and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic *emissions*, parasitic *emissions*, intermodulation products and frequency conversion products, but exclude *out-of-band emissions*.

1.146 *unwanted emissions**: Consist of *spurious emissions* and *out-of-band emissions*.

1.146A *out-of-band domain* (of an emission): The frequency range, immediately outside the *necessary bandwidth* but excluding the *spurious domain*, in which *out-of-band emissions* generally predominate. *Out-of-band emissions*, defined based on their source, occur in the out-of-band domain and, to a lesser extent, in the *spurious domain*. *Spurious emissions* likewise may occur in the out-of-band domain as well as in the *spurious domain*. (WRC-03)

1.146B *spurious domain* (of an emission): The frequency range beyond the *out-of-band domain* in which *spurious emissions* generally predominate. (WRC-03)

1.147 *assigned frequency band:* The frequency band within which the *emission* of a *station* is authorized; the width of the band equals the *necessary bandwidth* plus twice the absolute value of the *frequency tolerance*. Where *space stations* are concerned, the assigned frequency band includes twice the maximum Doppler shift that may occur in relation to any point of the Earth's surface.

1.148 *assigned frequency:* The centre of the frequency band assigned to a *station*.

1.149 *characteristic frequency:* A frequency which can be easily identified and measured in a given *emission*.

A carrier frequency may, for example, be designated as the characteristic frequency.

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* The terms associated with the definitions given by Nos. **1.144**, **1.145** and **1.146** shall be expressed in the working languages as follows:

Numbers	In French	In English	In Spanish	In Arabic	In Chinese	In Russian
1.144	Emission hors bande	Out-of-band emission	Emisión fuera de banda	بث خارج النطاق	带外发射	внеполосное излучение
1.145	Rayonnement non essentiel	Spurious emission	Emisión no esencial	بث هامشي	杂散发射	побочное излучение
1.146	Rayonnements non désirés	Unwanted emissions	Emisiones no deseadas	بث غير مطلوب	无用发射	нежелательные излучения

1.150 *reference frequency:* A frequency having a fixed and specified position with respect to the *assigned frequency*. The displacement of this frequency with respect to the *assigned frequency* has the same absolute value and sign that the displacement of the *characteristic frequency* has with respect to the centre of the frequency band occupied by the *emission*.

1.151 *frequency tolerance:* The maximum permissible departure by the centre frequency of the frequency band occupied by an *emission* from the *assigned frequency* or, by the *characteristic frequency* of an *emission* from the *reference frequency*.

The frequency tolerance is expressed in parts in 10^6 or in hertz.

1.152 *necessary bandwidth:* For a given *class of emission*, the width of the frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions.

1.153 *occupied bandwidth:* The width of a frequency band such that, below the lower and above the upper frequency limits, the *mean powers* emitted are each equal to a specified percentage $\beta/2$ of the total *mean power* of a given *emission*.

Unless otherwise specified in an ITU-R Recommendation for the appropriate *class of emission*, the value of $\beta/2$ should be taken as 0.5%.

1.154 *right-hand* (clockwise) *polarized wave:* An elliptically- or circularly-polarized wave, in which the electric field vector, observed in any fixed plane, normal to the direction of propagation, whilst looking in the direction of propagation, rotates with time in a right-hand or clockwise direction.

1.155 *left-hand* (anticlockwise) *polarized wave:* An elliptically- or circularly-polarized wave, in which the electric field vector, observed in any fixed plane, normal to the direction of propagation, whilst looking in the direction of propagation, rotates with time in a left-hand or anticlockwise direction.

1.156 *power:* Whenever the power of a radio transmitter, etc. is referred to it shall be expressed in one of the following forms, according to the class of *emission*, using the arbitrary symbols indicated:

– *peak envelope power* (PX or pX);

– *mean power* (PY or pY);

– *carrier power* (PZ or pZ).

For different *classes of emission*, the relationships between *peak envelope power*, *mean power* and *carrier power*, under the conditions of normal operation and of no modulation, are contained in ITU-R Recommendations which may be used as a guide.

For use in formulae, the symbol p denotes power expressed in watts and the symbol P denotes power expressed in decibels relative to a reference level.

1.157 *peak envelope power* (of a radio transmitter): The average power supplied to the antenna transmission line by a transmitter during one radio frequency cycle at the crest of the modulation envelope taken under normal operating conditions.

1.158 *mean power* (of a radio transmitter): The average power supplied to the antenna transmission line by a transmitter during an interval of time sufficiently long compared with the lowest frequency encountered in the modulation taken under normal operating conditions.

1.159 *carrier power* (of a radio transmitter): The average power supplied to the antenna transmission line by a transmitter during one radio frequency cycle taken under the condition of no modulation.

1.160 *gain of an antenna:* The ratio, usually expressed in decibels, of the power required at the input of a loss-free reference antenna to the power supplied to the input of the given antenna to produce, in a given direction, the same field strength or the same power flux-density at the same distance. When not specified otherwise, the gain refers to the direction of maximum *radiation*. The gain may be considered for a specified polarization.

Depending on the choice of the reference antenna a distinction is made between:

a) absolute or isotropic gain (G_i), when the reference antenna is an isotropic antenna isolated in space;

b) gain relative to a half-wave dipole (G_d), when the reference antenna is a half-wave dipole isolated in space whose equatorial plane contains the given direction;

c) gain relative to a short vertical antenna (G_v), when the reference antenna is a linear conductor, much shorter than one quarter of the wavelength, normal to the surface of a perfectly conducting plane which contains the given direction.

1.161 *equivalent isotropically radiated power (e.i.r.p.):* The product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna *(absolute or isotropic gain)*.

1.162 *effective radiated power (e.r.p.)* (in a given direction)*:* The product of the power supplied to the antenna and its *gain relative to a half-wave dipole* in a given direction.

1.163 *effective monopole radiated power (e.m.r.p.)* (in a given direction)*:* The product of the power supplied to the antenna and its *gain relative to a short vertical antenna* in a given direction.

1.164 *tropospheric scatter:* The propagation of *radio waves* by scattering as a result of irregularities or discontinuities in the physical properties of the troposphere.

1.165 *ionospheric scatter:* The propagation of *radio waves* by scattering as a result of irregularities or discontinuities in the ionization of the ionosphere.

Section VII – Frequency sharing

1.166 *interference:* The effect of unwanted energy due to one or a combination of *emissions*, *radiations*, or inductions upon reception in a *radiocommunication* system, manifested by any performance degradation, misinterpretation, or loss of information which could be extracted in the absence of such unwanted energy.

1.167 *permissible interference*[3]*:* Observed or predicted *interference* which complies with quantitative *interference* and sharing criteria contained in these Regulations or in ITU-R Recommendations or in special agreements as provided for in these Regulations.

1.168 *accepted interference*[3]*: Interference* at a higher level than that defined as *permissible interference* and which has been agreed upon between two or more *administrations* without prejudice to other *administrations*.

1.169 *harmful interference: Interference* which endangers the functioning of a *radionavigation service* or of other *safety services* or seriously degrades, obstructs, or repeatedly interrupts a *radiocommunication service* operating in accordance with Radio Regulations (CS).

1.170 *protection ratio* (R.F.): The minimum value of the wanted-to-unwanted signal ratio, usually expressed in decibels, at the receiver input, determined under specified conditions such that a specified reception quality of the wanted signal is achieved at the receiver output.

1.171 *coordination area:* When determining the need for coordination, the area surrounding an *earth station* sharing the same frequency band with *terrestrial stations*, or surrounding a transmitting *earth station* sharing the same bidirectionally allocated frequency band with receiving *earth stations*, beyond which the level of *permissible interference* will not be exceeded and coordination is therefore not required. (WRC-2000)

1.172 *coordination contour:* The line enclosing the *coordination area*.

1.173 *coordination distance:* When determining the need for coordination, the distance on a given azimuth from an *earth station* sharing the same frequency band with *terrestrial stations*, or from a transmitting *earth station* sharing the same bidirectionally allocated frequency band with receiving *earth stations*, beyond which the level of *permissible interference* will not be exceeded and coordination is therefore not required. (WRC-2000)

1.174 *equivalent satellite link noise temperature:* The noise temperature referred to the output of the receiving antenna of the *earth station* corresponding to the radio frequency noise power which produces the total observed noise at the output of the *satellite link* excluding noise due to *interference* coming from *satellite links* using other *satellites* and from terrestrial systems.

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[3] **1.167.1** and **1.168.1** The terms "*permissible interference*" and "*accepted interference*" are used in the coordination of frequency assignments between *administrations*.

1.175 *effective boresight area* (of a steerable satellite beam): An area on the surface of the Earth within which the boresight of a *steerable satellite beam* is intended to be pointed.

There may be more than one unconnected effective boresight area to which a single *steerable satellite beam* is intended to be pointed.

1.176 *effective antenna gain contour* (of a steerable satellite beam): An envelope of antenna gain contours resulting from moving the boresight of a *steerable satellite beam* along the limits of the *effective boresight area*.

Section VIII – Technical terms relating to space

1.177 *deep space:* Space at distances from the Earth equal to, or greater than, 2×10^6 km.

1.178 *spacecraft:* A man-made vehicle which is intended to go beyond the major portion of the Earth's atmosphere.

1.179 *satellite:* A body which revolves around another body of preponderant mass and which has a motion primarily and permanently determined by the force of attraction of that other body.

1.180 *active satellite:* A *satellite* carrying a *station* intended to transmit or retransmit *radiocommunication* signals.

1.181 *reflecting satellite:* A *satellite* intended to reflect *radiocommunication* signals.

1.182 *active sensor:* A measuring instrument in the *earth exploration-satellite service* or in the *space research service* by means of which information is obtained by transmission and reception of *radio waves*.

1.183 *passive sensor:* A measuring instrument in the *earth exploration-satellite service* or in the *space research service* by means of which information is obtained by reception of *radio waves* of natural origin.

1.184 *orbit:* The path, relative to a specified frame of reference, described by the centre of mass of a *satellite* or other object in space subjected primarily to natural forces, mainly the force of gravity.

1.185 *inclination of an orbit* (of an earth satellite): The angle determined by the plane containing the *orbit* and the plane of the Earth's equator measured in degrees between 0º and 180º and in counter-clockwise direction from the Earth's equatorial plane at the ascending node of the *orbit*. (WRC-2000)

1.186 *period* (of a satellite): The time elapsing between two consecutive passages of a *satellite* through a characteristic point on its *orbit*.

1.187 *altitude of the apogee* or *of the perigee:* The altitude of the apogee or perigee above a specified reference surface serving to represent the surface of the Earth.

1.188 *geosynchronous satellite:* An earth *satellite* whose period of revolution is equal to the period of rotation of the Earth about its axis.

1.189 *geostationary satellite:* A *geosynchronous satellite* whose circular and direct *orbit* lies in the plane of the Earth's equator and which thus remains fixed relative to the Earth; by extension, a *geosynchronous satellite* which remains approximately fixed relative to the Earth. (WRC-03)

1.190 *geostationary-satellite orbit:* The *orbit* of a *geosynchronous satellite* whose circular and direct *orbit* lies in the plane of the Earth's equator.

1.191 *steerable satellite beam:* A *satellite* antenna beam that can be re-pointed.

ARTICLE 2

Nomenclature

Section I – Frequency and wavelength bands

2.1 The radio spectrum shall be subdivided into nine frequency bands, which shall be designated by progressive whole numbers in accordance with the following table. As the unit of frequency is the hertz (Hz), frequencies shall be expressed:

– in kilohertz (kHz), up to and including 3 000 kHz;

– in megahertz (MHz), above 3 MHz, up to and including 3 000 MHz;

– in gigahertz (GHz), above 3 GHz, up to and including 3 000 GHz.

However, where adherence to these provisions would introduce serious difficulties, for example in connection with the notification and registration of frequencies, the lists of frequencies and related matters, reasonable departures may be made[1]. (WRC-15)

Band number	Symbols	Frequency range (lower limit exclusive, upper limit inclusive)	Corresponding metric subdivision
4	VLF	3 to 30 kHz	Myriametric waves
5	LF	30 to 300 kHz	Kilometric waves
6	MF	300 to 3 000 kHz	Hectometric waves
7	HF	3 to 30 MHz	Decametric waves
8	VHF	30 to 300 MHz	Metric waves
9	UHF	300 to 3 000 MHz	Decimetric waves
10	SHF	3 to 30 GHz	Centimetric waves
11	EHF	30 to 300 GHz	Millimetric waves
12		300 to 3 000 GHz	Decimillimetric waves

NOTE 1: "Band N" (N = band number) extends from 0.3×10^N Hz to 3×10^N Hz.
NOTE 2: Prefix: k = kilo (10^3), M = mega (10^6), G = giga (10^9).

2.2 In communications between administrations and the ITU, no names, symbols or abbreviations should be used for the various frequency bands other than those specified in No. **2.1**.

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[1] **2.1.1** In the application of the Radio Regulations, the Radiocommunication Bureau uses the following units:

kHz for frequencies up to 28 000 kHz inclusive

MHz for frequencies above 28 000 kHz up to 10 500 MHz inclusive

GHz for frequencies above 10 500 MHz.

Section II – Dates and times

2.3 Any date used in relation to radiocommunication shall be according to the Gregorian Calendar.

2.4 If in a date the month is not indicated either in full or in an abbreviated form, it shall be expressed in an all-numeric form with the fixed sequence of figures, two of each representing the day, month and year.

2.5 Whenever a date is used in connection with Coordinated Universal Time (UTC), this date shall be that at the prime meridian, the prime meridian corresponding to zero degrees geographical longitude. (WRC-15)

2.6 Whenever a specified time is used in international radiocommunication activities, UTC shall be applied, unless otherwise indicated, and it shall be presented as a four-digit group (0000-2359). The abbreviation UTC shall be used in all languages.

Section III – Designation of emissions

2.7 Emissions shall be designated according to their necessary bandwidth and their classification in accordance with the method described in Appendix **1**.

ARTICLE 3

Technical characteristics of stations

3.1 The choice and performance of equipment to be used in a station and any emissions therefrom shall satisfy the provisions of these Regulations.

3.2 Also, as far as is compatible with practical considerations, the choice of transmitting, receiving and measuring equipment shall be based on the most recent advances in the technique as indicated, *inter alia*, in ITU-R Recommendations.

3.3 Transmitting and receiving equipment intended to be used in a given part of the frequency spectrum should be designed to take into account the technical characteristics of transmitting and receiving equipment likely to be employed in neighbouring and other parts of the spectrum, provided that all technically and economically justifiable measures have been taken to reduce the level of unwanted emissions from the latter transmitting equipment and to reduce the susceptibility to interference of the latter receiving equipment.

3.4 To the maximum extent possible, equipment to be used in a station should apply signal processing methods which enable the most efficient use of the frequency spectrum in accordance with the relevant ITU-R Recommendations. These methods include, *inter alia*, certain bandwidth expansion techniques, and in particular, in amplitude-modulation systems, the use of the single-sideband technique.

3.5 Transmitting stations shall conform to the frequency tolerances specified in Appendix **2**.

3.6 Transmitting stations shall conform to the maximum permitted power levels for unwanted emissions in the spurious domain specified in Appendix **3**. (WRC-12)

3.7 Transmitting stations shall conform to the maximum permitted power levels for out-of-band emissions, or unwanted emissions in the out-of-band domain, specified for certain services and classes of emission in the present Regulations. In the absence of such specified maximum permitted power levels transmitting stations should, to the maximum extent possible, satisfy the requirements relating to the limitation of the out-of-band emissions, or unwanted emissions in the out-of-band domain, specified in the relevant ITU-R Recommendations. (WRC-12)

3.8 Moreover, every effort should be made to keep frequency tolerances and levels of unwanted emissions at the lowest values which the state of the technique and the nature of the service permit.

3.9 The bandwidths of emissions also shall be such as to ensure the most efficient utilization of the spectrum; in general this requires that bandwidths be kept at the lowest values which the state of the technique and the nature of the service permit. Appendix **1** is provided as a guide for the determination of the necessary bandwidth.

3.10 Where bandwidth-expansion techniques are used, the minimum spectral power density consistent with efficient spectrum utilization shall be employed.

3.11 Wherever necessary for efficient spectrum use, the receivers used by any service should comply as far as possible with the frequency tolerances of the transmitters of that service, due regard being paid to the Doppler effect where appropriate.

3.12 Receiving stations should use equipment with technical characteristics appropriate for the class of emission concerned; in particular, selectivity should be appropriate having regard to No. **3.9** on the bandwidths of emissions.

3.13 The performance characteristics of receivers should be adequate to ensure that they do not suffer from interference due to transmitters situated at a reasonable distance and which operate in accordance with these Regulations.

3.14 To ensure compliance with these Regulations, administrations shall arrange for frequent checks to be made of the emissions of stations under their jurisdiction. For this purpose, they shall use the means indicated in Article **16**, if required. The technique of measurements and the intervals of measurements to be employed shall be, as far as is practicable, in accordance with the most recent ITU-R Recommendations.

3.15 The use of damped wave emissions is forbidden in all stations.

CHAPTER II

Frequencies

ARTICLE 4

Assignment and use of frequencies

4.1 Member States shall endeavour to limit the number of frequencies and the spectrum used to the minimum essential to provide in a satisfactory manner the necessary services. To that end they shall endeavour to apply the latest technical advances as soon as possible (CS 195).

4.2 Member States undertake that in assigning frequencies to stations which are capable of causing harmful interference to the services rendered by the stations of another country, such assignments are to be made in accordance with the Table of Frequency Allocations and other provisions of these Regulations.

4.3 Any new assignment or any change of frequency or other basic characteristic of an existing assignment (see Appendix **4**) shall be made in such a way as to avoid causing harmful interference to services rendered by stations using frequencies assigned in accordance with the Table of Frequency Allocations in this Chapter and the other provisions of these Regulations, the characteristics of which assignments are recorded in the Master International Frequency Register.

4.4 Administrations of the Member States shall not assign to a station any frequency in derogation of either the Table of Frequency Allocations in this Chapter or the other provisions of these Regulations, except on the express condition that such a station, when using such a frequency assignment, shall not cause harmful interference to, and shall not claim protection from harmful interference caused by, a station operating in accordance with the provisions of the Constitution, the Convention and these Regulations.

4.5 The frequency assigned to a station of a given service shall be separated from the limits of the band allocated to this service in such a way that, taking account of the frequency band assigned to a station, no harmful interference is caused to services to which frequency bands immediately adjoining are allocated.

4.6 For the purpose of resolving cases of harmful interference, the radio astronomy service shall be treated as a radiocommunication service. However, with regard to emissions from services operating in other bands, it shall be afforded the same degree of protection as such services are afforded vis-à-vis each other.

4.7 For the purpose of resolving cases of harmful interference, the space research (passive) service and the earth exploration-satellite (passive) service shall be afforded protection from different services in other bands only to the extent that these different services are protected from each other.

4.8 Where, in adjacent Regions or sub-Regions, a band of frequencies is allocated to different services of the same category (see Sections I and II of Article **5**), the basic principle is the equality of right to operate. Accordingly, the stations of each service in one Region or sub-Region must operate so as not to cause harmful interference to any service of the same or higher category in the other Regions or sub-Regions. (WRC-03)

4.9 No provision of these Regulations prevents the use by a station in distress, or by a station providing assistance to it, of any means of radiocommunication at its disposal to attract attention, make known the condition and location of the station in distress, and obtain or provide assistance.

4.10 Member States recognize that the safety aspects of radionavigation and other safety services require special measures to ensure their freedom from harmful interference; it is necessary therefore to take this factor into account in the assignment and use of frequencies.

4.11 Member States recognize that among frequencies which have long-distance propagation characteristics, those in the bands between 5 MHz and 30 MHz are particularly useful for long-distance communications; they agree to make every possible effort to reserve these bands for such communications. Whenever frequencies in these bands are used for short- or medium-distance communications, the minimum power necessary shall be employed.

4.12 To reduce requirements for frequencies in the bands between 5 MHz and 30 MHz and thus to prevent harmful interference to long-distance radiocommunications, administrations are encouraged to use, whenever practicable, any other possible means of communication.

4.13 When special circumstances make it indispensable to do so, an administration may, as an exception to the normal methods of working authorized by these Regulations, have recourse to the special methods of working enumerated below, on the sole condition that the characteristics of the stations still conform to those inserted in the Master International Frequency Register:

4.14 *a)* a station in the fixed service or an earth station in the fixed-satellite service may, under the conditions defined in Nos. **5.28** to **5.31**, transmit to mobile stations on its normal frequencies;

4.15 *b)* a land station may communicate, under the conditions defined in Nos. **5.28** to **5.31**, with fixed stations in the fixed service or earth stations in the fixed-satellite service or other land stations of the same category.

4.15A (SUP - WRC-12)

4.16 However, in circumstances involving the safety of life, or the safety of a ship or aircraft, a land station may communicate with fixed stations or land stations of another category.

4.17 Any administration may assign a frequency in a band allocated to the fixed service or allocated to the fixed-satellite service to a station authorized to transmit, unilaterally, from one specified fixed point to one or more specified fixed points provided that such transmissions are not intended to be received directly by the general public.

4.18 Any mobile station using an emission which satisfies the frequency tolerance applicable to the coast station with which it is communicating may transmit on the same frequency as the coast station on condition that the latter requests such transmission and that no harmful interference is caused to other stations.

4.19 In certain cases provided for in Articles **31** and **51**, aircraft stations are authorized to use frequencies in the bands allocated to the maritime mobile service for the purpose of communicating with stations of that service (see No. **51.73**). (WRC-07)

4.20 Aircraft earth stations are authorized to use frequencies in the bands allocated to the maritime mobile-satellite service for the purpose of communicating, via the stations of that service, with the public telegraph and telephone networks.

4.21 In exceptional cases, land mobile earth stations in the land mobile-satellite service may communicate with stations in the maritime mobile-satellite and aeronautical mobile-satellite services. Such operations shall comply with the relevant provisions of the Radio Regulations relating to those services and shall be subject to agreement among administrations concerned, taking due account of No. **4.10**.

4.22 Any emission capable of causing harmful interference to distress, alarm, urgency or safety communications on the international distress and emergency frequencies established for these purposes by these Regulations is prohibited. Supplementary distress frequencies available on less than a worldwide basis should be afforded adequate protection.

4.23 Transmissions to or from high altitude platform stations shall be limited to bands specifically identified in Article **5**. (WRC-12)

4.24 Space research systems intended to operate in deep space may also use the space research service (deep space) allocations, with the same status as those allocations, when the spacecraft is near the Earth, such as during launch, early orbit, flying by the Earth and returning to the Earth. (WRC-15)

ARTICLE 5

Frequency allocations

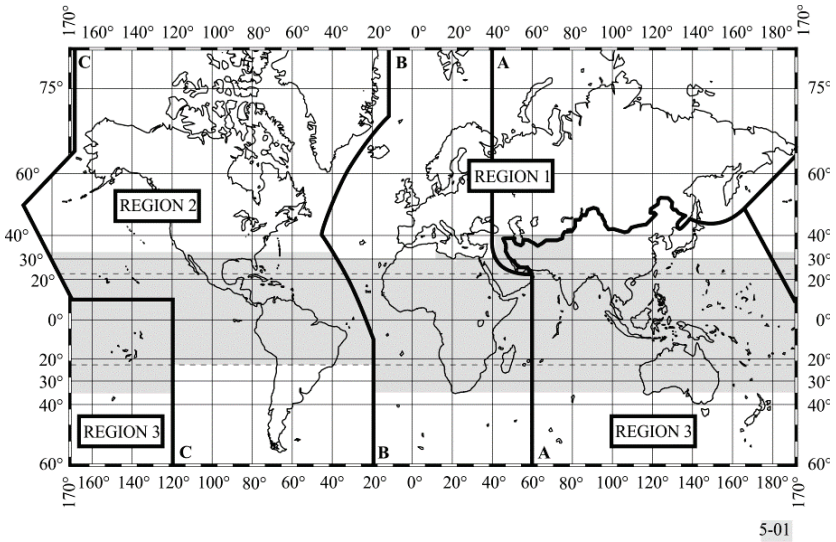
Introduction

5.1 In all documents of the Union where the terms *allocation*, *allotment* and *assignment* are to be used, they shall have the meaning given them in Nos. **1.16** to **1.18**, the terms used in the six working languages being as follows:

Frequency distribution to	French	English	Spanish	Arabic	Chinese	Russian
Services	Attribution (attribuer)	Allocation (to allocate)	Atribución (atribuir)	توزيع (يوزع)	划分	распределение (распределять)
Areas or countries	Allotissement (allotir)	Allotment (to allot)	Adjudicación (adjudicar)	تعيين (يعين)	分配	выделение (выделять)
Stations	Assignation (assigner)	Assignment (to assign)	Asignación (asignar)	تخصيص (يخصص)	指配	присвоение (присваивать)

Section I – Regions and areas

5.2 For the allocation of frequencies the world has been divided into three Regions[1] as shown on the following map and described in Nos. **5.3** to **5.9**:



The shaded part represents the Tropical Zones as defined in Nos. **5.16** to **5.20** and **5.21**.

[1] **5.2.1** It should be noted that where the words "regions" or "regional" are without a capital "R" in these Regulations, they do not relate to the three Regions here defined for purposes of frequency allocation.

5.3 *Region 1:* Region 1 includes the area limited on the east by line A (lines A, B and C are defined below) and on the west by line B, excluding any of the territory of the Islamic Republic of Iran which lies between these limits. It also includes the whole of the territory of Armenia, Azerbaijan, the Russian Federation, Georgia, Kazakhstan, Mongolia, Uzbekistan, Türkiye, Kyrgyzstan, Tajikistan, Turkmenistan and Ukraine and the area to the north of Russian Federation which lies between lines A and C. (WRC-23)

5.4 *Region 2:* Region 2 includes the area limited on the east by line B and on the west by line C.

5.5 *Region 3:* Region 3 includes the area limited on the east by line C and on the west by line A, except any of the territory of Armenia, Azerbaijan, the Russian Federation, Georgia, Kazakhstan, Mongolia, Uzbekistan, Türkiye, Kyrgyzstan, Tajikistan, Turkmenistan and Ukraine and the area to the north of Russian Federation. It also includes that part of the territory of the Islamic Republic of Iran lying outside of those limits. (WRC-23)

5.6 The lines A, B and C are defined as follows:

5.7 *Line A:* Line A extends from the North Pole along meridian 40° East of Greenwich to parallel 40° North; thence by great circle arc to the intersection of meridian 60° East and the Tropic of Cancer; thence along the meridian 60° East to the South Pole.

5.8 *Line B:* Line B extends from the North Pole along meridian 10° West of Greenwich to its intersection with parallel 72° North; thence by great circle arc to the intersection of meridian 50° West and parallel 40° North; thence by great circle arc to the intersection of meridian 20° West and parallel 10° South; thence along meridian 20° West to the South Pole.

5.9 *Line C:* Line C extends from the North Pole by great circle arc to the intersection of parallel 65° 30′ North with the international boundary in Bering Strait; thence by great circle arc to the intersection of meridian 165° East of Greenwich and parallel 50° North; thence by great circle arc to the intersection of meridian 170° West and parallel 10° North; thence along parallel 10° North to its intersection with meridian 120° West; thence along meridian 120° West to the South Pole.

5.10 For the purposes of these Regulations, the term “African Broadcasting Area” means:

5.11 *a)* African countries, parts of countries, territories and groups of territories situated between the parallels 40° South and 30° North;

5.12 *b)* islands in the Indian Ocean west of meridian 60° East of Greenwich, situated between the parallel 40° South and the great circle arc joining the points 45° East, 11° 30′ North and 60° East, 15° North;

5.13 *c)* islands in the Atlantic Ocean east of line B defined in No. **5.8** of these Regulations, situated between the parallels 40° South and 30° North.

5.14 The "European Broadcasting Area" is bounded on the west by the western boundary of Region 1, on the east by the meridian 40° East of Greenwich and on the south by the parallel 30° North so as to include the northern part of Saudi Arabia and that part of those countries bordering the Mediterranean within these limits. In addition, Armenia, Azerbaijan, Georgia and those parts of the territories of Iraq, Jordan, Syrian Arab Republic, Türkiye and Ukraine lying outside the above limits are included in the European Broadcasting Area. (WRC-23)

5.15 The "European Maritime Area" is bounded to the north by a line extending along parallel 72° North from its intersection with meridian 55° East of Greenwich to its intersection with meridian 5° West, then along meridian 5° West to its intersection with parallel 67° North, thence along parallel 67° North to its intersection with meridian 32° West; to the west by a line extending along meridian 32° West to its intersection with parallel 30° North; to the south by a line extending along parallel 30° North to its intersection with meridian 43° East; to the east by a line extending along meridian 43° East to its intersection with parallel 60° North, thence along parallel 60° North to its intersection with meridian 55° East and thence along meridian 55° East to its intersection with parallel 72° North.

5.16 1) The "Tropical Zone" (see map in No. **5.2**) is defined as:

5.17 *a)* the whole of that area in Region 2 between the Tropics of Cancer and Capricorn;

5.18 *b)* the whole of that area in Regions 1 and 3 contained between the parallels 30° North and 35° South with the addition of:

5.19 i) The area contained between the meridians 40° East and 80° East of Greenwich and the parallels 30° North and 40° North;

5.20 ii) that part of Libya north of parallel 30° North.

5.21 2) In Region 2, the Tropical Zone may be extended to parallel 33° North, subject to special agreements between the countries concerned in that Region (see Article **6**).

5.22 A sub-Region is an area consisting of two or more countries in the same Region.

Section II – Categories of services and allocations

5.23 *Primary and secondary services*

5.24 1) Where, in a box of the Table in Section IV of this Article, a band is indicated as allocated to more than one service, either on a worldwide or Regional basis, such services are listed in the following order:

5.25 *a)* services the names of which are printed in "capitals" (example: FIXED); these are called "primary" services;

5.26 *b)* services the names of which are printed in "normal characters" (example: Mobile); these are called "secondary" services (see Nos. **5.28** to **5.31**).

5.27 2) Additional remarks shall be printed in normal characters (example: MOBILE except aeronautical mobile).

5.28 3) Stations of a secondary service:

5.29 *a)* shall not cause harmful interference to stations of primary services to which frequencies are already assigned or to which frequencies may be assigned at a later date;

5.30 *b)* cannot claim protection from harmful interference from stations of a primary service to which frequencies are already assigned or may be assigned at a later date;

5.31 *c)* can claim protection, however, from harmful interference from stations of the same or other secondary service(s) to which frequencies may be assigned at a later date.

5.32 4) Where a band is indicated in a footnote of the Table as allocated to a service "on a secondary basis" in an area smaller than a Region, or in a particular country, this is a secondary service (see Nos. **5.28** to **5.31**).

5.33 5) Where a band is indicated in a footnote of the Table as allocated to a service "on a primary basis", in an area smaller than a Region, or in a particular country, this is a primary service only in that area or country.

5.34 *Additional allocations*

5.35 1) Where a band is indicated in a footnote of the Table as "also allocated" to a service in an area smaller than a Region, or in a particular country, this is an "additional" allocation, i.e. an allocation which is added in this area or in this country to the service or services which are indicated in the Table (see No. **5.36**).

5.36 2) If the footnote does not include any restriction on the service or services concerned apart from the restriction to operate only in a particular area or country, stations of this service or these services shall have equality of right to operate with stations of the other primary service or services indicated in the Table.

5.37 3) If restrictions are imposed on an additional allocation in addition to the restriction to operate only in a particular area or country, this is indicated in the footnote of the Table.

5.38 *Alternative allocations*

5.39 1) Where a band is indicated in a footnote of the Table as "allocated" to one or more services in an area smaller than a Region, or in a particular country, this is an "alternative" allocation, i.e. an allocation which replaces, in this area or in this country, the allocation indicated in the Table (see No. **5.40**).

5.40 2) If the footnote does not include any restriction on stations of the service or services concerned, apart from the restriction to operate only in a particular area or country, these stations of such a service or services shall have an equality of right to operate with stations of the primary service or services, indicated in the Table, to which the band is allocated in other areas or countries.

5.41 3) If restrictions are imposed on stations of a service to which an alternative allocation is made, in addition to the restriction to operate only in a particular country or area, this is indicated in the footnote.

5.42 *Miscellaneous provisions*

5.43 1) Where it is indicated in these Regulations that a service or stations in a service may operate in a specific frequency band subject to not causing harmful interference to another service or to another station in the same service, this means also that the service which is subject to not causing harmful interference cannot claim protection from harmful interference caused by the other service or other station in the same service. (WRC-2000)

5.43A 1*bis*) Where it is indicated in these Regulations that a service or stations in a service may operate in a specific frequency band subject to not claiming protection from another service or from another station in the same service, this means also that the service which is subject to not claiming protection shall not cause harmful interference to the other service or other station in the same service. (WRC-2000)

5.44 2) Except if otherwise specified in a footnote, the term "fixed service", where appearing in Section IV of this Article, does not include systems using ionospheric scatter propagation.

5.45 Not used.

Section III – Description of the Table of Frequency Allocations

5.46 1) The heading of the Table in Section IV of this Article includes three columns, each of which corresponds to one of the Regions (see No. **5.2**). Where an allocation occupies the whole of the width of the Table or only one or two of the three columns, this is a worldwide allocation or a Regional allocation, respectively.

5.47 2) The frequency band referred to in each allocation is indicated in the left-hand top corner of the part of the Table concerned.

5.48 3) Within each of the categories specified in Nos. **5.25** and **5.26**, services are listed in alphabetical order according to the French language. The order of listing does not indicate relative priority within each category.

5.49 4) In the case where there is a parenthetical addition to an allocation in the Table, that service allocation is restricted to the type of operation so indicated.

5.50 5) The footnote references which appear in the Table below the allocated service or services apply to more than one of the allocated services, or to the whole of the allocation concerned. (WRC-2000)

5.51 6) The footnote references which appear to the right of the name of a service are applicable only to that particular service.

5.52 7) In certain cases, the names of countries appearing in the footnotes have been simplified in order to shorten the text.

Section IV – Table of Frequency Allocations
(See No. **2.1**)

8.3-110 kHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
Below 8.3	(Not allocated) 5.53 5.54	
8.3-9	METEOROLOGICAL AIDS 5.54A 5.54B 5.54C	
9-11.3	METEOROLOGICAL AIDS 5.54A RADIONAVIGATION	
11.3-14	RADIONAVIGATION	
14-19.95	FIXED MARITIME MOBILE 5.57 5.55 5.56	
19.95-20.05	STANDARD FREQUENCY AND TIME SIGNAL (20 kHz)	
20.05-70	FIXED MARITIME MOBILE 5.57 5.56 5.58	
70-72 RADIONAVIGATION 5.60	**70-90** FIXED MARITIME MOBILE 5.57 MARITIME RADIO-NAVIGATION 5.60 Radiolocation	**70-72** RADIONAVIGATION 5.60 Fixed Maritime mobile 5.57 5.59
72-84 FIXED MARITIME MOBILE 5.57 RADIONAVIGATION 5.60 5.56		**72-84** FIXED MARITIME MOBILE 5.57 RADIONAVIGATION 5.60
84-86 RADIONAVIGATION 5.60		**84-86** RADIONAVIGATION 5.60 Fixed Maritime mobile 5.57 5.59
86-90 FIXED MARITIME MOBILE 5.57 RADIONAVIGATION 5.56	5.61	**86-90** FIXED MARITIME MOBILE 5.57 RADIONAVIGATION 5.60
90-110	RADIONAVIGATION 5.62 Fixed 5.64	

5.53 Administrations authorizing the use of frequencies below 8.3 kHz shall ensure that no harmful interference is caused to services to which the bands above 8.3 kHz are allocated. (WRC-12)

5.54 Administrations conducting scientific research using frequencies below 8.3 kHz are urged to advise other administrations that may be concerned in order that such research may be afforded all practicable protection from harmful interference. (WRC-12)

5.54A Use of the 8.3-11.3 kHz frequency band by stations in the meteorological aids service is limited to passive use only. In the band 9-11.3 kHz, meteorological aids stations shall not claim protection from stations of the radionavigation service submitted for notification to the Bureau prior to 1 January 2013. For sharing between stations of the meteorological aids service and stations in the radionavigation service submitted for notification after this date, the most recent version of Recommendation ITU-R RS.1881 should be applied. (WRC-12)

5.54B *Additional allocation:* in Algeria, Saudi Arabia, Bahrain, Egypt, the United Arab Emirates, the Russian Federation, Iran (Islamic Republic of), Iraq, Kuwait, Lebanon, Morocco, Qatar, the Syrian Arab Republic, Sudan and Tunisia, the frequency band 8.3-9 kHz is also allocated to the radionavigation, fixed and mobile services on a primary basis. (WRC-15)

5.54C *Additional allocation:* in China, the frequency band 8.3-9 kHz is also allocated to the maritime radionavigation and maritime mobile services on a primary basis. (WRC-12)

5.55 *Additional allocation:* in Armenia, the Russian Federation, Georgia, Kyrgyzstan, Tajikistan and Turkmenistan, the frequency band 14-17 kHz is also allocated to the radionavigation service on a primary basis. (WRC-15)

5.56 The stations of services to which the frequency bands 14-19.95 kHz and 20.05-70 kHz and in Region 1 also the frequency bands 72-84 kHz and 86-90 kHz are allocated may transmit standard frequency and time signals. Such stations shall be afforded protection from harmful interference. In Armenia, Azerbaijan, Belarus, the Russian Federation, Georgia, Kyrgyzstan, Tajikistan and Turkmenistan, the frequencies 25 kHz and 50 kHz will be used for this purpose under the same conditions. (WRC-23)

5.57 The use of the bands 14-19.95 kHz, 20.05-70 kHz and 70-90 kHz (72-84 kHz and 86-90 kHz in Region 1) by the maritime mobile service is limited to coast radiotelegraph stations (A1A and F1B only). Exceptionally, the use of class J2B or J7B emissions is authorized subject to the necessary bandwidth not exceeding that normally used for class A1A or F1B emissions in the band concerned.

5.58 *Additional allocation:* in Armenia, Azerbaijan, the Russian Federation, Georgia, Kyrgyzstan, Tajikistan and Turkmenistan, the frequency band 67-70 kHz is also allocated to the radionavigation service on a primary basis. (WRC-23)

5.59 *Different category of service:* in Bangladesh and Pakistan, the allocation of the bands 70-72 kHz and 84-86 kHz to the fixed and maritime mobile services is on a primary basis (see No. **5.33**). (WRC-2000)

5.60 In the bands 70-90 kHz (70-86 kHz in Region 1) and 110-130 kHz (112-130 kHz in Region 1), pulsed radionavigation systems may be used on condition that they do not cause harmful interference to other services to which these bands are allocated.

5.61 In Region 2, the establishment and operation of stations in the maritime radionavigation service in the bands 70-90 kHz and 110-130 kHz shall be subject to agreement obtained under No. **9.21** with administrations whose services, operating in accordance with the Table, may be affected. However, stations of the fixed, maritime mobile and radiolocation services shall not cause harmful interference to stations in the maritime radionavigation service established under such agreements.

5.62 Administrations which operate stations in the radionavigation service in the band 90-110 kHz are urged to coordinate technical and operating characteristics in such a way as to avoid harmful interference to the services provided by these stations.

5.63 (SUP - WRC-97)

5.64 Only classes A1A or F1B, A2C, A3C, F1C or F3C emissions are authorized for stations of the fixed service in the bands allocated to this service between 90 kHz and 160 kHz (148.5 kHz in Region 1) and for stations of the maritime mobile service in the bands allocated to this service between 110 kHz and 160 kHz (148.5 kHz in Region 1). Exceptionally, class J2B or J7B emissions are also authorized in the bands between 110 kHz and 160 kHz (148.5 kHz in Region 1) for stations of the maritime mobile service.

110-255 kHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
110-112 FIXED MARITIME MOBILE RADIONAVIGATION 5.64	**110-130** FIXED MARITIME MOBILE MARITIME RADIO-NAVIGATION 5.60 Radiolocation	**110-112** FIXED MARITIME MOBILE RADIONAVIGATION 5.60 5.64
112-115 RADIONAVIGATION 5.60		**112-117.6** RADIONAVIGATION 5.60 Fixed Maritime mobile 5.64 5.65
115-117.6 RADIONAVIGATION 5.60 Fixed Maritime mobile 5.64 5.66		
117.6-126 FIXED MARITIME MOBILE RADIONAVIGATION 5.60 5.64		**117.6-126** FIXED MARITIME MOBILE RADIONAVIGATION 5.60 5.64
126-129 RADIONAVIGATION 5.60		**126-129** RADIONAVIGATION 5.60 Fixed Maritime mobile 5.64 5.65
129-130 FIXED MARITIME MOBILE RADIONAVIGATION 5.60 5.64	5.61 5.64	**129-130** FIXED MARITIME MOBILE RADIONAVIGATION 5.60 5.64
130-135.7 FIXED MARITIME MOBILE 5.64 5.67	**130-135.7** FIXED MARITIME MOBILE 5.64	**130-135.7** FIXED MARITIME MOBILE RADIONAVIGATION 5.64
135.7-137.8 FIXED MARITIME MOBILE Amateur 5.67A 5.64 5.67 5.67B	**135.7-137.8** FIXED MARITIME MOBILE Amateur 5.67A 5.64	**135.7-137.8** FIXED MARITIME MOBILE RADIONAVIGATION Amateur 5.67A 5.64 5.67B
137.8-148.5 FIXED MARITIME MOBILE 5.64 5.67	**137.8-160** FIXED MARITIME MOBILE 5.64	**137.8-160** FIXED MARITIME MOBILE RADIONAVIGATION 5.64
148.5-255 BROADCASTING 5.68 5.69 5.70	**160-190** FIXED	**160-190** FIXED Aeronautical radionavigation
	190-200 AERONAUTICAL RADIONAVIGATION	

5.65 *Different category of service:* in Bangladesh, the allocation of the bands 112-117.6 kHz and 126-129 kHz to the fixed and maritime mobile services is on a primary basis (see No. **5.33**). (WRC-2000)

5.66 *Different category of service:* in Germany, the allocation of the band 115-117.6 kHz to the fixed and maritime mobile services is on a primary basis (see No. **5.33**) and to the radionavigation service on a secondary basis (see No. **5.32**).

5.67 *Additional allocation:* in Kyrgyzstan and Turkmenistan, the frequency band 130-148.5 kHz is also allocated to the radionavigation service on a secondary basis. Within and between these countries this service shall have an equal right to operate. (WRC-19)

5.67A Stations in the amateur service using frequencies in the band 135.7-137.8 kHz shall not exceed a maximum radiated power of 1 W (e.i.r.p.) and shall not cause harmful interference to stations of the radionavigation service operating in countries listed in No. **5.67**. (WRC-07)

5.67B The use of the frequency band 135.7-137.8 kHz in Algeria, Egypt, Iraq, Lebanon, Syrian Arab Republic, Sudan, South Sudan and Tunisia is limited to the fixed and maritime mobile services. The amateur service shall not be used in the above-mentioned countries in the frequency band 135.7-137.8 kHz, and this should be taken into account by the countries authorizing such use. (WRC-19)

5.68 *Alternative allocation:* in Congo (Rep. of the), the Dem. Rep. of the Congo and South Africa, the frequency band 160-200 kHz is allocated to the fixed service on a primary basis. (WRC-15)

5.69 *Additional allocation:* in Somalia, the band 200-255 kHz is also allocated to the aeronautical radionavigation service on a primary basis.

5.70 *Alternative allocation:* in Angola, Botswana, Burundi, the Central African Rep., Congo (Rep. of the), Eswatini, Ethiopia, Kenya, Lesotho, Madagascar, Malawi, Mozambique, Namibia, Nigeria, Oman, the Dem. Rep. of the Congo, South Africa, Tanzania, Chad, Zambia and Zimbabwe, the frequency band 200-283.5 kHz is allocated to the aeronautical radionavigation service on a primary basis. (WRC-19)

200-415 kHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td rowspan="2"></td><td rowspan="2">200-275
AERONAUTICAL RADIONAVIGATION
Aeronautical mobile</td><td rowspan="3">200-285
AERONAUTICAL RADIONAVIGATION
Aeronautical mobile</td></tr>
<tr><td rowspan="2">255-283.5
BROADCASTING
AERONAUTICAL RADIONAVIGATION
5.70</td></tr>
<tr><td>275-285
AERONAUTICAL RADIONAVIGATION
Aeronautical mobile
Maritime radionavigation (radiobeacons)</td></tr>
<tr><td rowspan="2">283.5-315
AERONAUTICAL RADIONAVIGATION
MARITIME RADIONAVIGATION (radiobeacons) 5.73
5.74</td><td colspan="2">285-315
AERONAUTICAL RADIONAVIGATION
MARITIME RADIONAVIGATION (radiobeacons) 5.73</td></tr>
<tr><td>315-325
AERONAUTICAL RADIONAVIGATION
Maritime radionavigation (radiobeacons) 5.73
5.75</td><td>315-325
MARITIME RADIONAVIGATION (radiobeacons) 5.73
Aeronautical radionavigation</td><td>315-325
AERONAUTICAL RADIONAVIGATION
MARITIME RADIONAVIGATION (radiobeacons) 5.73</td></tr>
<tr><td rowspan="2">325-405
AERONAUTICAL RADIONAVIGATION</td><td>325-335
AERONAUTICAL RADIONAVIGATION
Aeronautical mobile
Maritime radionavigation (radiobeacons)</td><td rowspan="2">325-405
AERONAUTICAL RADIONAVIGATION
Aeronautical mobile</td></tr>
<tr><td>335-405
AERONAUTICAL RADIONAVIGATION
Aeronautical mobile</td></tr>
<tr><td>405-415
RADIONAVIGATION 5.76</td><td colspan="2">405-415
RADIONAVIGATION 5.76
Aeronautical mobile</td></tr>
</table>

5.71 (SUP - WRC-19)

5.72 (SUP - WRC-12)

5.73 The band 285-325 kHz (283.5-325 kHz in Region 1) in the maritime radionavigation service may be used to transmit supplementary navigational information using narrow-band techniques, on condition that no harmful interference is caused to radiobeacon stations operating in the radionavigation service. (WRC-97)

5.74 *Additional Allocation:* in Region 1, the frequency band 285.3-285.7 kHz is also allocated to the maritime radionavigation service (other than radiobeacons) on a primary basis.

5.75 *Different category of service:* in Armenia, Azerbaijan, Belarus, the Russian Federation, Georgia, Moldova, Kyrgyzstan, Tajikistan, Turkmenistan, Ukraine and the Black Sea areas of Romania, the allocation of the band 315-325 kHz to the maritime radionavigation service is on a primary basis under the condition that in the Baltic Sea area, the assignment of frequencies in this band to new stations in the maritime or aeronautical radionavigation services shall be subject to prior consultation between the administrations concerned. (WRC-07)

5.76 The frequency 410 kHz is designated for radio direction-finding in the maritime radionavigation service. The other radionavigation services to which the band 405-415 kHz is allocated shall not cause harmful interference to radio direction-finding in the band 406.5-413.5 kHz.

415-495 kHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
415-435 MARITIME MOBILE 5.79 AERONAUTICAL RADIONAVIGATION	**415-472** MARITIME MOBILE 5.79 Aeronautical radionavigation 5.77 5.78 5.80	
435-472 MARITIME MOBILE 5.79 Aeronautical radionavigation 5.77 5.82	5.82	
472-479 MARITIME MOBILE 5.79 Amateur 5.80A Aeronautical radionavigation 5.77 5.80 5.80B 5.82		
479-495 MARITIME MOBILE 5.79 5.79A Aeronautical radionavigation 5.77 5.82	**479-495** MARITIME MOBILE 5.79 5.79A Aeronautical radionavigation 5.77 5.80 5.82	

5.77 *Different category of service:* in Australia, China, the French overseas communities of Region 3, Korea (Rep. of), India, Iran (Islamic Republic of), Japan, Pakistan, Papua New Guinea, the Dem. People's Rep. of Korea and Sri Lanka, the allocation of the frequency band 415-495 kHz to the aeronautical radionavigation service is on a primary basis. In Armenia, Azerbaijan, Belarus, the Russian Federation, Kazakhstan, Latvia, Uzbekistan and Kyrgyzstan, the allocation of the frequency band 435-495 kHz to the aeronautical radionavigation service is on a primary basis. Administrations in all the aforementioned countries shall take all practical steps necessary to ensure that aeronautical radionavigation stations in the frequency band 435-495 kHz do not cause interference to reception by coast stations of transmissions from ship stations on frequencies designated for ship stations on a worldwide basis. (WRC-19)

5.78 *Different category of service:* in Cuba, the United States of America and Mexico, the allocation of the band 415-435 kHz to the aeronautical radionavigation service is on a primary basis.

5.79 In the maritime mobile service, the frequency bands 415-495 kHz and 505-526.5 kHz are limited to radiotelegraphy and may also be used for the NAVDAT system in accordance with the most recent version of Recommendation ITU-R M.2010, subject to agreement between interested and affected administrations. NAVDAT transmitting stations are limited to coast stations. (WRC-19)

5.79A When establishing coast stations in the NAVTEX service on the frequencies 490 kHz, 518 kHz and 4 209.5 kHz, administrations are strongly recommended to coordinate the operating characteristics in accordance with the procedures of the International Maritime Organization (IMO) (see Resolution **339 (Rev.WRC-07)**). (WRC-07)

5.80 In Region 2, the use of the band 435-495 kHz by the aeronautical radionavigation service is limited to non-directional beacons not employing voice transmission.

5.80A The maximum equivalent isotropically radiated power (e.i.r.p.) of stations in the amateur service using frequencies in the band 472-479 kHz shall not exceed 1 W. Administrations may increase this limit of e.i.r.p. to 5 W in portions of their territory which are at a distance of over 800 km from the borders of Algeria, Saudi Arabia, Azerbaijan, Bahrain, Belarus, China, Comoros, Djibouti, Egypt, United Arab Emirates, the Russian Federation, Iran (Islamic Republic of), Iraq, Jordan, Kazakhstan, Kuwait, Lebanon, Libya, Morocco, Mauritania, Oman, Uzbekistan, Qatar, Syrian Arab Republic, Kyrgyzstan, Somalia, Sudan, Tunisia, Ukraine and Yemen. In this frequency band, stations in the amateur service shall not cause harmful interference to, or claim protection from, stations of the aeronautical radionavigation service. (WRC-12)

5.80B The use of the frequency band 472-479 kHz in Algeria, Saudi Arabia, Azerbaijan, Bahrain, Belarus, China, Comoros, Djibouti, Egypt, United Arab Emirates, the Russian Federation, Iraq, Jordan, Kazakhstan, Kuwait, Lebanon, Libya, Mauritania, Oman, Uzbekistan, Qatar, Syrian Arab Republic, Kyrgyzstan, Somalia, Sudan, Tunisia and Yemen is limited to the maritime mobile and aeronautical radionavigation services. The amateur service shall not be used in the above-mentioned countries in this frequency band, and this should be taken into account by the countries authorizing such use. (WRC-12)

5.81 (SUP - WRC-2000)

5.82 In the maritime mobile service, the frequency 490 kHz is to be used exclusively for the transmission by coast stations of navigational and meteorological warnings and urgent information to ships, by means of narrow-band direct-printing telegraphy. The conditions for use of the frequency 490 kHz are prescribed in Articles **31** and **52**. In using the frequency band 415-495 kHz for the aeronautical radionavigation service, administrations are requested to ensure that no harmful interference is caused to the frequency 490 kHz. In using the frequency band 472-479 kHz for the amateur service, administrations shall ensure that no harmful interference is caused to the frequency 490 kHz. (WRC-12)

495-1 800 kHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
495-505	MARITIME MOBILE 5.82C 5.82D	
505-526.5 MARITIME MOBILE 5.79 5.79A 5.84 AERONAUTICAL RADIONAVIGATION	**505-510** MARITIME MOBILE 5.79 **510-525** MARITIME MOBILE 5.79A 5.84 AERONAUTICAL RADIONAVIGATION **525-535** BROADCASTING 5.86 AERONAUTICAL RADIONAVIGATION	**505-526.5** MARITIME MOBILE 5.79 5.79A 5.84 AERONAUTICAL RADIONAVIGATION Aeronautical mobile Land mobile
526.5-1 606.5 BROADCASTING 5.87 5.87A		**526.5-535** BROADCASTING Mobile 5.88
	535-1 605 BROADCASTING **1 605-1 625** BROADCASTING 5.89 5.90	**535-1 606.5** BROADCASTING
1 606.5-1 625 FIXED MARITIME MOBILE 5.90 LAND MOBILE 5.92		**1 606.5-1 800** FIXED MOBILE RADIOLOCATION RADIONAVIGATION 5.91
1 625-1 635 RADIOLOCATION 5.93	**1 625-1 705** FIXED MOBILE BROADCASTING 5.89 Radiolocation 5.90	
1 635-1 800 FIXED MARITIME MOBILE 5.90 LAND MOBILE 5.92 5.96	**1 705-1 800** FIXED MOBILE RADIOLOCATION AERONAUTICAL RADIONAVIGATION	

5.82A (SUP - WRC-12)

5.82B (SUP - WRC-12)

5.82C The frequency band 495-505 kHz is used for the international NAVDAT system as described in the most recent version of Recommendation ITU-R M.2010. NAVDAT transmitting stations are limited to coast stations. (WRC-19)

5.82D When establishing coast stations in the NAVDAT system on the frequencies 500 kHz and 4 226 kHz, the conditions for the use of the frequencies 500 kHz and 4 226 kHz are prescribed in Articles **31** and **52**. Administrations are strongly recommended to coordinate the NAVDAT systems operating characteristics in accordance with the procedures of the International Maritime Organization (IMO) (see Resolution **364 (WRC-23)**). (WRC-23)

5.83 (SUP - WRC-07)

5.84 The conditions for the use of the frequency 518 kHz by the maritime mobile service are prescribed in Articles **31** and **52**. (WRC-07)

5.85 Not used.

5.86 In Region 2, in the band 525-535 kHz the carrier power of broadcasting stations shall not exceed 1 kW during the day and 250 W at night.

5.87 *Additional allocation:* in Angola, Botswana, Eswatini, Lesotho, Malawi, Mozambique, Namibia and Niger, the frequency band 526.5-535 kHz is also allocated to the mobile service on a secondary basis. (WRC-19)

5.87A *Additional allocation:* in Uzbekistan, the band 526.5-1 606.5 kHz is also allocated to the radionavigation service on a primary basis. Such use is subject to agreement obtained under No. **9.21** with administrations concerned and limited to ground-based radiobeacons in operation on 27 October 1997 until the end of their lifetime. (WRC-97)

5.88 *Additional allocation:* in China, the band 526.5-535 kHz is also allocated to the aeronautical radionavigation service on a secondary basis.

5.89 In Region 2, the use of the band 1 605-1 705 kHz by stations of the broadcasting service is subject to the Plan established by the Regional Administrative Radio Conference (Rio de Janeiro, 1988).

The examination of frequency assignments to stations of the fixed and mobile services in the band 1 625-1 705 kHz shall take account of the allotments appearing in the Plan established by the Regional Administrative Radio Conference (Rio de Janeiro, 1988).

5.90 In the band 1 605-1 705 kHz, in cases where a broadcasting station of Region 2 is concerned, the service area of the maritime mobile stations in Region 1 shall be limited to that provided by ground-wave propagation.

5.91 *Additional allocation:* in the Philippines and Sri Lanka, the band 1 606.5-1 705 kHz is also allocated to the broadcasting service on a secondary basis. (WRC-97)

5.92 Some countries of Region 1 use radiodetermination systems in the bands 1 606.5-1 625 kHz, 1 635-1 800 kHz, 1 850-2 160 kHz, 2 194-2 300 kHz, 2 502-2 850 kHz and 3 500-3 800 kHz, subject to agreement obtained under No. **9.21**. The radiated mean power of these stations shall not exceed 50 W.

5.93 *Additional allocation:* in Armenia, Azerbaijan, Belarus, the Russian Federation, Georgia, Hungary, Kazakhstan, Latvia, Lithuania, Mongolia, Nigeria, Uzbekistan, Poland, Kyrgyzstan, Slovakia, Tajikistan, Chad, Turkmenistan and Ukraine, the frequency bands 1 625-1 635 kHz, 1 800-1 810 kHz and 2 160-2 170 kHz are also allocated to the fixed and land mobile services on a primary basis, subject to agreement obtained under No. **9.21**. (WRC-15)

5.94 and **5.95** Not used.

5.96 In Germany, Armenia, Austria, Azerbaijan, Belarus, Croatia, Denmark, Estonia, the Russian Federation, Finland, Georgia, Hungary, Ireland, Iceland, Israel, Kazakhstan, Latvia, Liechtenstein, Lithuania, Malta, Moldova, Norway, Uzbekistan, Poland, Kyrgyzstan, Slovakia, the Czech Rep., the United Kingdom, Sweden, Switzerland, Tajikistan, Turkmenistan and Ukraine, administrations may allocate up to 200 kHz to their amateur service in the frequency bands 1 715-1 800 kHz and 1 850-2 000 kHz. However, when allocating the frequency bands within this range to their amateur service, administrations shall, after prior consultation with administrations of neighbouring countries, take such steps as may be necessary to prevent harmful interference from their amateur service to the fixed and mobile services of other countries. The mean power of any amateur station shall not exceed 10 W. (WRC-15)

1 800-2 194 kHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>1 800-1 810
RADIOLOCATION
5.93</td><td rowspan="2">1 800-1 850
AMATEUR</td><td rowspan="3">1 800-2 000
AMATEUR
FIXED
MOBILE except aeronautical mobile
RADIONAVIGATION
Radiolocation</td></tr>
<tr><td>1 810-1 850
AMATEUR
5.98 5.99 5.100</td></tr>
<tr><td>1 850-2 000
FIXED
MOBILE except aeronautical mobile
5.92 5.96 5.103</td><td>1 850-2 000
AMATEUR
FIXED
MOBILE except aeronautical mobile
RADIOLOCATION
RADIONAVIGATION
5.102</td><td>5.97</td></tr>
<tr><td>2 000-2 025
FIXED
MOBILE except aeronautical mobile (R)
5.92 5.103</td><td colspan="2" rowspan="3">2 000-2 065
FIXED
MOBILE</td></tr>
<tr><td>2 025-2 045
FIXED
MOBILE except aeronautical mobile (R)
Meteorological aids 5.104
5.92 5.103</td></tr>
<tr><td>2 045-2 160
FIXED
MARITIME MOBILE
LAND MOBILE
5.92</td></tr>
<tr><td rowspan="2">2 160-2 170
RADIOLOCATION
5.93 5.107</td><td colspan="2">2 065-2 107
MARITIME MOBILE 5.105
5.106</td></tr>
<tr><td colspan="2">2 107-2 170
FIXED
MOBILE</td></tr>
<tr><td>2 170-2 173.5</td><td colspan="2">MARITIME MOBILE</td></tr>
<tr><td>2 173.5-2 190.5</td><td colspan="2">MOBILE (distress and calling)
5.108 5.109 5.110 5.111</td></tr>
<tr><td>2 190.5-2 194</td><td colspan="2">MARITIME MOBILE</td></tr>
</table>

5.97 In Region 3, the Loran system operates either on 1 850 kHz or 1 950 kHz, the bands occupied being 1 825-1 875 kHz and 1 925-1 975 kHz respectively. Other services to which the band 1 800-2 000 kHz is allocated may use any frequency therein on condition that no harmful interference is caused to the Loran system operating on 1 850 kHz or 1 950 kHz.

5.98 *Alternative allocation*: in Armenia, Azerbaijan, Belarus, Belgium, Cameroon, Congo (Rep. of the), Denmark, Eritrea, Spain, Ethiopia, the Russian Federation, Georgia, Greece, Italy, Kazakhstan, Lebanon, Lithuania, the Syrian Arab Republic, Türkiye, Kyrgyzstan, Somalia, Tajikistan, Tunisia and Turkmenistan, the frequency band 1 810-1 830 kHz is allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-23)

5.99 *Additional allocation:* in Saudi Arabia, Austria, Egypt, Iraq, Libya, Uzbekistan, Romania, Slovakia, Slovenia, Chad, and Togo, the frequency band 1 810-1 830 kHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-23)

5.100 In Region 1, the authorization to use the band 1 810-1 830 kHz by the amateur service in countries situated totally or partially north of 40° N shall be given only after consultation with the countries mentioned in Nos. **5.98** and **5.99** to define the necessary steps to be taken to prevent harmful interference between amateur stations and stations of other services operating in accordance with Nos. **5.98** and **5.99**.

5.101 (SUP - WRC-12)

5.102 *Alternative allocation:* in Bolivia, Chile, Paraguay and Peru, the frequency band 1 850-2 000 kHz is allocated to the fixed, mobile except aeronautical mobile, radiolocation and radionavigation services on a primary basis. (WRC-15)

5.103 In Region 1, in making assignments to stations in the fixed and mobile services in the bands 1 850-2 045 kHz, 2 194-2 498 kHz, 2 502-2 625 kHz and 2 650-2 850 kHz, administrations should bear in mind the special requirements of the maritime mobile service.

5.104 In Region 1, the use of the band 2 025-2 045 kHz by the meteorological aids service is limited to oceanographic buoy stations.

5.105 In Region 2, except in Greenland, coast stations and ship stations using radiotelephony in the band 2 065-2 107 kHz shall be limited to class J3E emissions and to a peak envelope power not exceeding 1 kW. Preferably, the following carrier frequencies should be used: 2 065.0 kHz, 2 079.0 kHz, 2 082.5 kHz, 2 086.0 kHz, 2 093.0 kHz, 2 096.5 kHz, 2 100.0 kHz and 2 103.5 kHz. In Argentina and Uruguay, the carrier frequencies 2 068.5 kHz and 2 075.5 kHz are also used for this purpose, while the frequencies within the band 2 072-2 075.5 kHz are used as provided in No. **52.165**.

5.106 In Regions 2 and 3, provided no harmful interference is caused to the maritime mobile service, the frequencies between 2 065 kHz and 2 107 kHz may be used by stations of the fixed service communicating only within national borders and whose mean power does not exceed 50 W. In notifying the frequencies, the attention of the Bureau should be drawn to these provisions.

5.107 *Additional allocation:* in Saudi Arabia, Eritrea, Eswatini, Ethiopia, Iraq, Libya and Somalia, the frequency band 2 160-2 170 kHz is also allocated to the fixed and mobile, except aeronautical mobile (R), services on a primary basis. The mean power of stations in these services shall not exceed 50 W. (WRC-19)

5.108 The carrier frequency 2 182 kHz is an international distress and calling frequency for radiotelephony. The conditions for the use of the band 2 173.5-2 190.5 kHz are prescribed in Articles **31** and **52**. (WRC-07)

5.109 The frequencies 2 187.5 kHz, 4 207.5 kHz, 6 312 kHz, 8 414.5 kHz, 12 577 kHz and 16 804.5 kHz are international distress frequencies for digital selective calling. The conditions for the use of these frequencies are prescribed in Article **31**.

5.110 The frequencies 2 174.5 kHz, 4 177.5 kHz, 6 268 kHz, 8 376.5 kHz, 12 520 kHz and 16 695 kHz are used for the automatic connection system (ACS), as described in the most recent version of Recommendation ITU-R M.541. (WRC-23)

5.111 The carrier frequencies 2 182 kHz, 3 023 kHz, 5 680 kHz, 8 364 kHz and the frequencies 121.5 MHz, 156.525 MHz, 156.8 MHz and 243 MHz may also be used, in accordance with the procedures in force for terrestrial radiocommunication services, for search and rescue operations concerning manned space vehicles. The conditions for the use of the frequencies are prescribed in Article **31**.

The same applies to the frequencies 10 003 kHz, 14 993 kHz and 19 993 kHz, but in each of these cases emissions must be confined in a band of ± 3 kHz about the frequency. (WRC-07)

2 194-3 230 kHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
2 194-2 300 FIXED MOBILE except aeronautical mobile (R) 5.92 5.103	**2 194-2 300** FIXED MOBILE 5.112	
2 300-2 498 FIXED MOBILE except aeronautical mobile (R) BROADCASTING 5.113 5.103	**2 300-2 495** FIXED MOBILE BROADCASTING 5.113	
2 498-2 501 STANDARD FREQUENCY AND TIME SIGNAL (2 500 kHz)	**2 495-2 501** STANDARD FREQUENCY AND TIME SIGNAL (2 500 kHz)	
2 501-2 502	STANDARD FREQUENCY AND TIME SIGNAL Space Research	
2 502-2 625 FIXED MOBILE except aeronautical mobile (R) 5.92 5.103 5.114	**2 502-2 505** STANDARD FREQUENCY AND TIME SIGNAL	
2 625-2 650 MARITIME MOBILE MARITIME RADIONAVIGATION 5.92	**2 505-2 850** FIXED MOBILE	
2 650-2 850 FIXED MOBILE except aeronautical mobile (R) 5.92 5.103		
2 850-3 025	AERONAUTICAL MOBILE (R) 5.111 5.115	
3 025-3 155	AERONAUTICAL MOBILE (OR)	
3 155-3 200	FIXED MOBILE except aeronautical mobile (R) 5.116 5.117	
3 200-3 230	FIXED MOBILE except aeronautical mobile (R) BROADCASTING 5.113 5.116	

5.112 *Alternative allocation:* in Sri Lanka, the frequency band 2 194-2 300 kHz is allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-19)

5.113 For the conditions for the use of the bands 2 300-2 495 kHz (2 498 kHz in Region 1), 3 200-3 400 kHz, 4 750-4 995 kHz and 5 005-5 060 kHz by the broadcasting service, see Nos. **5.16** to **5.20**, **5.21** and **23.3** to **23.10**.

5.114 *Alternative allocation*: in Iraq, the frequency band 2 502-2 625 kHz is allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-19)

5.115 The carrier (reference) frequencies 3 023 kHz and 5 680 kHz may also be used, in accordance with Article **31**, by stations of the maritime mobile service engaged in coordinated search and rescue operations. (WRC-07)

5.116 Administrations are urged to authorize the use of the band 3 155-3 195 kHz to provide a common worldwide channel for low power wireless hearing aids. Additional channels for these devices may be assigned by administrations in the bands between 3 155 kHz and 3 400 kHz to suit local needs.

It should be noted that frequencies in the range 3 000 kHz to 4 000 kHz are suitable for hearing aid devices which are designed to operate over short distances within the induction field.

5.117 *Alternative allocation*: in Liberia, Sri Lanka and Togo, the frequency band 3 155-3 200 kHz is allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-23)

3 230-5 003 kHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
3 230-3 400	FIXED MOBILE except aeronautical mobile BROADCASTING 5.113 5.116 5.118	
3 400-3 500	AERONAUTICAL MOBILE (R)	
3 500-3 800 AMATEUR FIXED MOBILE except aeronautical mobile 5.92	**3 500-3 750** AMATEUR 5.119	**3 500-3 900** AMATEUR FIXED MOBILE
3 800-3 900 FIXED AERONAUTICAL MOBILE (OR) LAND MOBILE	**3 750-4 000** AMATEUR FIXED MOBILE except aeronautical mobile (R)	
3 900-3 950 AERONAUTICAL MOBILE (OR) 5.123		**3 900-3 950** AERONAUTICAL MOBILE BROADCASTING
3 950-4 000 FIXED BROADCASTING	5.122 5.125	**3 950-4 000** FIXED BROADCASTING 5.126
4 000-4 063	FIXED MARITIME MOBILE 5.127 5.126	
4 063-4 438	MARITIME MOBILE 5.79A 5.82D 5.109 5.110 5.130 5.131 5.132 5.128	
4 438-4 488 FIXED MOBILE except aeronautical mobile (R) Radiolocation 5.132A 5.132B	**4 438-4 488** FIXED MOBILE except aeronautical mobile (R) RADIOLOCATION 5.132A	**4 438-4 488** FIXED MOBILE except aeronautical mobile Radiolocation 5.132A
4 488-4 650 FIXED MOBILE except aeronautical mobile (R)		**4 488-4 650** FIXED MOBILE except aeronautical mobile
4 650-4 700	AERONAUTICAL MOBILE (R)	
4 700-4 750	AERONAUTICAL MOBILE (OR)	
4 750-4 850 FIXED AERONAUTICAL MOBILE (OR) LAND MOBILE BROADCASTING 5.113	**4 750-4 850** FIXED MOBILE except aeronautical mobile (R) BROADCASTING 5.113	**4 750-4 850** FIXED BROADCASTING 5.113 Land mobile
4 850-4 995	FIXED LAND MOBILE BROADCASTING 5.113	
4 995-5 003	STANDARD FREQUENCY AND TIME SIGNAL (5 000 kHz)	

5.118 *Additional allocation:* in the United States, Mexico and Peru, the frequency band 3 230-3 400 kHz is also allocated to the radiolocation service on a secondary basis. (WRC-19)

5.119 *Additional allocation:* in Peru, the frequency band 3 500-3 750 kHz is also allocated to the fixed and mobile services on a primary basis. (WRC-15)

5.120 (SUP - WRC-2000)

5.121 Not used.

5.122 *Alternative allocation:* in Bolivia, Chile, Ecuador, Paraguay and Peru, the frequency band 3 750-4 000 kHz is allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-15)

5.123 *Additional allocation:* in Botswana, Eswatini, Lesotho, Malawi, Mozambique, Namibia, South Africa, Zambia and Zimbabwe, the frequency band 3 900-3 950 kHz is also allocated to the broadcasting service on a primary basis, subject to agreement obtained under No. **9.21**. (WRC-19)

5.124 (SUP - WRC-2000)

5.125 *Additional allocation:* in Greenland, the band 3 950-4 000 kHz is also allocated to the broadcasting service on a primary basis. The power of the broadcasting stations operating in this band shall not exceed that necessary for a national service and shall in no case exceed 5 kW.

5.126 In Region 3, the stations of those services to which the band 3 995-4 005 kHz is allocated may transmit standard frequency and time signals.

5.127 The use of the band 4 000-4 063 kHz by the maritime mobile service is limited to ship stations using radiotelephony (see No. **52.220** and Appendix **17**).

5.128 Frequencies in the frequency bands 4 063-4 123 kHz and 4 130-4 438 kHz may be used exceptionally by stations in the fixed service, communicating only within the boundary of the country in which they are located, with a mean power not exceeding 50 W, on condition that harmful interference is not caused to the maritime mobile service. In addition, in Afghanistan, Argentina, Armenia, Belarus, Botswana, Burkina Faso, the Central African Rep., China, the Russian Federation, Georgia, India, Kazakhstan, Mali, Niger, Pakistan, Kyrgyzstan, Tajikistan, Chad, Turkmenistan and Ukraine, in the frequency bands 4 063-4 123 kHz, 4 130-4 133 kHz and 4 408-4 438 kHz, stations in the fixed service, with a mean power not exceeding 1 kW, can be operated on condition that they are situated at least 600 km from the coast and that harmful interference is not caused to the maritime mobile service. (WRC-19)

5.129 (SUP - WRC-07)

5.130 The conditions for the use of the carrier frequencies 4 125 kHz and 6 215 kHz are prescribed in Articles **31** and **52**. (WRC-07)

5.131 The frequency 4 209.5 kHz is used exclusively for the transmission by coast stations of meteorological and navigational warnings and urgent information to ships by means of narrow-band direct-printing techniques. (WRC-97)

5.132 The frequencies 4 210 kHz, 6 314 kHz, 8 416.5 kHz, 12 579 kHz, 16 806.5 kHz, 19 680.5 kHz, 22 376 kHz and 26 100.5 kHz are the international frequencies for the transmission of maritime safety information (MSI) (see Appendices **15** and **17**). (WRC-23)

5.132A Stations in the radiolocation service shall not cause harmful interference to, or claim protection from, stations operating in the fixed or mobile services. Applications of the radiolocation service are limited to oceanographic radars operating in accordance with Resolution **612 (Rev.WRC-12)**. (WRC-12)

5.132B *Alternative allocation:* in Armenia, Belarus, Moldova and Kyrgyzstan, the frequency band 4 438-4 488 kHz is allocated to the fixed and mobile, except aeronautical mobile (R), services on a primary basis. (WRC-19)

5 003-7 000 kHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
5 003-5 005	STANDARD FREQUENCY AND TIME SIGNAL Space research	
5 005-5 060	FIXED BROADCASTING 5.113	
5 060-5 250	FIXED Mobile except aeronautical mobile 5.133	
5 250-5 275 FIXED MOBILE except aeronautical mobile Radiolocation 5.132A 5.133A	**5 250-5 275** FIXED MOBILE except aeronautical mobile RADIOLOCATION 5.132A	**5 250-5 275** FIXED MOBILE except aeronautical mobile Radiolocation 5.132A
5 275-5 351.5	FIXED MOBILE except aeronautical mobile	
5 351.5-5 366.5	FIXED MOBILE except aeronautical mobile Amateur 5.133B	
5 366.5-5 450	FIXED MOBILE except aeronautical mobile	
5 450-5 480 FIXED AERONAUTICAL MOBILE (OR) LAND MOBILE	**5 450-5 480** AERONAUTICAL MOBILE (R)	**5 450-5 480** FIXED AERONAUTICAL MOBILE (OR) LAND MOBILE
5 480-5 680	AERONAUTICAL MOBILE (R) 5.111 5.115	
5 680-5 730	AERONAUTICAL MOBILE (OR) 5.111 5.115	
5 730-5 900 FIXED LAND MOBILE	**5 730-5 900** FIXED MOBILE except aeronautical mobile (R)	**5 730-5 900** FIXED Mobile except aeronautical mobile (R)
5 900-5 950	BROADCASTING 5.134 5.136	
5 950-6 200	BROADCASTING	
6 200-6 525	MARITIME MOBILE 5.109 5.110 5.130 5.132 5.137A 5.137	
6 525-6 685	AERONAUTICAL MOBILE (R)	
6 685-6 765	AERONAUTICAL MOBILE (OR)	
6 765-7 000	FIXED MOBILE except aeronautical mobile (R) 5.138	

5.133 *Different category of service:* in Armenia, Azerbaijan, Belarus, the Russian Federation, Georgia, Kazakhstan, Latvia, Lithuania, Niger, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan and Ukraine, the allocation of the band 5 130-5 250 kHz to the mobile, except aeronautical mobile, service is on a primary basis (see No. **5.33**). (WRC-12)

5.133A *Alternative allocation:* in Armenia, Belarus, Moldova and Kyrgyzstan, the frequency bands 5 250-5 275 kHz and 26 200-26 350 kHz are allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-19)

5.133B Stations in the amateur service using the frequency band 5 351.5-5 366.5 kHz shall not exceed a maximum radiated power of 15 W (e.i.r.p.). However, in Region 2 in Mexico, stations in the amateur service using the frequency band 5 351.5-5 366.5 kHz shall not exceed a maximum radiated power of 20 W (e.i.r.p.). In the following Region 2 countries: Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Dominica, El Salvador, Ecuador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Nicaragua, Panama, Paraguay, Peru, Saint Lucia, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela, as well as the overseas countries and territories within the Kingdom of the Netherlands in Region 2, stations in the amateur service using the frequency band 5 351.5-5 366.5 kHz shall not exceed a maximum radiated power of 25 W (e.i.r.p.). (WRC-19)

5.134 The use of the frequency bands 5 900-5 950 kHz, 7 300-7 350 kHz, 9 400-9 500 kHz, 11 600-11 650 kHz, 12 050-12 100 kHz, 13 570-13 600 kHz, 13 800-13 870 kHz, 15 600-15 800 kHz, 17 480-17 550 kHz and 18 900-19 020 kHz by the broadcasting service is subject to the application of the procedure of Article **12**. Administrations are encouraged to use these frequency bands to facilitate the introduction of digitally modulated emissions in accordance with the provisions of Resolution **517 (Rev.WRC-19)**. (WRC-19)

5.135 (SUP - WRC-97)

5.136 *Additional allocation:* frequencies in the band 5 900-5 950 kHz may be used by stations in the following services, communicating only within the boundary of the country in which they are located: fixed service (in all three Regions), land mobile service (in Region 1), mobile except aeronautical mobile (R) service (in Regions 2 and 3), on condition that harmful interference is not caused to the broadcasting service. When using frequencies for these services, administrations are urged to use the minimum power required and to take account of the seasonal use of frequencies by the broadcasting service published in accordance with the Radio Regulations. (WRC-07)

5.137 On condition that harmful interference is not caused to the maritime mobile service, the bands 6 200-6 213.5 kHz and 6 220.5-6 525 kHz may be used exceptionally by stations in the fixed service, communicating only within the boundary of the country in which they are located, with a mean power not exceeding 50 W. At the time of notification of these frequencies, the attention of the Bureau will be drawn to the above conditions.

5.137A The frequencies 6 337.5 kHz, 8 443 kHz, 12 663.5 kHz, 16 909.5 kHz and 22 450.5 kHz are the regional frequencies for the transmission of maritime safety information (MSI) by means of the NAVDAT system (see Appendices **15** and **17**). (WRC-23)

5.138 The following bands:

6 765-6 795 kHz	(centre frequency 6 780 kHz),
433.05-434.79 MHz	(centre frequency 433.92 MHz) in Region 1 except in the countries mentioned in No. **5.280**,
61-61.5 GHz	(centre frequency 61.25 GHz),
122-123 GHz	(centre frequency 122.5 GHz), and
244-246 GHz	(centre frequency 245 GHz)

are designated for industrial, scientific and medical (ISM) applications. The use of these frequency bands for ISM applications shall be subject to special authorization by the administration concerned, in agreement with other administrations whose radiocommunication services might be affected. In applying this provision, administrations shall have due regard to the latest relevant ITU-R Recommendations.

5.138A (SUP - WRC-12)

5.139 (SUP - WRC-12)

7 000-7 450 kHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
7 000-7 100	AMATEUR AMATEUR-SATELLITE 5.140 5.141 5.141A	
7 100-7 200	AMATEUR 5.141A 5.141B	
7 200-7 300 BROADCASTING	**7 200-7 300** AMATEUR 5.142	**7 200-7 300** BROADCASTING
7 300-7 400	BROADCASTING 5.134 5.143 5.143A 5.143B 5.143C 5.143D	
7 400-7 450 BROADCASTING 5.143B 5.143C	**7 400-7 450** FIXED MOBILE except aeronautical mobile (R)	**7 400-7 450** BROADCASTING 5.143A 5.143C

5.140 *Additional allocation:* in Angola, Iraq, Somalia and Togo, the frequency band 7 000-7 050 kHz is also allocated to the fixed service on a primary basis. (WRC-15)

5.141 *Alternative allocation:* in Egypt, Eritrea, Ethiopia, Guinea, Libya, Madagascar and Niger, the band 7 000-7 050 kHz is allocated to the fixed service on a primary basis. (WRC-12)

5.141A *Additional allocation:* in Uzbekistan and Kyrgyzstan, the bands 7 000-7 100 kHz and 7 100-7 200 kHz are also allocated to the fixed and land mobile services on a secondary basis. (WRC-03)

5.141B *Additional allocation:* in Algeria, Saudi Arabia, Australia, Bahrain, Botswana, Brunei Darussalam, China, Comoros, Korea (Rep. of), Diego Garcia, Djibouti, Egypt, United Arab Emirates, Eritrea, Guinea, Indonesia, Iran (Islamic Republic of), Japan, Jordan, Kuwait, Libya, Mali, Morocco, Mauritania, Niger, New Zealand, Oman, Papua New Guinea, Qatar, the Syrian Arab Republic, the Dem. People's Rep. of Korea, Singapore, Sudan, South Sudan, Tunisia, Viet Nam and Yemen, the frequency band 7 100-7 200 kHz is also allocated to the fixed and the mobile, except aeronautical mobile (R), services on a primary basis. (WRC-19)

5.141C (SUP - WRC-12)

5.142 The use of the band 7 200-7 300 kHz in Region 2 by the amateur service shall not impose constraints on the broadcasting service intended for use within Region 1 and Region 3. (WRC-12)

5.143 *Additional allocation:* frequencies in the band 7 300-7 350 kHz may be used by stations in the fixed service and in the land mobile service, communicating only within the boundary of the country in which they are located, on condition that harmful interference is not caused to the broadcasting service. When using frequencies for these services, administrations are urged to use the minimum power required and to take account of the seasonal use of frequencies by the broadcasting service published in accordance with the Radio Regulations. (WRC-07)

5.143A In Region 3, frequencies in the band 7 350-7 450 kHz may be used by stations in the fixed service on a primary basis and land mobile service on a secondary basis, communicating only within the boundary of the country in which they are located, on condition that harmful interference is not caused to the broadcasting service. When using frequencies for these services, administrations are urged to use the minimum power required and to take account of the seasonal use of frequencies by the broadcasting service published in accordance with the Radio Regulations. (WRC-12)

5.143B In Region 1, frequencies in the band 7 350-7 450 kHz may be used by stations in the fixed and land mobile services communicating only within the boundary of the country in which they are located on condition that harmful interference is not caused to the broadcasting service. The total radiated power of each station shall not exceed 24 dBW. (WRC-12)

5.143C *Additional allocation:* in Algeria, Saudi Arabia, Bahrain, Comoros, Djibouti, Egypt, United Arab Emirates, Iran (Islamic Republic of), Jordan, Kuwait, Libya, Morocco, Mauritania, Niger, Oman, Qatar, the Syrian Arab Republic, Sudan, South Sudan, Tunisia and Yemen, the bands 7 350-7 400 kHz and 7 400-7 450 kHz are also allocated to the fixed service on a primary basis. (WRC-12)

5.143D In Region 2, frequencies in the band 7 350-7 400 kHz may be used by stations in the fixed service and in the land mobile service, communicating only within the boundary of the country in which they are located, on condition that harmful interference is not caused to the broadcasting service. When using frequencies for these services, administrations are urged to use the minimum power required and to take account of the seasonal use of frequencies by the broadcasting service published in accordance with the Radio Regulations. (WRC-12)

7 450-13 360 kHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
7 450-8 100	FIXED MOBILE except aeronautical mobile (R) 5.144	
8 100-8 195	FIXED MARITIME MOBILE	
8 195-8 815	MARITIME MOBILE 5.109 5.110 5.132 5.137A 5.145 5.111	
8 815-8 965	AERONAUTICAL MOBILE (R)	
8 965-9 040	AERONAUTICAL MOBILE (OR)	
9 040-9 305 FIXED	**9 040-9 400** FIXED	**9 040-9 305** FIXED
9 305-9 355 FIXED Radiolocation 5.145A 5.145B		**9 305-9 355** FIXED Radiolocation 5.145A
9 355-9 400 FIXED		**9 355-9 400** FIXED
9 400-9 500	BROADCASTING 5.134 5.146	
9 500-9 900	BROADCASTING 5.147	
9 900-9 995	FIXED	
9 995-10 003	STANDARD FREQUENCY AND TIME SIGNAL (10 000 kHz) 5.111	
10 003-10 005	STANDARD FREQUENCY AND TIME SIGNAL Space research 5.111	
10 005-10 100	AERONAUTICAL MOBILE (R) 5.111	
10 100-10 150	FIXED Amateur	
10 150-11 175	FIXED Mobile except aeronautical mobile (R)	
11 175-11 275	AERONAUTICAL MOBILE (OR)	
11 275-11 400	AERONAUTICAL MOBILE (R)	
11 400-11 600	FIXED	
11 600-11 650	BROADCASTING 5.134 5.146	
11 650-12 050	BROADCASTING 5.147	
12 050-12 100	BROADCASTING 5.134 5.146	
12 100-12 230	FIXED	
12 230-13 200	MARITIME MOBILE 5.109 5.110 5.132 5.137A 5.145	
13 200-13 260	AERONAUTICAL MOBILE (OR)	
13 260-13 360	AERONAUTICAL MOBILE (R)	

5.143E (SUP - WRC-12)

5.144 In Region 3, the stations of those services to which the band 7 995-8 005 kHz is allocated may transmit standard frequency and time signals.

5.145 The conditions for the use of the carrier frequencies 8 291 kHz, 12 290 kHz and 16 420 kHz are prescribed in Articles **31** and **52**. (WRC-07)

5.145A Stations in the radiolocation service shall not cause harmful interference to, or claim protection from, stations operating in the fixed service. Applications of the radiolocation service are limited to oceanographic radars operating in accordance with Resolution **612 (Rev.WRC-12)**. (WRC-12)

5.145B *Alternative allocation:* in Armenia, Belarus, Moldova and Kyrgyzstan, the frequency bands 9 305-9 355 kHz and 16 100-16 200 kHz are allocated to the fixed service on a primary basis. (WRC-19)

5.146 *Additional allocation:* frequencies in the bands 9 400-9 500 kHz, 11 600-11 650 kHz, 12 050-12 100 kHz, 15 600-15 800 kHz, 17 480-17 550 kHz and 18 900-19 020 kHz may be used by stations in the fixed service, communicating only within the boundary of the country in which they are located, on condition that harmful interference is not caused to the broadcasting service. When using frequencies in the fixed service, administrations are urged to use the minimum power required and to take account of the seasonal use of frequencies by the broadcasting service published in accordance with the Radio Regulations. (WRC-07)

5.147 On condition that harmful interference is not caused to the broadcasting service, frequencies in the bands 9 775-9 900 kHz, 11 650-11 700 kHz and 11 975-12 050 kHz may be used by stations in the fixed service communicating only within the boundary of the country in which they are located, each station using a total radiated power not exceeding 24 dBW.

5.148 (SUP - WRC-97)

13 360-18 030 kHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
13 360-13 410	FIXED RADIO ASTRONOMY 5.149	
13 410-13 450	FIXED Mobile except aeronautical mobile (R)	
13 450-13 550 FIXED Mobile except aeronautical mobile (R) Radiolocation 5.132A 5.149A	**13 450-13 550** FIXED Mobile except aeronautical mobile (R) Radiolocation 5.132A	
13 550-13 570	FIXED Mobile except aeronautical mobile (R) 5.150	
13 570-13 600	BROADCASTING 5.134 5.151	
13 600-13 800	BROADCASTING	
13 800-13 870	BROADCASTING 5.134 5.151	
13 870-14 000	FIXED Mobile except aeronautical mobile (R)	
14 000-14 250	AMATEUR AMATEUR-SATELLITE	
14 250-14 350	AMATEUR 5.152	
14 350-14 990	FIXED Mobile except aeronautical mobile (R)	
14 990-15 005	STANDARD FREQUENCY AND TIME SIGNAL (15 000 kHz) 5.111	
15 005-15 010	STANDARD FREQUENCY AND TIME SIGNAL Space research	
15 010-15 100	AERONAUTICAL MOBILE (OR)	
15 100-15 600	BROADCASTING	
15 600-15 800	BROADCASTING 5.134 5.146	
15 800-16 100	FIXED 5.153	
16 100-16 200 FIXED Radiolocation 5.145A 5.145B	**16 100-16 200** FIXED RADIOLOCATION 5.145A	**16 100-16 200** FIXED Radiolocation 5.145A
16 200-16 360	FIXED	
16 360-17 410	MARITIME MOBILE 5.109 5.110 5.132 5.137A 5.145	
17 410-17 480	FIXED	
17 480-17 550	BROADCASTING 5.134 5.146	
17 550-17 900	BROADCASTING	
17 900-17 970	AERONAUTICAL MOBILE (R)	
17 970-18 030	AERONAUTICAL MOBILE (OR)	

5.149 In making assignments to stations of other services to which the bands:

13 360-13 410 kHz,	4 950-4 990 MHz,	102-109.5 GHz,
25 550-25 670 kHz,	4 990-5 000 MHz,	111.8-114.25 GHz,
37.5-38.25 MHz,	6 650-6 675.2 MHz,	128.33-128.59 GHz,
73-74.6 MHz in Regions 1 and 3,	10.6-10.68 GHz,	129.23-129.49 GHz,
150.05-153 MHz in Region 1,	14.47-14.5 GHz,	130-134 GHz,
322-328.6 MHz,	22.01-22.21 GHz,	136-148.5 GHz,
406.1-410 MHz,	22.21-22.5 GHz,	151.5-158.5 GHz,
608-614 MHz in Regions 1 and 3,	22.81-22.86 GHz,	168.59-168.93 GHz,
1 330-1 400 MHz,	23.07-23.12 GHz,	171.11-171.45 GHz,
1 610.6-1 613.8 MHz,	31.2-31.3 GHz,	172.31-172.65 GHz,
1 660-1 670 MHz,	31.5-31.8 GHz in Regions 1 and 3,	173.52-173.85 GHz,
1 718.8-1 722.2 MHz,	36.43-36.5 GHz,	195.75-196.15 GHz,
2 655-2 690 MHz,	42.5-43.5 GHz,	209-226 GHz,
3 260-3 267 MHz,	48.94-49.04 GHz,	241-250 GHz,
3 332-3 339 MHz,	76-86 GHz,	252-275 GHz
3 345.8-3 352.5 MHz,	92-94 GHz,	
4 825-4 835 MHz,	94.1-100 GHz,	

are allocated, administrations are urged to take all practicable steps to protect the radio astronomy service from harmful interference. Emissions from spaceborne or airborne stations can be particularly serious sources of interference to the radio astronomy service (see Nos. **4.5** and **4.6** and Article **29**). (WRC-07)

5.149A *Alternative allocation:* in Armenia, Belarus, Moldova and Kyrgyzstan, the frequency band 13 450-13 550 kHz is allocated to the fixed service on a primary basis and to the mobile, except aeronautical mobile (R), service on a secondary basis. (WRC-19)

5.150 The following bands:

13 553-13 567 kHz	(centre frequency 13 560 kHz),
26 957-27 283 kHz	(centre frequency 27 120 kHz),
40.66-40.70 MHz	(centre frequency 40.68 MHz),
902-928 MHz	in Region 2 (centre frequency 915 MHz),
2 400-2 500 MHz	(centre frequency 2 450 MHz),
5 725-5 875 MHz	(centre frequency 5 800 MHz), and
24-24.25 GHz	(centre frequency 24.125 GHz)

are also designated for industrial, scientific and medical (ISM) applications. Radiocommunication services operating within these bands must accept harmful interference which may be caused by these applications. ISM equipment operating in these bands is subject to the provisions of No. **15.13**.

5.151 *Additional allocation:* frequencies in the bands 13 570-13 600 kHz and 13 800-13 870 kHz may be used by stations in the fixed service and in the mobile except aeronautical mobile (R) service, communicating only within the boundary of the country in which they are located, on the condition that harmful interference is not caused to the broadcasting service. When using frequencies in these services, administrations are urged to use the minimum power required and to take account of the seasonal use of frequencies by the broadcasting service published in accordance with the Radio Regulations. (WRC-07)

5.152 *Additional allocation:* in Armenia, Azerbaijan, China, Côte d'Ivoire, the Russian Federation, Georgia, Iran (Islamic Republic of), Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan and Ukraine, the band 14 250-14 350 kHz is also allocated to the fixed service on a primary basis. Stations of the fixed service shall not use a radiated power exceeding 24 dBW. (WRC-03)

5.153 In Region 3, the stations of those services to which the band 15 995-16 005 kHz is allocated may transmit standard frequency and time signals.

18 030-23 350 kHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
18 030-18 052	FIXED	
18 052-18 068	FIXED Space research	
18 068-18 168	AMATEUR AMATEUR-SATELLITE 5.154	
18 168-18 780	FIXED Mobile except aeronautical mobile	
18 780-18 900	MARITIME MOBILE	
18 900-19 020	BROADCASTING 5.134 5.146	
19 020-19 680	FIXED	
19 680-19 800	MARITIME MOBILE 5.132	
19 800-19 990	FIXED	
19 990-19 995	STANDARD FREQUENCY AND TIME SIGNAL Space research 5.111	
19 995-20 010	STANDARD FREQUENCY AND TIME SIGNAL (20 000 kHz) 5.111	
20 010-21 000	FIXED Mobile	
21 000-21 450	AMATEUR AMATEUR-SATELLITE	
21 450-21 850	BROADCASTING	
21 850-21 870	FIXED 5.155A 5.155	
21 870-21 924	FIXED 5.155B	
21 924-22 000	AERONAUTICAL MOBILE (R)	
22 000-22 855	MARITIME MOBILE 5.132 5.137A 5.156	
22 855-23 000	FIXED 5.156	
23 000-23 200	FIXED Mobile except aeronautical mobile (R) 5.156	
23 200-23 350	FIXED 5.156A AERONAUTICAL MOBILE (OR)	

5.154 *Additional allocation:* in Armenia, Azerbaijan, the Russian Federation, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Ukraine, the band 18 068-18 168 kHz is also allocated to the fixed service on a primary basis for use within their boundaries, with a peak envelope power not exceeding 1 kW. (WRC-03)

5.155 *Additional allocation:* in Armenia, Azerbaijan, Belarus, the Russian Federation, Georgia, Moldova, Uzbekistan, Kyrgyzstan, Slovakia, Tajikistan, Turkmenistan and Ukraine, the frequency band 21 850-21 870 kHz is also allocated to the aeronautical mobile (R) service on a primary basis. (WRC-23)

5.155A In Armenia, Azerbaijan, Belarus, the Russian Federation, Georgia, Moldova, Uzbekistan, Kyrgyzstan, Slovakia, Tajikistan, Turkmenistan and Ukraine, the use of the frequency band 21 850-21 870 kHz by the fixed service is limited to provision of services related to aircraft flight safety. (WRC-23)

5.155B The band 21 870-21 924 kHz is used by the fixed service for provision of services related to aircraft flight safety.

5.156 *Additional allocation:* in Nigeria, the band 22 720-23 200 kHz is also allocated to the meteorological aids service (radiosondes) on a primary basis.

5.156A The use of the band 23 200-23 350 kHz by the fixed service is limited to provision of services related to aircraft flight safety.

23 350-27 500 kHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
23 350-24 000	FIXED MOBILE except aeronautical mobile 5.157	
24 000-24 450	FIXED LAND MOBILE	
24 450-24 600 FIXED LAND MOBILE Radiolocation 5.132A 5.158	**24 450-24 650** FIXED LAND MOBILE RADIOLOCATION 5.132A	**24 450-24 600** FIXED LAND MOBILE Radiolocation 5.132A
24 600-24 890 FIXED LAND MOBILE	**24 650-24 890** FIXED LAND MOBILE	**24 600-24 890** FIXED LAND MOBILE
24 890-24 990	AMATEUR AMATEUR-SATELLITE	
24 990-25 005	STANDARD FREQUENCY AND TIME SIGNAL (25 000 kHz)	
25 005-25 010	STANDARD FREQUENCY AND TIME SIGNAL Space research	
25 010-25 070	FIXED MOBILE except aeronautical mobile	
25 070-25 210	MARITIME MOBILE	
25 210-25 550	FIXED MOBILE except aeronautical mobile	
25 550-25 670	RADIO ASTRONOMY 5.149	
25 670-26 100	BROADCASTING	
26 100-26 175	MARITIME MOBILE 5.132	
26 175-26 200	FIXED MOBILE except aeronautical mobile	
26 200-26 350 FIXED MOBILE except aeronautical mobile Radiolocation 5.132A 5.133A	**26 200-26 420** FIXED MOBILE except aeronautical mobile RADIOLOCATION 5.132A	**26 200-26 350** FIXED MOBILE except aeronautical mobile Radiolocation 5.132A
26 350-27 500 FIXED MOBILE except aeronautical mobile 5.150	**26 420-27 500** FIXED MOBILE except aeronautical mobile 5.150	**26 350-27 500** FIXED MOBILE except aeronautical mobile 5.150

5.157 The use of the band 23 350-24 000 kHz by the maritime mobile service is limited to inter-ship radiotelegraphy.

5.158 *Alternative allocation:* in Armenia, Belarus, Moldova and Kyrgyzstan, the frequency band 24 450-24 600 kHz is allocated to the fixed and land mobile services on a primary basis. (WRC-19)

27.5-40.98 MHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>27.5-28</td><td colspan="2">METEOROLOGICAL AIDS
FIXED
MOBILE</td></tr>
<tr><td>28-29.7</td><td colspan="2">AMATEUR
AMATEUR-SATELLITE</td></tr>
<tr><td>29.7-30.005</td><td colspan="2">FIXED
MOBILE</td></tr>
<tr><td>30.005-30.01</td><td colspan="2">SPACE OPERATION (satellite identification)
FIXED
MOBILE
SPACE RESEARCH</td></tr>
<tr><td>30.01-37.5</td><td colspan="2">FIXED
MOBILE</td></tr>
<tr><td>37.5-38.25</td><td colspan="2">FIXED
MOBILE
Radio astronomy
5.149</td></tr>
<tr><td>38.25-39
FIXED
MOBILE</td><td rowspan="3">38.25-39.986
FIXED
MOBILE</td><td>38.25-39.5
FIXED
MOBILE</td></tr>
<tr><td>39-39.5
FIXED
MOBILE
Radiolocation 5.132A
5.159</td><td rowspan="2"></td></tr>
<tr><td>39.5-39.986
FIXED
MOBILE</td><td>39.5-39.986
FIXED
MOBILE
RADIOLOCATION 5.132A</td></tr>
<tr><td colspan="2">39.986-40
FIXED
MOBILE
Space research</td><td>39.986-40
FIXED
MOBILE
RADIOLOCATION 5.132A
Space research</td></tr>
<tr><td colspan="2">40-40.02
FIXED
MOBILE
Earth exploration-satellite (active) 5.159A
Space research</td><td>40-40.02
FIXED
MOBILE
Earth exploration-satellite (active) 5.159A
Space research</td></tr>
<tr><td>40.02-40.98</td><td colspan="2">FIXED
MOBILE
Earth exploration-satellite (active) 5.159A
5.150</td></tr>
</table>

5.159 *Alternative allocation:* in Armenia, Belarus, Moldova and Kyrgyzstan, the frequency band 39-39.5 MHz is allocated to the fixed and mobile services on a primary basis. (WRC-19)

5.159A The use of the frequency band 40-50 MHz by the Earth exploration-satellite service (active) shall be in accordance with the geographical area restrictions and the operational and technical conditions defined in Resolution **677 (WRC-23)**. The provisions of this footnote in no way diminish the obligation of the Earth exploration-satellite service (active) to operate as a secondary service in accordance with Nos. **5.29** and **5.30**. (WRC-23)

40.98-47 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
40.98-41.015	FIXED MOBILE Earth exploration-satellite (active) 5.159A Space research 5.160 5.161	
41.015-42	FIXED MOBILE Earth exploration-satellite (active) 5.159A 5.160 5.161 5.161A	
42-42.5 FIXED MOBILE Earth exploration-satellite (active) 5.159A Radiolocation 5.132A 5.160 5.161B	**42-42.5** FIXED MOBILE Earth exploration-satellite (active) 5.159A 5.161	
42.5-44	FIXED MOBILE Earth exploration-satellite (active) 5.159A 5.160 5.161 5.161A	
44-47	FIXED MOBILE Earth exploration-satellite (active) 5.159A 5.162 5.162A	

5.160 *Additional allocation:* in Botswana, Burundi, Dem. Rep. of the Congo and Rwanda, the band 41-44 MHz is also allocated to the aeronautical radionavigation service on a primary basis. (WRC-12)

5.161 *Additional allocation:* in Iran (Islamic Republic of) and Japan, the band 41-44 MHz is also allocated to the radiolocation service on a secondary basis.

5.161A *Additional allocation:* in Korea (Rep. of), the United States and Mexico, the frequency bands 41.015-41.665 MHz and 43.35-44 MHz are also allocated to the radiolocation service on a primary basis. Stations in the radiolocation service shall not cause harmful interference to, or claim protection from, stations operating in the fixed or mobile services. Applications of the radiolocation service are limited to oceanographic radars operating in accordance with Resolution **612 (Rev.WRC-12)**. (WRC-19)

5.161B *Alternative allocation:* in Albania, Germany, Armenia, Austria, Belarus, Belgium, Bosnia and Herzegovina, Cyprus, Vatican, Croatia, Denmark, Spain, Estonia, Finland, France, Greece, Hungary, Ireland, Iceland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, North Macedonia, Malta, Moldova, Monaco, Montenegro, Norway, Uzbekistan, Netherlands, Portugal, Türkiye, Kyrgyzstan, Slovakia, Czech Rep., Romania, United Kingdom, San Marino, Slovenia, Sweden, Switzerland and Ukraine, the frequency band 42-42.5 MHz is allocated to the fixed and mobile services on a primary basis. (WRC-23)

5.162 *Additional allocation:* in Australia, the band 44-47 MHz is also allocated to the broadcasting service on a primary basis. (WRC-12)

5.162A *Additional allocation:* in Germany, Australia, Austria, Belgium, Bosnia and Herzegovina, China, Vatican, Korea (Rep. of), Denmark, Spain, Estonia, the Russian Federation, Finland, France, Indonesia, Ireland, Iceland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, North Macedonia, Monaco, Montenegro, Norway, the Netherlands, Poland, Portugal, the Dem. People's Rep. of Korea, the Czech Rep., the United Kingdom, Serbia, Slovenia, Sweden and Switzerland, the frequency band 46-68 MHz is also allocated to the radiolocation service on a secondary basis. This use is limited to the operation of wind profiler radars in accordance with Resolution **217 (Rev.WRC-23)**. (WRC-23)

47-75.2 MHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>47-50
BROADCASTING
Earth exploration-satellite (active) 5.159A

5.162A 5.163 5.164 5.165</td><td>47-50
FIXED
MOBILE
Earth exploration-satellite (active) 5.159A</td><td>47-50
FIXED
MOBILE
BROADCASTING
Earth exploration-satellite (active) 5.159A
5.162A</td></tr>
<tr><td>50-52
BROADCASTING
Amateur 5.166B 5.166C 5.166D 5.166E 5.169B
5.162A 5.164 5.165 5.166A 5.169 5.169A</td><td colspan="2" rowspan="2">50-54
AMATEUR

5.162A 5.167 5.167A 5.168 5.170</td></tr>
<tr><td>52-68
BROADCASTING

5.162A 5.163 5.164 5.165
5.169 5.169A 5.169B 5.171</td></tr>
<tr><td rowspan="5">68-74.8
FIXED
MOBILE except aeronautical mobile

5.149 5.175 5.177 5.179</td><td>54-68
BROADCASTING
Fixed
Mobile

5.172</td><td>54-68
FIXED
MOBILE
BROADCASTING

5.162A</td></tr>
<tr><td>68-72
BROADCASTING
Fixed
Mobile
5.173</td><td rowspan="4">68-74.8
FIXED
MOBILE

5.149 5.176 5.179</td></tr>
<tr><td>72-73
FIXED
MOBILE</td></tr>
<tr><td>73-74.6
RADIO ASTRONOMY
5.178</td></tr>
<tr><td>74.6-74.8
FIXED
MOBILE</td></tr>
<tr><td>74.8-75.2</td><td colspan="2">AERONAUTICAL RADIONAVIGATION
5.180 5.181</td></tr>
</table>

5.163 *Additional allocation:* in Armenia, Belarus, the Russian Federation, Georgia, Kazakhstan, Latvia, Moldova, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan and Ukraine, the frequency bands 47-48.5 MHz and 56.5-58 MHz are also allocated to the fixed and land mobile services on a secondary basis. (WRC-19)

5.164 *Additional allocation:* in Albania, Algeria, Germany, Austria, Belgium, Bosnia and Herzegovina, Botswana, Bulgaria, Côte d'Ivoire, Croatia, Denmark, Spain, Estonia, Eswatini, Finland, France, Gabon, Greece, Hungary, Ireland, Israel, Italy, Jordan, Lebanon, Libya, Liechtenstein, Lithuania, Luxembourg, Madagascar, Mali, Malta, Morocco, Mauritania, Monaco, Montenegro, Nigeria, Norway, the Netherlands, Poland, Syrian Arab Republic, Türkiye, Slovakia, Czech Rep., Romania, the United Kingdom, Serbia, Slovenia, Sweden, Switzerland, Chad, Togo and Tunisia, the frequency band 47-68 MHz, in South Africa the frequency band 47-50 MHz, and in Latvia the frequency bands 48.5-56.5 MHz and 58-68 MHz, are also allocated to the land mobile service on a primary basis. However, stations of the land mobile service in the countries mentioned in connection with each frequency band referred to in this footnote shall not cause harmful interference to, or claim protection from, existing or planned broadcasting stations of countries other than those mentioned in connection with the frequency band. (WRC-23)

5.165 *Additional allocation:* in Angola, Cameroon, Congo (Rep. of the), Egypt, Madagascar, Mozambique, Niger, Somalia, Sudan, South Sudan, Tanzania and Chad, the frequency band 47-68 MHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-19)

5.166 (SUP - WRC-15)

5.166A *Different category of service:* in Austria, Cyprus, the Vatican, Croatia, Denmark, Spain, Finland, Hungary, Latvia, the Netherlands, the Czech Republic, the United Kingdom, Slovakia and Slovenia, the frequency band 50.0-50.5 MHz is allocated to the amateur service on a primary basis. Stations in the amateur service in these countries shall not cause harmful interference to, or claim protection from, stations of the broadcasting, fixed and mobile services operating in accordance with the Radio Regulations in the frequency band 50.0-50.5 MHz in the countries not listed in this provision. For a station of these services, the protection criteria in No. **5.169B** shall also apply. In Region 1, with the exception of those countries listed in No. **5.169**, wind profiler radars operating in the radiolocation service under No. **5.162A** are authorized to operate on the basis of equality with stations in the amateur service in the frequency band 50.0-50.5 MHz. (WRC-19)

5.166B In Region 1, stations in the amateur service operating on a secondary basis shall not cause harmful interference to, or claim protection from, stations of the broadcasting service. The field strength generated by an amateur station in Region 1 in the frequency band 50-52 MHz shall not exceed a calculated value of +6 dB(μV/m) at a height of 10 m above ground for more than 10% of time along the border of a country with operational analogue broadcasting stations in Region 1 and of neighbouring countries with broadcasting stations in Region 3 listed in Nos. **5.167** and **5.168**. (WRC-19)

5.166C In Region 1, stations in the amateur service in the frequency band 50-52 MHz, with the exception of those countries listed in No. **5.169**, shall not cause harmful interference to, or claim protection from, wind profiler radars operating in the radiolocation service under No. **5.162A**. (WRC-19)

5.166D *Different category of service:* in Lebanon, the frequency band 50-52 MHz is allocated to the amateur service on a primary basis. Stations in the amateur service in Lebanon shall not cause harmful interference to, or claim protection from, stations of the broadcasting, fixed and mobile services operating in accordance with the Radio Regulations in the frequency band 50-52 MHz in the countries not listed in this provision. (WRC-19)

5.166E In the Russian Federation, only the frequency band 50.080-50.280 MHz is allocated to the amateur service on a secondary basis. The protection criteria for the other services in the countries not listed in this provision are specified in Nos. **5.166B** and **5.169B**. (WRC-19)

5.167 *Alternative allocation:* in Bangladesh, Brunei Darussalam, India, Iran (Islamic Republic of), Pakistan and Singapore, the frequency band 50-54 MHz is allocated to the fixed, mobile and broadcasting services on a primary basis. (WRC-15)

5.167A *Additional allocation:* in Indonesia and Thailand, the frequency band 50-54 MHz is also allocated to the fixed, mobile and broadcasting services on a primary basis. (WRC-15)

5.168 *Additional allocation:* in Australia, China and the Dem. People's Rep. of Korea, the band 50-54 MHz is also allocated to the broadcasting service on a primary basis.

5.169 *Alternative allocation:* in Botswana, Eswatini, Lesotho, Malawi, Namibia, Rwanda, South Africa, Zambia and Zimbabwe, the frequency band 50-54 MHz is allocated to the amateur service on a primary basis. In Senegal, the frequency band 50-51 MHz is allocated to the amateur service on a primary basis. (WRC-19)

5.169A *Alternative allocation:* in the following countries in Region 1: Angola, Saudi Arabia, Bahrain, Burkina Faso, Burundi, the United Arab Emirates, Gambia, Jordan, Kenya, Kuwait, Mauritius, Mozambique, Oman, Uganda, Qatar, South Sudan and Tanzania, the frequency band 50-54 MHz is allocated to the amateur service on a primary basis. In Guinea-Bissau, the frequency band 50.0-50.5 MHz is allocated to the amateur service on a primary basis. In Djibouti, the frequency band 50-52 MHz is allocated to the amateur service on a primary basis. With the exception of those countries listed in No. **5.169**, stations in the amateur service operating in Region 1 under this footnote, in all or part of the frequency band 50-54 MHz, shall not cause harmful interference to, or claim protection from, stations of other services operating in accordance with the Radio Regulations in Algeria, Egypt, Iran (Islamic Republic of), Iraq, Israel, Libya, Palestine*, the Syrian Arab Republic, the Dem. People's Republic of Korea, Sudan and Tunisia. The field strength generated by an amateur station in the frequency band 50-54 MHz shall not exceed a value of +6 dB(μV/m) at a height of 10 m above ground for more than 10% of time along the borders of listed countries requiring protection. (WRC-19)

5.169B Except countries listed under No. **5.169**, stations in the amateur service used in Region 1, in all or part of the 50-54 MHz frequency band, shall not cause harmful interference to, or claim protection from, stations of other services used in accordance with the Radio Regulations in Algeria, Armenia, Azerbaijan, Belarus, Egypt, Russian Federation, Iran (Islamic Republic of), Iraq, Kazakhstan, Kyrgyzstan, Libya, Uzbekistan, Palestine*, the Syrian Arab Republic, Sudan, Tunisia and Ukraine. The field strength generated by an amateur station in the frequency band 50-54 MHz shall not exceed a value of +6 dB(μV/m) at a height of 10 m above ground for more than 10% of time along the borders of the countries listed in this provision. (WRC-19)

5.170 *Additional allocation:* in New Zealand, the frequency band 51-54 MHz is also allocated to the fixed and mobile services on a primary basis. (WRC-15)

5.171 *Additional allocation:* in Botswana, Eswatini, Lesotho, Malawi, Mali, Namibia, Dem. Rep. of the Congo, Rwanda, South Africa, Zambia and Zimbabwe, the frequency band 54-68 MHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-19)

5.172 *Different category of service:* in the French overseas departments and communities in Region 2 and Guyana, the allocation of the frequency band 54-68 MHz to the fixed and mobile services is on a primary basis (see No. **5.33**). (WRC-15)

5.173 *Different category of service:* in the French overseas departments and communities in Region 2 and Guyana, the allocation of the frequency band 68-72 MHz to the fixed and mobile services is on a primary basis (see No. **5.33**). (WRC-15)

5.174 (SUP - WRC-07)

5.175 *Alternative allocation:* in Armenia, Belarus, the Russian Federation, Kazakhstan, Moldova, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan and Ukraine, the frequency bands 68-73 MHz and 76-87.5 MHz are allocated to the broadcasting service on a primary basis. In Latvia and Lithuania, the frequency bands 68-73 MHz and 76-87.5 MHz are allocated to the broadcasting and mobile, except aeronautical mobile, services on a primary basis. In Mongolia, the frequency band 76-87.5 MHz is allocated to the broadcasting service on a primary basis; the stations of the broadcasting service shall not cause harmful interference to, or claim protection from, existing or planned fixed and mobile stations in the neighbouring countries. The services to which these frequency bands are allocated in other countries and the broadcasting service in the countries listed above are subject to agreements with the neighbouring countries concerned. (WRC-23)

5.176 *Additional allocation:* in Australia, China, Korea (Rep. of), the Philippines, the Dem. People's Rep. of Korea and Samoa, the band 68-74 MHz is also allocated to the broadcasting service on a primary basis. (WRC-07)

5.177 *Additional allocation:* in Armenia, Belarus, the Russian Federation, Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan and Ukraine, the frequency band 73-74 MHz is also allocated to the broadcasting service on a primary basis, subject to agreement obtained under No. **9.21**. (WRC-23)

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* Pursuant to Resolution 99 (Rev. Dubai, 2018) and taking into account the Israeli-Palestinian Interim Agreement of 28 September 1995.

5.178 *Additional allocation:* in Colombia, Cuba, El Salvador, Guatemala, Guyana, Honduras and Nicaragua, the band 73-74.6 MHz is also allocated to the fixed and mobile services on a secondary basis. (WRC-12)

5.179 *Additional allocation:* in Armenia, Azerbaijan, Belarus, China, the Russian Federation, Georgia, Kazakhstan, Lithuania, Mongolia, Kyrgyzstan, Tajikistan, Turkmenistan and Ukraine, the bands 74.6-74.8 MHz and 75.2-75.4 MHz are also allocated to the aeronautical radionavigation service, on a primary basis, for ground-based transmitters only. (WRC-12)

5.180 The frequency 75 MHz is assigned to marker beacons. Administrations shall refrain from assigning frequencies close to the limits of the guardband to stations of other services which, because of their power or geographical position, might cause harmful interference or otherwise place a constraint on marker beacons.

Every effort should be made to improve further the characteristics of airborne receivers and to limit the power of transmitting stations close to the limits 74.8 MHz and 75.2 MHz.

5.181 *Additional allocation:* in Egypt, Israel and the Syrian Arab Republic, the band 74.8-75.2 MHz is also allocated to the mobile service on a secondary basis, subject to agreement obtained under No. **9.21**. In order to ensure that harmful interference is not caused to stations of the aeronautical radionavigation service, stations of the mobile service shall not be introduced in the band until it is no longer required for the aeronautical radionavigation service by any administration which may be identified in the application of the procedure invoked under No. **9.21**. (WRC-03)

75.2-137.175 MHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td rowspan="4">75.2-87.5
FIXED
MOBILE except aeronautical mobile

5.175 5.179 5.187</td><td colspan="2">75.2-75.4
FIXED
MOBILE
5.179</td></tr>
<tr><td>75.4-76
FIXED
MOBILE</td><td rowspan="2">75.4-87
FIXED
MOBILE

5.182 5.183 5.188</td></tr>
<tr><td rowspan="2">76-88
BROADCASTING
Fixed
Mobile

5.185</td></tr>
<tr><td rowspan="2">87.5-100
BROADCASTING

5.190</td><td rowspan="2">87-100
FIXED
MOBILE
BROADCASTING</td></tr>
<tr><td>88-100
BROADCASTING</td></tr>
<tr><td>100-108</td><td colspan="2">BROADCASTING
5.192 5.194</td></tr>
<tr><td>108-117.975</td><td colspan="2">AERONAUTICAL RADIONAVIGATION
5.197 5.197A</td></tr>
<tr><td>117.975-137</td><td colspan="2">AERONAUTICAL MOBILE (R)
AERONAUTICAL MOBILE-SATELLITE (R) 5.198A 5.198B
5.111 5.200 5.201 5.202</td></tr>
<tr><td>137-137.025</td><td colspan="2">SPACE OPERATION (space-to-Earth) 5.203C
METEOROLOGICAL-SATELLITE (space-to-Earth)
MOBILE-SATELLITE (space-to-Earth) 5.208 5.208A 5.208B 5.209
SPACE RESEARCH (space-to-Earth)
Fixed
Mobile except aeronautical mobile (R) 5.206
5.204 5.205 5.207</td></tr>
<tr><td>137.025-137.175</td><td colspan="2">SPACE OPERATION (space-to-Earth) 5.203C
METEOROLOGICAL-SATELLITE (space-to-Earth)
SPACE RESEARCH (space-to-Earth)
Fixed
Mobile except aeronautical mobile (R) 5.206
Mobile-satellite (space-to-Earth) 5.208 5.208A 5.208B 5.209
5.204 5.205 5.207</td></tr>
</table>

5.182 *Additional allocation:* in Samoa, the band 75.4-87 MHz is also allocated to the broadcasting service on a primary basis. (WRC-23)

5.183 *Additional allocation:* in China, Korea (Rep. of), Japan, the Philippines and the Dem. People's Rep. of Korea, the band 76-87 MHz is also allocated to the broadcasting service on a primary basis.

5.184 (SUP - WRC-07)

5.185 *Different category of service:* in the United States, the French overseas departments and communities in Region 2 and Guyana, the allocation of the frequency band 76-88 MHz to the fixed and mobile services is on a primary basis (see No. **5.33**). (WRC-23)

5.186 (SUP - WRC-97)

5.187 *Alternative allocation:* in Albania, the band 81-87.5 MHz is allocated to the broadcasting service on a primary basis and used in accordance with the decisions contained in the Final Acts of the Special Regional Conference (Geneva, 1960).

5.188 *Additional allocation:* in Australia, the band 85-87 MHz is also allocated to the broadcasting service on a primary basis. The introduction of the broadcasting service in Australia is subject to special agreements between the administrations concerned.

5.189 Not used.

5.190 *Additional allocation:* in Monaco, the band 87.5-88 MHz is also allocated to the land mobile service on a primary basis, subject to agreement obtained under No. **9.21**. (WRC-97)

5.191 Not used.

5.192 *Additional allocation:* in China and Korea (Rep. of), the band 100-108 MHz is also allocated to the fixed and mobile services on a primary basis. (WRC-97)

5.193 Not used.

5.194 *Additional allocation:* in Kyrgyzstan, Somalia and Turkmenistan, the frequency band 104-108 MHz is also allocated to the mobile, except aeronautical mobile (R), service on a secondary basis. (WRC-19)

5.195 and **5.196** Not used.

5.197 *Additional allocation:* in the Syrian Arab Republic, the band 108-111.975 MHz is also allocated to the mobile service on a secondary basis, subject to agreement obtained under No. **9.21**. In order to ensure that harmful interference is not caused to stations of the aeronautical radionavigation service, stations of the mobile service shall not be introduced in the band until it is no longer required for the aeronautical radionavigation service by any administration which may be identified in the application of the procedures invoked under No. **9.21**. (WRC-12)

5.197A *Additional allocation:* the frequency band 108-117.975 MHz is also allocated on a primary basis to the aeronautical mobile (R) service, limited to systems operating in accordance with recognized international aeronautical standards. Such use shall be in accordance with Resolution **413 (Rev.WRC-23)**. The use of the frequency band 108-112 MHz by the aeronautical mobile (R) service shall be limited to systems composed of ground-based transmitters and associated receivers that provide navigational information in support of air navigation functions in accordance with recognized international aeronautical standards. (WRC-23)

5.198 (SUP - WRC-07)

5.198A The use of the frequency band 117.975-137 MHz by the aeronautical mobile-satellite (R) service is subject to coordination under No. **9.11A**. No. **9.16** does not apply. Such use shall be limited to non-geostationary-satellite systems operated in accordance with international aeronautical standards. Resolution **406 (WRC-23)** applies. (WRC-23)

5.198B The use of the frequency band 117.975-137 MHz by the aeronautical mobile (R) service shall have priority over use by the aeronautical mobile-satellite (R) service. (WRC-23)

5.199 (SUP - WRC-07)

5.200 In the frequency band 117.975-137 MHz, the frequency 121.5 MHz is the aeronautical emergency frequency and, where required, the frequency 123.1 MHz is the aeronautical frequency auxiliary to 121.5 MHz. Mobile stations of the maritime mobile service may communicate on these frequencies under the conditions laid down in Article **31** for distress and safety purposes with stations of the aeronautical mobile service and the aeronautical mobile-satellite service. (WRC-23)

5.201 *Additional allocation:* in Saudi Arabia, Armenia, Azerbaijan, Bahrain, Egypt, Estonia, the Russian Federation, Georgia, Hungary, Iran (Islamic Republic of), Iraq (Republic of), Japan, Kazakhstan, Mali, Mongolia, Mozambique, Uzbekistan, Papua New Guinea, Poland, Qatar, Kyrgyzstan, Romania, Senegal, Somalia, Tajikistan and Turkmenistan, the frequency band 132-136 MHz is also allocated to the aeronautical mobile (OR) service on a primary basis. In assigning frequencies to stations of the aeronautical mobile (OR) service, the administration shall take account of the frequencies assigned to stations in the aeronautical mobile (R) service. (WRC-23)

5.202 *Additional allocation:* in Saudi Arabia, Armenia, Azerbaijan, Bahrain, the United Arab Emirates, the Russian Federation, Georgia, Iran (Islamic Republic of), Jordan, Mali, Oman, Uzbekistan, Poland, the Syrian Arab Republic, Kyrgyzstan, Romania, Senegal, Tajikistan and Turkmenistan, the frequency band 136-137 MHz is also allocated to the aeronautical mobile (OR) service on a primary basis. In assigning frequencies to stations of the aeronautical mobile (OR) service, the administration shall take account of the frequencies assigned to stations in the aeronautical mobile (R) service. (WRC-23)

5.203 (SUP - WRC-07)

5.203A (SUP - WRC-07)

5.203B (SUP - WRC-07)

5.203C The use of the space operation service (space-to-Earth) with non-geostationary satellite short-duration mission systems in the frequency band 137-138 MHz is subject to Resolution **660 (WRC-19)**. Resolution **32 (WRC-19)*** applies. These systems shall not cause harmful interference to, or claim protection from, the existing services to which the frequency band is allocated on a primary basis. (WRC-19)

5.204 *Different category of service:* in Afghanistan, Saudi Arabia, Bahrain, Bangladesh, Brunei Darussalam, China, Cuba, the United Arab Emirates, India, Indonesia, Iran (Islamic Republic of), Iraq, Kuwait, Montenegro, Oman, Pakistan, the Philippines, Qatar, Singapore, Thailand and Yemen, the frequency band 137-138 MHz is allocated to the fixed and mobile, except aeronautical mobile (R), services on a primary basis (see No. **5.33**). (WRC-19)

5.205 *Different category of service:* in Israel and Jordan, the allocation of the band 137-138 MHz to the fixed and mobile, except aeronautical mobile, services is on a primary basis (see No. **5.33**).

5.206 *Different category of service:* in Armenia, Azerbaijan, Belarus, Bulgaria, Egypt, the Russian Federation, Finland, France, Georgia, Greece, Kazakhstan, Lebanon, Moldova, Mongolia, Uzbekistan, Poland, Kyrgyzstan, the Syrian Arab Republic, Slovakia, the Czech Rep., Romania, Tajikistan, Turkmenistan and Ukraine, the allocation of the band 137-138 MHz to the aeronautical mobile (OR) service is on a primary basis (see No. **5.33**). (WRC-2000)

5.207 *Additional allocation:* in Australia, the band 137-144 MHz is also allocated to the broadcasting service on a primary basis until that service can be accommodated within regional broadcasting allocations.

5.208 The use of the band 137-138 MHz by the mobile-satellite service is subject to coordination under No. **9.11A**. (WRC-97)

5.208A In making assignments to space stations in the mobile-satellite service in the frequency bands 137-138 MHz, 387-390 MHz and 400.15-401 MHz and in the maritime mobile-satellite service (space-to-Earth) in the frequency bands 157.1875-157.3375 MHz and 161.7875-161.9375 MHz, administrations shall take all practicable steps to protect the radio astronomy service in the frequency bands 150.05-153 MHz, 322-328.6 MHz, 406.1-410 MHz and 608-614 MHz from harmful interference from unwanted emissions as shown in the most recent version of Recommendation ITU-R RA.769. (WRC-19)

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* *Note by the Secretariat:* This Resolution was revised by WRC-23.

5.208B* In the frequency bands:

137-138 MHz,
157.1875-157.3375 MHz,
161.7875-161.9375 MHz,
387-390 MHz,
400.15-401 MHz,
1 452-1 492 MHz,
1 525-1 610 MHz,
1 613.8-1 626.5 MHz,
2 655-2 690 MHz,
21.4-22 GHz,

Resolution **739 (Rev.WRC-19)** applies. (WRC-19)

5.209 The use of the bands 137-138 MHz, 148-150.05 MHz, 399.9-400.05 MHz, 400.15-401 MHz, 454-456 MHz and 459-460 MHz by the mobile-satellite service is limited to non-geostationary-satellite systems. (WRC-97)

5.209A The use of the frequency band 137.175-137.825 MHz by non-geostationary-satellite systems in the space operation service identified as short-duration mission in accordance with Appendix **4** is not subject to No. **9.11A**. (WRC-19)

* This provision was previously numbered as No. **5.347A**. It was renumbered to preserve the sequential order.

137.175-148 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
137.175-137.825	SPACE OPERATION (space-to-Earth) 5.203C 5.209A METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) 5.208 5.208A 5.208B 5.209 SPACE RESEARCH (space-to-Earth) Fixed Mobile except aeronautical mobile (R) 5.206 5.204 5.205 5.207	
137.825-138	SPACE OPERATION (space-to-Earth) 5.203C METEOROLOGICAL-SATELLITE (space-to-Earth) SPACE RESEARCH (space-to-Earth) Fixed Mobile except aeronautical mobile (R) 5.206 Mobile-satellite (space-to-Earth) 5.208A 5.208B 5.209 5.204 5.205 5.207	
138-143.6 AERONAUTICAL MOBILE (OR) 5.210 5.211 5.212 5.214	**138-143.6** FIXED MOBILE RADIOLOCATION Space research (space-to-Earth)	**138-143.6** FIXED MOBILE Space research (space-to-Earth) 5.207 5.213
143.6-143.65 AERONAUTICAL MOBILE (OR) SPACE RESEARCH (space-to-Earth) 5.211 5.212 5.214	**143.6-143.65** FIXED MOBILE RADIOLOCATION SPACE RESEARCH (space-to-Earth)	**143.6-143.65** FIXED MOBILE SPACE RESEARCH (space-to-Earth) 5.207 5.213
143.65-144 AERONAUTICAL MOBILE (OR) 5.210 5.211 5.212 5.214	**143.65-144** FIXED MOBILE RADIOLOCATION Space research (space-to-Earth)	**143.65-144** FIXED MOBILE Space research (space-to-Earth) 5.207 5.213
144-146	AMATEUR AMATEUR-SATELLITE 5.216	
146-148 FIXED MOBILE except aeronautical mobile (R)	**146-148** AMATEUR 5.217	**146-148** AMATEUR FIXED MOBILE 5.217

5.210 *Additional allocation:* in Italy and the United Kingdom, the frequency bands 138-143.6 MHz and 143.65-144 MHz are also allocated to the space research service (space-to-Earth) on a secondary basis. (WRC-23)

5.211 *Additional allocation:* in Germany, Saudi Arabia, Austria, Bahrain, Belgium, Denmark, the United Arab Emirates, Spain, Finland, Greece, Guinea, Ireland, Israel, Kenya, Kuwait, Lebanon, Liechtenstein, Luxembourg, North Macedonia, Mali, Malta, Montenegro, Norway, the Netherlands, Qatar, Türkiye, Slovakia, the United Kingdom, Serbia, Slovenia, Somalia, Sweden, Switzerland, Tanzania and Tunisia, the frequency band 138-144 MHz is also allocated to the maritime mobile and land mobile services on a primary basis. (WRC-23)

5.212 *Alternative allocation:* in Angola, Botswana, Cameroon, the Central African Rep., Congo (Rep. of the), Eswatini, Gabon, Gambia, Ghana, Guinea, Iraq, Jordan, Lesotho, Liberia, Libya, Malawi, Mozambique, Namibia, Niger, Oman, Uganda, Syrian Arab Republic, the Dem. Rep. of the Congo, Rwanda, Sierra Leone, South Africa, Chad, Togo, Zambia and Zimbabwe, the frequency band 138-144 MHz is allocated to the fixed and mobile services on a primary basis. (WRC-19)

5.213 *Additional allocation:* in China, the band 138-144 MHz is also allocated to the radiolocation service on a primary basis.

5.214 *Additional allocation:* in Eritrea, Ethiopia, Kenya, North Macedonia, Montenegro, Serbia, Somalia, Sudan, South Sudan and Tanzania, the frequency band 138-144 MHz is also allocated to the fixed service on a primary basis. (WRC-19)

5.215 Not used.

5.216 *Additional allocation:* in China, the band 144-146 MHz is also allocated to the aeronautical mobile (OR) service on a secondary basis.

5.217 *Alternative allocation:* in Afghanistan, Bangladesh, Cuba, Guyana and India, the band 146-148 MHz is allocated to the fixed and mobile services on a primary basis.

148-156.8375 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
148-149.9 FIXED MOBILE except aeronautical mobile (R) MOBILE-SATELLITE (Earth-to-space) 5.209 5.218 5.218A 5.219 5.221	**148-149.9** FIXED MOBILE MOBILE-SATELLITE (Earth-to-space) 5.209 5.218 5.218A 5.219 5.221	
149.9-150.05	MOBILE-SATELLITE (Earth-to-space) 5.209 5.220	
150.05-153 FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY 5.149	**150.05-154** FIXED MOBILE	
153-154 FIXED MOBILE except aeronautical mobile (R) Meteorological aids	5.225	
154-156.4875 FIXED MOBILE except aeronautical mobile (R) 5.225A 5.226	**154-156.4875** FIXED MOBILE 5.226	**154-156.4875** FIXED MOBILE 5.225A 5.226
156.4875-156.5625	MARITIME MOBILE (distress and calling via DSC) 5.111 5.226 5.227	
156.5625-156.7625 FIXED MOBILE except aeronautical mobile (R) 5.226	**156.5625-156.7625** FIXED MOBILE 5.226	
156.7625-156.7875 MARITIME MOBILE Mobile-satellite (Earth-to-space) 5.111 5.226 5.228	**156.7625-156.7875** MARITIME MOBILE MOBILE-SATELLITE (Earth-to-space) 5.111 5.226 5.228	**156.7625-156.7875** MARITIME MOBILE Mobile-satellite (Earth-to-space) 5.111 5.226 5.228
156.7875-156.8125	MARITIME MOBILE (distress and calling) 5.111 5.226	
156.8125-156.8375 MARITIME MOBILE Mobile-satellite (Earth-to-space) 5.111 5.226 5.228	**156.8125-156.8375** MARITIME MOBILE MOBILE-SATELLITE (Earth-to-space) 5.111 5.226 5.228	**156.8125-156.8375** MARITIME MOBILE Mobile-satellite (Earth-to-space) 5.111 5.226 5.228

5.218 *Additional allocation:* the band 148-149.9 MHz is also allocated to the space operation service (Earth-to-space) on a primary basis, subject to agreement obtained under No. **9.21**. The bandwidth of any individual transmission shall not exceed ± 25 kHz.

5.218A The frequency band 148-149.9 MHz in the space operation service (Earth-to-space) may be used by non-geostationary-satellite systems with short-duration missions. Non-geostationary-satellite systems in the space operation service used for a short-duration mission in accordance with Resolution **32 (WRC-19)*** of the Radio Regulations are not subject to agreement under No. **9.21**. At the stage of coordination, the provisions of Nos. **9.17** and **9.18** also apply. In the frequency band 148-149.9 MHz, non-geostationary-satellite systems with short-duration missions shall not cause unacceptable interference to, or claim protection from, existing primary services within this frequency band, or impose additional constraints on the space operation and mobile-satellite services. In addition, earth stations in non-geostationary-satellite systems in the space operation service with short-duration missions in the frequency band 148-149.9 MHz shall ensure that the power flux-density does not exceed −149 dB(W/(m^2 · 4 kHz)) for more than 1% of time at the border of the territory of the following countries: Armenia, Azerbaijan, Belarus, China, Korea (Rep. of), Cuba, Russian Federation, India, Iran (Islamic Republic of), Japan, Kazakhstan, Malaysia, Uzbekistan, Kyrgyzstan, Thailand and Viet Nam. In case this power flux-density limit is exceeded, agreement under No. **9.21** is required to be obtained from countries mentioned in this footnote. (WRC-19)

5.219 The use of the frequency band 148-149.9 MHz by the mobile-satellite service is subject to coordination under No. **9.11A**. The mobile-satellite service shall not constrain the development and use of the fixed, mobile and space operation services in the frequency band 148-149.9 MHz. The use of the frequency band 148-149.9 MHz by non-geostationary-satellite systems in the space operation service identified as short-duration mission is not subject to No. **9.11A**. (WRC-19)

5.220 The use of the frequency bands 149.9-150.05 MHz and 399.9-400.05 MHz by the mobile-satellite service is subject to coordination under No. **9.11A**. (WRC-15)

5.221 Stations of the mobile-satellite service in the frequency band 148-149.9 MHz shall not cause harmful interference to, or claim protection from, stations of the fixed or mobile services operating in accordance with the Table of Frequency Allocations in the following countries: Albania, Algeria, Germany, Saudi Arabia, Australia, Austria, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Benin, Bosnia and Herzegovina, Botswana, Brunei Darussalam, Bulgaria, Cameroon, China, Cyprus, Congo (Rep. of the), Korea (Rep. of), Côte d'Ivoire, Croatia, Cuba, Denmark, Djibouti, Egypt, the United Arab Emirates, Eritrea, Spain, Estonia, Eswatini, Ethiopia, the Russian Federation, Finland, France, Gabon, Georgia, Ghana, Greece, Guinea, Guinea Bissau, Hungary, India, Iran (Islamic Republic of), Ireland, Iceland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kuwait, Lesotho, Latvia, Lebanon, Libya, Liechtenstein, Lithuania, Luxembourg, North Macedonia, Malaysia, Mali, Malta, Mauritania, Moldova, Mongolia, Montenegro, Mozambique, Namibia, Norway, New Zealand, Oman, Uganda, Uzbekistan, Pakistan, Panama, Papua New Guinea, Paraguay, the Netherlands, the Philippines, Poland, Portugal, Qatar, the Syrian Arab Republic, Türkiye, Kyrgyzstan, Dem. People's Rep. of Korea, Slovakia, Romania, the United Kingdom, Senegal, Serbia, Sierra Leone, Singapore, Slovenia, Somalia, Sudan, Sri Lanka, South Africa, Sweden, Switzerland, Tanzania, Chad, Togo, Tonga, Trinidad and Tobago, Tunisia, Ukraine, Viet Nam, Yemen, Zambia and Zimbabwe. (WRC-23)

5.222 (SUP - WRC-15)

5.223 (SUP - WRC-15)

5.224 (SUP - WRC-97)

5.224A (SUP - WRC-15)

5.224B (SUP - WRC-15)

5.225 *Additional allocation:* in Australia and India, the band 150.05-153 MHz is also allocated to the radio astronomy service on a primary basis.

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* *Note by the Secretariat:* This Resolution was revised by WRC-23.

5.225A *Additional allocation:* in Algeria, Armenia, Azerbaijan, Belarus, China, the Russian Federation, France, Iran (Islamic Republic of), Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan, Ukraine and Viet Nam, the frequency band 154-156 MHz is also allocated to the radiolocation service on a primary basis. The usage of the frequency band 154-156 MHz by the radiolocation service shall be limited to space-object detection systems operating from terrestrial locations. The operation of stations in the radiolocation service in the frequency band 154-156 MHz shall be subject to agreement obtained under No. **9.21**. For the identification of potentially affected administrations in Region 1, the instantaneous field-strength value of 12 dB(μV/m) for 10% of the time produced at 10 m above ground level in the 25 kHz reference frequency band at the border of the territory of any other administration shall be used. For the identification of potentially affected administrations in Region 3, the interference-to-noise ratio (I/N) value of −6 dB (N = −161 dBW/4 kHz), or −10 dB for applications with greater protection requirements, such as public protection and disaster relief (PPDR (N = −161 dBW/4 kHz)), for 1% of the time produced at 60 m above ground level at the border of the territory of any other administration shall be used. In the frequency bands 156.7625-156.8375 MHz, 156.5125-156.5375 MHz, 161.9625-161.9875 MHz, 162.0125-162.0375 MHz, out-of-band e.i.r.p. of space surveillance radars shall not exceed −16 dBW. Frequency assignments to the radiolocation service under this allocation in Ukraine shall not be used without the agreement of Moldova. (WRC-12)

5.226 The frequency 156.525 MHz is the international distress, safety and calling frequency for the maritime mobile VHF radiotelephone service using digital selective calling (DSC). The conditions for the use of this frequency and the band 156.4875-156.5625 MHz are contained in Articles **31** and **52**, and in Appendix **18**.

The frequency 156.8 MHz is the international distress, safety and calling frequency for the maritime mobile VHF radiotelephone service. The conditions for the use of this frequency and the band 156.7625-156.8375 MHz are contained in Article **31** and Appendix **18**.

In the bands 156-156.4875 MHz, 156.5625-156.7625 MHz, 156.8375-157.45 MHz, 160.6-160.975 MHz and 161.475-162.05 MHz, each administration shall give priority to the maritime mobile service on only such frequencies as are assigned to stations of the maritime mobile service by the administration (see Articles **31** and **52**, and Appendix **18**).

Any use of frequencies in these bands by stations of other services to which they are allocated should be avoided in areas where such use might cause harmful interference to the maritime mobile VHF radiocommunication service.

However, the frequencies 156.8 MHz and 156.525 MHz and the frequency bands in which priority is given to the maritime mobile service may be used for radiocommunications on inland waterways subject to agreement between interested and affected administrations and taking into account current frequency usage and existing agreements. (WRC-07)

5.227 *Additional allocation:* the bands 156.4875-156.5125 MHz and 156.5375-156.5625 MHz are also allocated to the fixed and land mobile services on a primary basis. The use of these bands by the fixed and land mobile services shall not cause harmful interference to nor claim protection from the maritime mobile VHF radiocommunication service. (WRC-07)

5.227A (SUP - WRC-12)

5.228 The use of the frequency bands 156.7625-156.7875 MHz and 156.8125-156.8375 MHz by the mobile-satellite service (Earth-to-space) is limited to the reception of automatic identification system (AIS) emissions of long-range AIS broadcast messages (Message 27, see the most recent version of Recommendation ITU-R M.1371). With the exception of AIS emissions, emissions in these frequency bands by systems operating in the maritime mobile service for communications shall not exceed 1 W. (WRC-12)

156.8375-161.9375 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
156.8375-157.1875 FIXED MOBILE except aeronautical mobile 5.226	**156.8375-157.1875** FIXED MOBILE 5.226	
157.1875-157.3375 FIXED MOBILE except aeronautical mobile Maritime mobile-satellite 5.208A 5.208B 5.228AB 5.228AC 5.226	**157.1875-157.3375** FIXED MOBILE Maritime mobile-satellite 5.208A 5.208B 5.228AB 5.228AC 5.226	
157.3375-161.7875 FIXED MOBILE except aeronautical mobile 5.226	**157.3375-161.7875** FIXED MOBILE 5.226	
161.7875-161.9375 FIXED MOBILE except aeronautical mobile Maritime mobile-satellite 5.208A 5.208B 5.228AB 5.228AC 5.226	**161.7875-161.9375** FIXED MOBILE Maritime mobile-satellite 5.208A 5.208B 5.228AB 5.228AC 5.226	

5.228AB The use of the frequency bands 157.1875-157.3375 MHz and 161.7875-161.9375 MHz by the maritime mobile-satellite service (Earth-to-space) is limited to non-geostationary-satellite systems operating in accordance with Appendix **18**. (WRC-19)

5.228AC The use of the frequency bands 157.1875-157.3375 MHz and 161.7875-161.9375 MHz by the maritime mobile-satellite service (space-to-Earth) is limited to non-geostationary-satellite systems operating in accordance with Appendix **18**. Such use is subject to agreement obtained under No. **9.21** with respect to the terrestrial services in Azerbaijan, Belarus, China, Korea (Rep. of), Cuba, the Russian Federation, the Syrian Arab Republic, the Dem. People's Rep. of Korea, South Africa and Viet Nam. (WRC-19)

161.9375-223 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
161.9375-161.9625 FIXED MOBILE except aeronautical mobile Maritime mobile-satellite (Earth-to-space) 5.228AA 5.226	**161.9375-161.9625** FIXED MOBILE Maritime mobile-satellite (Earth-to-space) 5.228AA 5.226	
161.9625-161.9875 FIXED MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) 5.228F 5.226 5.228A 5.228B	**161.9625-161.9875** AERONAUTICAL MOBILE (OR) MARITIME MOBILE MOBILE-SATELLITE (Earth-to-space) 5.228C 5.228D	**161.9625-161.9875** MARITIME MOBILE Aeronautical mobile (OR) 5.228E Mobile-satellite (Earth-to-space) 5.228F 5.226
161.9875-162.0125 FIXED MOBILE except aeronautical mobile Maritime mobile-satellite (Earth-to-space) 5.228AA 5.226	**161.9875-162.0125** FIXED MOBILE Maritime mobile-satellite (Earth-to-space) 5.228AA 5.226	
162.0125-162.0375 FIXED MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) 5.228F 5.226 5.228A 5.228B	**162.0125-162.0375** AERONAUTICAL MOBILE (OR) MARITIME MOBILE MOBILE-SATELLITE (Earth-to-space) 5.228C 5.228D	**162.0125-162.0375** MARITIME MOBILE Aeronautical mobile (OR) 5.228E Mobile-satellite (Earth-to-space) 5.228F 5.226
162.0375-174 FIXED MOBILE except aeronautical mobile 5.226	**162.0375-174** FIXED MOBILE 5.226 5.230 5.231	
174-223 BROADCASTING 5.235 5.237 5.243	**174-216** BROADCASTING Fixed Mobile **216-220** FIXED MARITIME MOBILE Radiolocation 5.241 5.242	**174-223** FIXED MOBILE BROADCASTING 5.233 5.238 5.240 5.245

5.228A The frequency bands 161.9625-161.9875 MHz and 162.0125-162.0375 MHz may be used by aircraft stations for the purpose of search and rescue operations and other safety-related communications. (WRC-12)

5.228AA The use of the frequency bands 161.9375-161.9625 MHz and 161.9875-162.0125 MHz by the maritime mobile-satellite (Earth-to-space) service is limited to the systems which operate in accordance with Appendix **18**. (WRC-15)

5.228B The use of the frequency bands 161.9625-161.9875 MHz and 162.0125-162.0375 MHz by the fixed and land mobile services shall not cause harmful interference to, or claim protection from, the maritime mobile service. (WRC-12)

5.228C The use of the frequency bands 161.9625-161.9875 MHz and 162.0125-162.0375 MHz by the maritime mobile service and the mobile-satellite (Earth-to-space) service is limited to the automatic identification system (AIS), including AIS search and rescue transmitters (AIS-SART) and satellite emergency position indicating radio beacons with AIS (EPIRB-AIS). The use of these frequency bands by the aeronautical mobile (OR) service is limited to AIS emissions from search and rescue aircraft operations. The AIS, AIS-SART and EPIRB-AIS operations in these frequency bands shall not constrain the development and use of the fixed and mobile services operating in the adjacent frequency bands. (WRC-23)

5.228D The frequency bands 161.9625-161.9875 MHz (AIS 1) and 162.0125-162.0375 MHz (AIS 2) may continue to be used by the fixed and mobile services on a primary basis until 1 January 2025, at which time this allocation shall no longer be valid. Administrations are encouraged to make all practicable efforts to discontinue the use of these bands by the fixed and mobile services prior to the transition date. During this transition period, the maritime mobile service in these frequency bands has priority over the fixed, land mobile and aeronautical mobile services. (WRC-12)

5.228E The use of the automatic identification system in the frequency bands 161.9625-161.9875 MHz and 162.0125-162.0375 MHz by the aeronautical mobile (OR) service is limited to aircraft stations for the purpose of search and rescue operations and other safety-related communications. (WRC-12)

5.228F The use of the frequency bands 161.9625-161.9875 MHz and 162.0125-162.0375 MHz by the mobile-satellite service (Earth-to-space) is limited to the reception of automatic identification system emissions from stations operating in the maritime mobile service. (WRC-12)

5.229 (SUP - WRC-23)

5.230 *Additional allocation:* in China, the band 163-167 MHz is also allocated to the space operation service (space-to-Earth) on a primary basis, subject to agreement obtained under No. **9.21**.

5.231 *Additional allocation:* in Afghanistan and China, the band 167-174 MHz is also allocated to the broadcasting service on a primary basis. The introduction of the broadcasting service into this band shall be subject to agreement with the neighbouring countries in Region 3 whose services are likely to be affected. (WRC-12)

5.232 (SUP - WRC-15)

5.233 *Additional allocation:* in China, the band 174-184 MHz is also allocated to the space research (space-to-Earth) and the space operation (space-to-Earth) services on a primary basis, subject to agreement obtained under No. **9.21**. These services shall not cause harmful interference to, or claim protection from, existing or planned broadcasting stations.

5.234 (SUP - WRC-15)

5.235 *Additional allocation:* in Germany, Austria, Belgium, Denmark, Spain, Finland, France, Israel, Italy, Liechtenstein, Malta, Monaco, Norway, the Netherlands, the United Kingdom, Sweden and Switzerland, the band 174-223 MHz is also allocated to the land mobile service on a primary basis. However, the stations of the land mobile service shall not cause harmful interference to, or claim protection from, broadcasting stations, existing or planned, in countries other than those listed in this footnote.

5.236 Not used.

5.237 *Additional allocation:* in Congo (Rep. of the), Egypt, Eritrea, Ethiopia, Gambia, Guinea, Libya, Mali, Sierra Leone, Somalia and Chad, the band 174-223 MHz is also allocated to the fixed and mobile services on a secondary basis. (WRC-12)

5.238 *Additional allocation:* in Bangladesh, India, Pakistan and the Philippines, the band 200-216 MHz is also allocated to the aeronautical radionavigation service on a primary basis.

5.239 Not used.

5.240 *Additional allocation:* in China and India, the band 216-223 MHz is also allocated to the aeronautical radionavigation service on a primary basis and to the radiolocation service on a secondary basis.

5.241 In Region 2, no new stations in the radiolocation service may be authorized in the band 216-225 MHz. Stations authorized prior to 1 January 1990 may continue to operate on a secondary basis.

5.242 *Additional allocation:* in Canada and Mexico, the frequency band 216-220 MHz is also allocated to the land mobile service on a primary basis. (WRC-19)

5.243 *Additional allocation:* in Somalia, the band 216-225 MHz is also allocated to the aeronautical radionavigation service on a primary basis, subject to not causing harmful interference to existing or planned broadcasting services in other countries.

5.244 (SUP - WRC-97)

5.245 *Additional allocation:* in Japan, the band 222-223 MHz is also allocated to the aeronautical radionavigation service on a primary basis and to the radiolocation service on a secondary basis.

220-335.4 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
	220-225 AMATEUR FIXED MOBILE Radiolocation 5.241	
223-230 BROADCASTING Fixed Mobile 5.243 5.246 5.247	**225-235** FIXED MOBILE	**223-230** FIXED MOBILE BROADCASTING AERONAUTICAL RADIONAVIGATION Radiolocation 5.250
230-235 FIXED MOBILE 5.247 5.251 5.252		**230-235** FIXED MOBILE AERONAUTICAL RADIONAVIGATION 5.250
235-267	FIXED MOBILE 5.111 5.252 5.254 5.256 5.256A	
267-272	FIXED MOBILE Space operation (space-to-Earth) 5.254 5.257	
272-273	SPACE OPERATION (space-to-Earth) FIXED MOBILE 5.254	
273-312	FIXED MOBILE 5.254	
312-315	FIXED MOBILE Mobile-satellite (Earth-to-space) 5.254 5.255	
315-322	FIXED MOBILE 5.254	
322-328.6	FIXED MOBILE RADIO ASTRONOMY 5.149	
328.6-335.4	AERONAUTICAL RADIONAVIGATION 5.258 5.259	

5.246 *Alternative allocation:* in Spain, France, Israel and Monaco, the band 223-230 MHz is allocated to the broadcasting and land mobile services on a primary basis (see No. **5.33**) on the basis that, in the preparation of frequency plans, the broadcasting service shall have prior choice of frequencies; and allocated to the fixed and mobile, except land mobile, services on a secondary basis. However, the stations of the land mobile service shall not cause harmful interference to, or claim protection from, existing or planned broadcasting stations in Morocco and Algeria.

5.247 *Additional allocation:* in Saudi Arabia, Bahrain, the United Arab Emirates, Jordan, Oman, Qatar and Syrian Arab Republic, the band 223-235 MHz is also allocated to the aeronautical radionavigation service on a primary basis.

5.248 and **5.249** Not used.

5.250 *Additional allocation*: in China, the band 225-235 MHz is also allocated to the radio astronomy service on a secondary basis.

5.251 *Additional allocation:* in Nigeria, the band 230-235 MHz is also allocated to the aeronautical radionavigation service on a primary basis, subject to agreement obtained under No. **9.21**.

5.252 *Alternative allocation:* in Botswana, Eswatini, Lesotho, Malawi, Mozambique, Namibia, South Africa, Zambia and Zimbabwe, the frequency bands 230-238 MHz and 246-254 MHz are allocated to the broadcasting service on a primary basis, subject to agreement obtained under No. **9.21**. (WRC-19)

5.253 Not used.

5.254 The bands 235-322 MHz and 335.4-399.9 MHz may be used by the mobile-satellite service, subject to agreement obtained under No. **9.21**, on condition that stations in this service do not cause harmful interference to those of other services operating or planned to be operated in accordance with the Table of Frequency Allocations except for the additional allocation made in footnote No. **5.256A**. (WRC-03)

5.255 The bands 312-315 MHz (Earth-to-space) and 387-390 MHz (space-to-Earth) in the mobile-satellite service may also be used by non-geostationary-satellite systems. Such use is subject to coordination under No. **9.11A**.

5.256 The frequency 243 MHz is the frequency in this band for use by survival craft stations and equipment used for survival purposes. (WRC-07)

5.256A *Additional allocation:* in China, the Russian Federation and Kazakhstan, the frequency band 258-261 MHz is also allocated to the space research service (Earth-to-space) and space operation service (Earth-to-space) on a primary basis. Stations in the space research service (Earth-to-space) and space operation service (Earth-to-space) shall not cause harmful interference to, or claim protection from, or constrain the use and development of, the mobile service systems and mobile-satellite service systems operating in the frequency band. Stations in space research service (Earth-to-space) and space operation service (Earth-to-space) shall not constrain the future development of fixed service systems of other countries. (WRC-15)

5.257 The band 267-272 MHz may be used by administrations for space telemetry in their countries on a primary basis, subject to agreement obtained under No. **9.21**.

5.258 The use of the band 328.6-335.4 MHz by the aeronautical radionavigation service is limited to Instrument Landing Systems (glide path).

5.259 *Additional allocation:* in Egypt and the Syrian Arab Republic, the band 328.6-335.4 MHz is also allocated to the mobile service on a secondary basis, subject to agreement obtained under No. **9.21**. In order to ensure that harmful interference is not caused to stations of the aeronautical radionavigation service, stations of the mobile service shall not be introduced in the band until it is no longer required for the aeronautical radionavigation service by any administration which may be identified in the application of the procedure invoked under No. **9.21**. (WRC-12)

335.4-410 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
335.4-387	FIXED MOBILE 5.254	
387-390	FIXED MOBILE Mobile-satellite (space-to-Earth) 5.208A 5.208B 5.254 5.255	
390-399.9	FIXED MOBILE 5.254	
399.9-400.05	MOBILE-SATELLITE (Earth-to-space) 5.209 5.220 5.260A 5.260B	
400.05-400.15	STANDARD FREQUENCY AND TIME SIGNAL-SATELLITE (400.1 MHz) 5.261 5.262	
400.15-401	METEOROLOGICAL AIDS METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) 5.208A 5.208B 5.209 SPACE RESEARCH (space-to-Earth) 5.263 Space operation (space-to-Earth) 5.262 5.264	
401-402	METEOROLOGICAL AIDS SPACE OPERATION (space-to-Earth) EARTH EXPLORATION-SATELLITE (Earth-to-space) METEOROLOGICAL-SATELLITE (Earth-to-space) Fixed Mobile except aeronautical mobile 5.264A 5.264B	
402-403	METEOROLOGICAL AIDS EARTH EXPLORATION-SATELLITE (Earth-to-space) METEOROLOGICAL-SATELLITE (Earth-to-space) Fixed Mobile except aeronautical mobile 5.264A 5.264B	
403-406	METEOROLOGICAL AIDS Fixed Mobile except aeronautical mobile 5.265	
406-406.1	MOBILE-SATELLITE (Earth-to-space) 5.265 5.266 5.267	
406.1-410	FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY 5.149 5.265	

5.260 (SUP - WRC-15)

5.260A In the frequency band 399.9-400.05 MHz, the maximum e.i.r.p. of any emission of earth stations in the mobile-satellite service shall not exceed 5 dBW in any 4 kHz band and the maximum e.i.r.p. of each earth station in the mobile-satellite service shall not exceed 5 dBW in the whole 399.9-400.05 MHz frequency band. Until 22 November 2022, this limit shall not apply to satellite systems for which complete notification information has been received by the Radiocommunication Bureau by 22 November 2019 and that have been brought into use by that date. After 22 November 2022, these limits shall apply to all systems within the mobile-satellite service operating in this frequency band.

In the frequency band 399.99-400.02 MHz, the e.i.r.p. limits as specified above shall apply after 22 November 2022 to all systems within the mobile-satellite service. Administrations are requested that their mobile-satellite service satellite links in the 399.99-400.02 MHz frequency band comply with the e.i.r.p. limits as specified above, after 22 November 2019. (WRC-19)

5.260B In the frequency band 400.02-400.05 MHz, the provisions of No. **5.260A** are not applicable for telecommand uplinks within the mobile-satellite service. (WRC-19)

5.261 Emissions shall be confined in a band of ± 25 kHz about the standard frequency 400.1 MHz.

5.262 *Additional allocation:* in Saudi Arabia, Armenia, Azerbaijan, Bahrain, Belarus, Botswana, Colombia, Cuba, Egypt, the United Arab Emirates, Ecuador, the Russian Federation, Georgia, Hungary, Iran (Islamic Republic of), Iraq, Israel, Jordan, Kazakhstan, Kuwait, Liberia, Malaysia, Moldova, Oman, Uzbekistan, Pakistan, the Philippines, Qatar, the Syrian Arab Republic, Kyrgyzstan, Singapore, Somalia, Tajikistan, Chad, Turkmenistan and Ukraine, the band 400.05-401 MHz is also allocated to the fixed and mobile services on a primary basis. (WRC-12)

5.263 The band 400.15-401 MHz is also allocated to the space research service in the space-to-space direction for communications with manned space vehicles. In this application, the space research service will not be regarded as a safety service.

5.264 The use of the band 400.15-401 MHz by the mobile-satellite service is subject to coordination under No. **9.11A**. The power flux-density limit indicated in Annex 1 of Appendix **5** shall apply until such time as a competent world radiocommunication conference revises it.

5.264A In the frequency band 401-403 MHz, the maximum e.i.r.p. of any emission of each earth station in the meteorological-satellite service and the Earth exploration-satellite service shall not exceed 22 dBW in any 4 kHz band for geostationary-satellite systems and non-geostationary-satellite systems with an orbit of apogee equal or greater than 35 786 km.

The maximum e.i.r.p. of any emission of each earth station in the meteorological-satellite service and the Earth exploration-satellite service shall not exceed 7 dBW in any 4 kHz band for non-geostationary-satellite systems with an orbit of apogee lower than 35 786 km.

The maximum e.i.r.p. of each earth station in the meteorological-satellite service and the Earth exploration-satellite service shall not exceed 22 dBW for geostationary-satellite systems and non-geostationary-satellite systems with an orbit of apogee equal or greater than 35 786 km in the whole 401-403 MHz frequency band. The maximum e.i.r.p. of each earth station in the meteorological-satellite service and the Earth exploration-satellite service shall not exceed 7 dBW for non-geostationary-satellite systems with an orbit of apogee lower than 35 786 km in the whole 401-403 MHz frequency band.

Until 22 November 2029, these limits shall not apply to satellite systems for which complete notification information has been received by the Radiocommunication Bureau by 22 November 2019 and that have been brought into use by that date. After 22 November 2029, these limits shall apply to all systems within the meteorological-satellite service and the Earth exploration-satellite service operating in this frequency band. (WRC-19)

5.264B Non-geostationary-satellite systems in the meteorological-satellite service and the Earth exploration-satellite service for which complete notification information has been received by the Radiocommunication Bureau no later than 28 April 2007 are exempt from provisions of No. **5.264A** and may continue to operate in the frequency band 401.898-402.522 MHz on a primary basis without exceeding a maximum e.i.r.p. level of 12 dBW. (WRC-23)

5.265 In the frequency band 403-410 MHz, Resolution **205 (Rev.WRC-19)** applies. (WRC-19)

5.266 The use of the band 406-406.1 MHz by the mobile-satellite service is limited to low power satellite emergency position-indicating radiobeacons (see also Article **31**). (WRC-07)

5.267 Any emission capable of causing harmful interference to the authorized uses of the band 406-406.1 MHz is prohibited.

410-460 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
410-420	FIXED MOBILE except aeronautical mobile SPACE RESEARCH (space-to-space) 5.268	
420-430	FIXED MOBILE except aeronautical mobile Radiolocation 5.269 5.270 5.271	
430-432 AMATEUR RADIOLOCATION 5.271 5.274 5.275 5.276 5.277	**430-432** RADIOLOCATION Amateur 5.278 5.271 5.276 5.279	
432-438 AMATEUR RADIOLOCATION Earth exploration-satellite (active) 5.279A 5.138 5.271 5.276 5.277 5.280 5.281 5.282	**432-438** RADIOLOCATION Amateur 5.278 Earth exploration-satellite (active) 5.279A 5.271 5.276 5.279 5.281 5.282	
438-440 AMATEUR RADIOLOCATION 5.271 5.274 5.275 5.276 5.277 5.283	**438-440** RADIOLOCATION Amateur 5.278 5.271 5.276 5.279	
440-450	FIXED MOBILE except aeronautical mobile Radiolocation 5.269 5.285 5.270 5.271 5.284 5.286	
450-455	FIXED MOBILE 5.286AA 5.209 5.271 5.286 5.286A 5.286B 5.286C 5.286D 5.286E	
455-456 FIXED MOBILE 5.286AA 5.209 5.271 5.286A 5.286B 5.286C 5.286E	**455-456** FIXED MOBILE 5.286AA MOBILE-SATELLITE (Earth-to-space) 5.209 5.286A 5.286B 5.286C	**455-456** FIXED MOBILE 5.286AA 5.209 5.271 5.286A 5.286B 5.286C 5.286E
456-459	FIXED MOBILE 5.286AA 5.287 5.288 5.271	
459-460 FIXED MOBILE 5.286AA 5.209 5.271 5.286A 5.286B 5.286C 5.286E	**459-460** FIXED MOBILE 5.286AA MOBILE-SATELLITE (Earth-to-space) 5.209 5.286A 5.286B 5.286C	**459-460** FIXED MOBILE 5.286AA 5.209 5.271 5.286A 5.286B 5.286C 5.286E

5.268 Use of the frequency band 410-420 MHz by the space research service is limited to space-to-space communication links with an orbiting, manned space vehicle. The power flux-density at the surface of the Earth produced by emissions from transmitting stations of the space research service (space-to-space) in the frequency band 410-420 MHz shall not exceed −153 dB(W/m^2) for $0° \leq \delta \leq 5°$, $-153 + 0.077\ (\delta - 5)$ dB(W/m^2) for $5° \leq \delta \leq 70°$ and −148 dB(W/m^2) for $70° \leq \delta \leq 90°$, where δ is the angle of arrival of the radio-frequency wave and the reference bandwidth is 4 kHz. In this frequency band, stations of the space research service (space-to-space) shall not claim protection from, nor constrain the use and development of, stations of the fixed and mobile services. No. **4.10** does not apply. (WRC-15)

5.269 *Different category of service:* in Australia, Brazil, the United States, India, Japan and the United Kingdom, the allocation of the frequency bands 420-430 MHz and 440-450 MHz to the radiolocation service is on a primary basis (see No. **5.33**). (WRC-23)

5.270 *Additional allocation:* in Australia, the United States, Jamaica and the Philippines, the bands 420-430 MHz and 440-450 MHz are also allocated to the amateur service on a secondary basis.

5.271 *Additional allocation:* in Belarus, China, India, Kyrgyzstan and Turkmenistan, the band 420-460 MHz is also allocated to the aeronautical radionavigation service (radio altimeters) on a secondary basis. (WRC-07)

5.272 (SUP - WRC-12)

5.273 (SUP - WRC-12)

5.274 *Alternative allocation:* in Denmark, Norway, Sweden and Chad, the bands 430-432 MHz and 438-440 MHz are allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-12)

5.275 *Additional allocation:* in Croatia, Estonia, Finland, Libya, North Macedonia, Montenegro and Serbia, the frequency bands 430-432 MHz and 438-440 MHz are also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-19)

5.276 *Additional allocation:* in Afghanistan, Algeria, Saudi Arabia, Bahrain, Bangladesh, Brunei Darussalam, Burkina Faso, Djibouti, Egypt, the United Arab Emirates, Ecuador, Eritrea, Ethiopia, Greece, Guinea, India, Indonesia, Iran (Islamic Republic of), Iraq, Israel, Italy, Jordan, Kenya, Kuwait, Libya, Malaysia, Niger, Nigeria, Oman, Pakistan, the Philippines, Qatar, the Syrian Arab Republic, Türkiye, the Dem. People's Rep. of Korea, Singapore, Somalia, Sudan, Switzerland, Thailand, Togo and Yemen, the frequency band 430-440 MHz is also allocated to the fixed service on a primary basis and the frequency bands 430-435 MHz and 438-440 MHz are also allocated, except in Ecuador, to the mobile, except aeronautical mobile, service on a primary basis. (WRC-23)

5.277 *Additional allocation:* in Angola, Armenia, Azerbaijan, Belarus, Cameroon, Congo (Rep. of the), Djibouti, the Russian Federation, Georgia, Hungary, Israel, Kazakhstan, Mali, Uzbekistan, Poland, the Dem. Rep. of the Congo, Kyrgyzstan, Slovakia, Romania, Rwanda, Tajikistan, Chad, Turkmenistan and Ukraine, the frequency band 430-440 MHz is also allocated to the fixed service on a primary basis. (WRC-19)

5.278 *Different category of service:* in Argentina, Brazil, Colombia, Costa Rica, Cuba, Guyana, Honduras, Panama, Paraguay, Uruguay and Venezuela, the allocation of the frequency band 430-440 MHz to the amateur service is on a primary basis (see No. **5.33**). (WRC-19)

5.279 *Additional allocation:* in Mexico, the frequency bands 430-435 MHz and 438-440 MHz are also allocated on a primary basis to the mobile, except aeronautical mobile, service, and on a secondary basis to the fixed service, subject to agreement obtained under No. **9.21**. (WRC-19)

5.279A The use of the frequency band 432-438 MHz by sensors in the Earth exploration-satellite service (active) shall be in accordance with Recommendation ITU-R RS.1260-2. Additionally, the Earth exploration-satellite service (active) in the frequency band 432-438 MHz shall not cause harmful interference to the aeronautical radionavigation service in China. The provisions of this footnote in no way diminish the obligation of the Earth exploration-satellite service (active) to operate as a secondary service in accordance with Nos. **5.29** and **5.30**. (WRC-19)

5.280 In Germany, Austria, Bosnia and Herzegovina, Croatia, Liechtenstein, North Macedonia, Montenegro, Portugal, Serbia, Slovenia and Switzerland, the frequency band 433.05-434.79 MHz (centre frequency 433.92 MHz) is designated for industrial, scientific and medical (ISM) applications. Radiocommunication services of these countries operating within this frequency band must accept harmful interference which may be caused by these applications. ISM equipment operating in this frequency band is subject to the provisions of No. **15.13**. (WRC-19)

5.281 *Additional allocation:* in the French overseas departments and communities in Region 2 and India, the band 433.75-434.25 MHz is also allocated to the space operation service (Earth-to-space) on a primary basis. In France and in Brazil, the band is allocated to the same service on a secondary basis.

5.282 In the bands 435-438 MHz, 1 260-1 270 MHz, 2 400-2 450 MHz, 3 400-3 410 MHz (in Regions 2 and 3 only) and 5 650-5 670 MHz, the amateur-satellite service may operate subject to not causing harmful interference to other services operating in accordance with the Table (see No. **5.43**). Administrations authorizing such use shall ensure that any harmful interference caused by emissions from a station in the amateur-satellite service is immediately eliminated in accordance with the provisions of No. **25.11**. The use of the bands 1 260-1 270 MHz and 5 650-5 670 MHz by the amateur-satellite service is limited to the Earth-to-space direction.

5.283 *Additional allocation:* in Austria, the band 438-440 MHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis.

5.284 *Additional allocation:* in Canada, the band 440-450 MHz is also allocated to the amateur service on a secondary basis.

5.285 *Different category of service:* in Canada, the allocation of the band 440-450 MHz to the radiolocation service is on a primary basis (see No. **5.33**).

5.286 The band 449.75-450.25 MHz may be used for the space operation service (Earth-to-space) and the space research service (Earth-to-space), subject to agreement obtained under No. **9.21**.

5.286A The use of the bands 454-456 MHz and 459-460 MHz by the mobile-satellite service is subject to coordination under No. **9.11A**. (WRC-97)

5.286AA The frequency band 450-470 MHz is identified for use by administrations wishing to implement International Mobile Telecommunications (IMT) - see Resolution **224 (Rev.WRC-19)***. This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. (WRC-19)

5.286B The use of the band 454-455 MHz in the countries listed in No. **5.286D**, 455-456 MHz and 459-460 MHz in Region 2, and 454-456 MHz and 459-460 MHz in the countries listed in No. **5.286E**, by stations in the mobile-satellite service, shall not cause harmful interference to, or claim protection from, stations of the fixed or mobile services operating in accordance with the Table of Frequency Allocations. (WRC-97)

5.286C The use of the band 454-455 MHz in the countries listed in No. **5.286D**, 455-456 MHz and 459-460 MHz in Region 2, and 454-456 MHz and 459-460 MHz in the countries listed in No. **5.286E**, by stations in the mobile-satellite service, shall not constrain the development and use of the fixed and mobile services operating in accordance with the Table of Frequency Allocations. (WRC-97)

5.286D *Additional allocation:* in Canada, the United States and Panama, the band 454-455 MHz is also allocated to the mobile-satellite service (Earth-to-space) on a primary basis. (WRC-07)

5.286E *Additional allocation:* in Cabo Verde, Nepal and Nigeria, the bands 454-456 MHz and 459-460 MHz are also allocated to the mobile-satellite (Earth-to-space) service on a primary basis. (WRC-23)

5.287 Use of the frequency bands 457.5125-457.5875 MHz and 467.5125-467.5875 MHz by the maritime mobile service is limited to on-board communication stations. The characteristics of the equipment and the channelling arrangement shall be in accordance with Recommendation ITU-R M.1174-4. The use of these frequency bands in territorial waters is subject to the national regulations of the administration concerned. (WRC-19)

5.288 In the territorial waters of the United States and the Philippines, the preferred frequencies for use by on-board communication stations shall be 457.525 MHz, 457.550 MHz, 457.575 MHz and 457.600 MHz paired, respectively, with 467.750 MHz, 467.775 MHz, 467.800 MHz and 467.825 MHz. The characteristics of the equipment used shall conform to those specified in Recommendation ITU-R M.1174-4. (WRC-19)

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* *Note by the Secretariat:* This Resolution was revised by WRC-23.

460-890 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
460-470 FIXED MOBILE 5.286AA 5.287 5.288 Meteorological-satellite (space-to-Earth) 5.290 5.289		
470-694 BROADCASTING 5.149 5.291A 5.294 5.295A 5.296 5.300 5.304 5.306 5.307A 5.307B 5.312	**470-512** BROADCASTING Fixed Mobile 5.292 5.293 5.295	**470-585** FIXED MOBILE 5.296A BROADCASTING 5.291 5.298
694-790 MOBILE except aeronautical mobile 5.312A 5.312B 5.317A BROADCASTING 5.300 5.312	**512-608** BROADCASTING 5.295 5.297	**585-610** FIXED MOBILE 5.296A BROADCASTING RADIONAVIGATION 5.149 5.305 5.306 5.307
790-862 FIXED MOBILE except aeronautical mobile 5.312B 5.316B 5.317A BROADCASTING 5.312 5.319	**608-614** RADIO ASTRONOMY Mobile-satellite except aeronautical mobile-satellite (Earth-to-space)	**610-890** FIXED MOBILE 5.296A 5.313A 5.314A 5.317A BROADCASTING 5.149 5.305 5.306 5.307 5.320
862-890 FIXED MOBILE except aeronautical mobile 5.312B 5.317A BROADCASTING 5.322 5.319 5.323	**614-698** BROADCASTING Fixed 5.309 Mobile 5.308 5.293 5.308A **698-806** MOBILE 5.312B 5.317A BROADCASTING Fixed 5.309 5.293 **806-890** FIXED MOBILE 5.312B 5.317A BROADCASTING 5.317 5.318	

5.289 Earth exploration-satellite service applications, other than the meteorological-satellite service, may also be used in the bands 460-470 MHz and 1 690-1 710 MHz for space-to-Earth transmissions subject to not causing harmful interference to stations operating in accordance with the Table.

5.290 *Different category of service:* in Afghanistan, Azerbaijan, Belarus, China, the Russian Federation, Japan, Kyrgyzstan, Tajikistan and Turkmenistan, the allocation of the band 460-470 MHz to the meteorological-satellite service (space-to-Earth) is on a primary basis (see No. **5.33**), subject to agreement obtained under No. **9.21**. (WRC-12)

5.291 *Additional allocation:* in China, the band 470-485 MHz is also allocated to the space research (space-to-Earth) and the space operation (space-to-Earth) services on a primary basis subject to agreement obtained under No. **9.21** and subject to not causing harmful interference to existing and planned broadcasting stations.

5.291A *Additional allocation:* in Germany, Austria, Denmark, Estonia, Liechtenstein, Serbia and Switzerland, the frequency band 470-494 MHz is also allocated to the radiolocation service on a secondary basis. This use is limited to the operation of wind profiler radars in accordance with Resolution **217 (Rev.WRC-23)**. (WRC-23)

5.292 *Different category of service:* in Argentina, Uruguay and Venezuela, the allocation of the frequency band 470-512 MHz to the mobile service is on a primary basis (see No. **5.33**), subject to agreement obtained under No. **9.21**. (WRC-15)

5.293 *Different category of service:* in Canada, Chile, Cuba, the United States, Guyana and Panama, the allocation of the frequency bands 470-512 MHz and 614-806 MHz to the fixed service is on a primary basis (see No. **5.33**), subject to agreement obtained under No. **9.21**. In the Bahamas, Barbados, Canada, Chile, Cuba, the United States, Guyana, Jamaica, Mexico and Panama, the allocation of the frequency bands 470-512 MHz and 614-698 MHz to the mobile service is on a primary basis (see No. **5.33**), subject to agreement obtained under No. **9.21**. In Argentina and Ecuador, the allocation of the frequency band 470-512 MHz to the fixed and mobile services is on a primary basis (see No. **5.33**), subject to agreement obtained under No. **9.21**. (WRC-23)

5.294 *Additional allocation:* in Saudi Arabia, Cameroon, Côte d'Ivoire, Egypt, Ethiopia, Israel, Libya, Palestine*, the Syrian Arab Republic, Chad and Yemen, the frequency band 470-582 MHz is also allocated to the fixed service on a secondary basis. (WRC-23)

5.295 In the Bahamas, Barbados, Canada, the United States and Mexico, the frequency band 470-608 MHz, or portions thereof, is identified for International Mobile Telecommunications (IMT) – see Resolution **224 (Rev.WRC-19)****. This identification does not preclude the use of these frequency bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. Mobile service stations of the IMT system within the frequency band are subject to agreement obtained under No. **9.21** and shall not cause harmful interference to, or claim protection from, the broadcasting service of neighbouring countries. Nos. **5.43** and **5.43A** apply. (WRC-19)

5.295A *Additional allocation:* in Albania, Germany, Andorra, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Cyprus, Vatican, Croatia, Denmark, Estonia, Finland, France, Georgia, Greece, Hungary, Ireland, Iceland, Latvia, Liechtenstein, Lithuania, Luxembourg, North Macedonia, Malta, Moldova, Monaco, Montenegro, Norway, Uzbekistan, Kingdom of the Netherlands, Poland, Portugal, Türkiye, Slovakia, the Czech Republic, Romania, the United Kingdom, San Marino, Serbia, Slovenia, Sweden, Switzerland and Ukraine, the frequency band 470-694 MHz is allocated to the mobile, except aeronautical mobile, service on a secondary basis, subject to agreement obtained under No. **9.21**. For the protection of the broadcasting service, stations in the mobile service shall not create a field strength for more than 1% of the time at the highest of the clutter height or 10 m above ground level at the border of the territory of any other administration that exceeds the field strength value as calculated using § 4.1.3.2 of Annex 2 to the GE06 Agreement with regard to allowance for multiple interference, Table A.1.10 and the methodology given in the GE06 Agreement. These limits may be exceeded on the territory of any country whose administration has so agreed. This allocation shall in no way adversely affect the broadcast development or undermine new entries of the broadcasting service to the GE06 Plan. (WRC-23)

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* Pursuant to Resolution 99 (Rev. Dubai, 2018) of the Plenipotentiary Conference and taking into account the Israeli-Palestinian Interim Agreement of 28 September 1995.

** *Note by the Secretariat:* This Resolution was revised by WRC-23.

5.296 *Additional allocation:* in Albania, Algeria, Germany, Angola, Saudi Arabia, Austria, Bahrain, Belgium, Benin, Bosnia and Herzegovina, Botswana, Bulgaria, Burkina Faso, Burundi, Cameroon, Vatican, Congo (Rep. of the), Côte d'Ivoire, Croatia, Denmark, Djibouti, Egypt, United Arab Emirates, Spain, Estonia, Eswatini, Finland, France, Gabon, Gambia, Georgia, Ghana, Hungary, Iraq, Ireland, Iceland, Israel, Italy, Jordan, Kenya, Kuwait, Lesotho, Latvia, Lebanon, Libya, Liechtenstein, Lithuania, Luxembourg, North Macedonia, Malawi, Mali, Malta, Morocco, Mauritius, Mauritania, Moldova, Monaco, Mozambique, Namibia, Niger, Nigeria, Norway, Oman, Uganda, Palestine*, the Netherlands, Poland, Portugal, Qatar, the Syrian Arab Republic, Türkiye, Slovakia, the Czech Republic, Romania, the United Kingdom, Rwanda, San Marino, Senegal, Serbia, Sudan, South Africa, Sweden, Switzerland, Tanzania, Chad, Togo, Tunisia, Ukraine, Zambia and Zimbabwe, the frequency band 470-694 MHz is also allocated on a secondary basis to the land mobile service, intended for applications ancillary to broadcasting and programme-making. Stations of the land mobile service in the countries listed in this footnote shall not cause harmful interference to existing or planned stations operating in accordance with the Table in countries other than those listed in this footnote. (WRC-23)

5.296A In Micronesia, the Solomon Islands, Tuvalu and Vanuatu, the frequency band 470-698 MHz, or portions thereof, and in Bangladesh, Lao P.D.R., Maldives, New Zealand and Viet Nam, the frequency band 610-698 MHz, or portions thereof, are identified for use by these administrations wishing to implement International Mobile Telecommunications (IMT) – see Resolution **224 (Rev.WRC-23)**. This identification does not preclude the use of these frequency bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. The mobile allocation in this frequency band shall not be used for IMT systems unless subject to agreement obtained under No. **9.21** and shall not cause harmful interference to, or claim protection from, the broadcasting service of neighbouring countries. Nos. **5.43** and **5.43A** apply. (WRC-23)

5.297 *Additional allocation:* in Canada, Costa Rica, Cuba, El Salvador, the United States, Guatemala, Guyana and Jamaica, the frequency band 512-608 MHz is also allocated to the fixed and mobile services on a primary basis, subject to agreement obtained under No. **9.21**. In the Bahamas, Barbados and Mexico, the frequency band 512-608 MHz is also allocated to the mobile service on a primary basis, subject to agreement obtained under No. **9.21**. In Mexico, the frequency band 512-608 MHz is also allocated on a secondary basis to the fixed service (see No. **5.32**). (WRC-19)

5.298 *Additional allocation:* in India, the band 549.75-550.25 MHz is also allocated to the space operation service (space-to-Earth) on a secondary basis.

5.299 Not used.

5.300 *Additional allocation:* in Saudi Arabia, Cameroon, Egypt, the United Arab Emirates, Iraq, Israel, Jordan, Libya, Oman, Palestine*, Qatar, the Syrian Arab Republic and Sudan, the frequency band 582-790 MHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a secondary basis. (WRC-23)

5.301 Not used.

5.302 (SUP - WRC-12)

5.303 Not used.

5.304 *Additional allocation:* in the African Broadcasting Area (see Nos. **5.10** to **5.13**), the band 606-614 MHz is also allocated to the radio astronomy service on a primary basis.

5.305 *Additional allocation:* in China, the band 606-614 MHz is also allocated to the radio astronomy service on a primary basis.

5.306 *Additional allocation:* in Region 1, except in the African Broadcasting Area (see Nos. **5.10** to **5.13**), and in Region 3, except in China and India, the band 608-614 MHz is also allocated to the radio astronomy service on a secondary basis. (WRC-23)

5.307 *Additional allocation:* in India, the band 608-614 MHz is also allocated to the radio astronomy service on a primary basis.

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* Pursuant to Resolution 99 (Rev. Dubai, 2018) of the Plenipotentiary Conference, and taking into account the Israeli-Palestinian Interim Agreement of 28 September 1995.

5.307A *Additional allocation*: in Saudi Arabia, Bahrain, Egypt, the United Arab Emirates, Iraq, Jordan, Kuwait, Oman, Palestine*, Qatar and the Syrian Arab Republic, the frequency band 614-694 MHz is allocated to the mobile, except aeronautical mobile, service on a primary basis and identified for International Mobile Telecommunications (IMT) – see Resolution **224 (Rev.WRC-23)** subject to the agreement obtained under No. **9.21.** Stations in the mobile service shall not create a field strength for more than 1% of the time at the highest of the clutter height or 10 m above ground level at the border of the territory of any other administration that exceeds the field strength value as calculated using § 4.1.3.2 of Annex 2 to the GE06 Agreement with regard to allowance for multiple interference, Table A.1.10 and the methodology given in the GE06 Agreement. Stations in the mobile service of the countries listed in this footnote shall not cause harmful interference to, or claim protection from the existing and future broadcasting stations of the neighbouring countries operating in accordance with the GE06 Plan. This identification does not preclude the use of these frequency bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations and shall in no way adversely affect the development of the existing and future broadcasting service in accordance with the GE06 Agreement. For countries party to the GE06 Agreement, the use of stations in the mobile service is also subject to the successful application of the procedures of that Agreement. This allocation does not establish priority in the Radio Regulations and shall allow the implementation and development of the broadcasting service in accordance with the GE06 Agreement. The countries listed in this footnote and located in the African Broadcasting Area should ensure protection of the radio astronomy service within the frequency band 606-614 MHz, as allocated in No. **5.304**, consistent with the most recent version of Recommendation ITU-R RA.769. The countries listed in this footnote, which are neighbouring to the countries listed in No. **5.312**, should ensure the protection of the aeronautical radionavigation service in the frequency band 645-862 MHz. (WRC-23)

5.307B *Additional allocation:* in Gambia, Mauritania, Namibia, Nigeria, Senegal, Somalia, Tanzania and Chad, the frequency band 614-694 MHz is allocated to the mobile service on a secondary basis. For the protection of the broadcasting service, stations in the mobile service shall not create a field strength for more than 1% of the time at the highest of the clutter height or 10 m above ground level at the border of the territory of any other administration that exceeds the field strength value as calculated using § 4.1.3.2 of Annex 2 to the GE06 Agreement with regard to allowance for multiple interference, Table A.1.10 and the methodology given in the GE06 Agreement. This allocation shall in no way adversely affect the broadcast development or undermine new entries of the broadcasting service to the GE06 Plan. Additional measures shall be used by administrations implementing stations in the mobile services to protect stations in the broadcasting service of neighbouring administrations such as a distance limitation from the border of a neighbouring country. (WRC-23)

5.308 *Different category of service:* in Belize, Colombia, El Salvador and Guatemala, the frequency band 614-698 MHz is allocated to the mobile service on a primary basis. Stations of the mobile service within the frequency band are subject to agreement obtained under No. **9.21**. (WRC-23)

5.308A In the Bahamas, Barbados, Belize, Canada, Colombia, El Salvador, the United States, Guatemala, Jamaica and Mexico, the frequency band 614-698 MHz, or portions thereof, is identified for International Mobile Telecommunications (IMT) – see Resolution **224 (Rev.WRC-23)**. This identification does not preclude the use of these frequency bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. Mobile service stations of the IMT system within the frequency band are subject to agreement obtained under No. **9.21** and shall not cause harmful interference to, or claim protection from, the broadcasting service of neighbouring countries. Nos. **5.43** and **5.43A** apply. (WRC-23)

5.309 *Different category of service*: in El Salvador, the allocation of the frequency band 614-806 MHz to the fixed service is on a primary basis (see No. **5.33**), subject to agreement obtained under No. **9.21**. (WRC-15)

5.310 (SUP - WRC-97)

5.311 (SUP - WRC-07)

5.311A (SUP - WRC-19)

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* Pursuant to Resolution 99 (Rev. Dubai, 2018) of the Plenipotentiary Conference, and taking into account the Israeli-Palestinian Interim Agreement of 28 September 1995.

5.312 *Additional allocation*: in Armenia, Azerbaijan, Belarus, the Russian Federation, Georgia, Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan and Ukraine, the frequency band 645-862 MHz, and in Bulgaria the frequency bands 726-753 MHz, 778-811 MHz and 822-852 MHz, are also allocated to the aeronautical radionavigation service on a primary basis. (WRC-23)

5.312A In Region 1, the use of the frequency band 694-790 MHz by the mobile, except aeronautical mobile, service is subject to the provisions of Resolution **760 (Rev.WRC-23)**. See also Resolution **224 (Rev.WRC-23)**. (WRC-23)

5.312B The frequency band 698-960 MHz, or portions thereof, in Region 2, and the frequency band 694-960 MHz, or portions thereof, in Region 1, are identified for use by high-altitude platform stations as International Mobile Telecommunications (IMT) base stations (HIBS). This identification does not preclude the use of these frequency bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. Resolution **213 (WRC-23)** shall apply. HIBS shall not claim protection from existing primary services. No. **5.43A** does not apply, see *resolves* 2 of Resolution **213 (WRC-23)**. Such use of HIBS in the frequency bands 694-728 MHz, 830-835 MHz and 805.3-806.9 MHz is limited to reception by HIBS. (WRC-23)

5.313 (SUP - WRC-97)

5.313A The frequency band, or portions of the frequency band 698-790 MHz, in Australia, Bangladesh, Brunei Darussalam, Cambodia, China, Korea (Rep. of), Fiji, India, Indonesia, Japan, Kiribati, Lao P.D.R., Malaysia, Myanmar (Union of), New Zealand, Pakistan, Papua New Guinea, the Philippines, the Dem. People's Rep. of Korea, Solomon Islands, Samoa, Singapore, Thailand, Tonga, Tuvalu, Vanuatu and Viet Nam, are identified for use by these administrations wishing to implement International Mobile Telecommunications (IMT). This identification does not preclude the use of these frequency bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. (WRC-19)

5.313B (SUP - WRC-15)

5.314 (SUP - WRC-15)

5.314A The frequency band 698-960 MHz, or portions thereof, in Australia, Maldives, Micronesia, Papua New Guinea, Tonga and Vanuatu, and the frequency bands 703-733 MHz, 758-788 MHz, 890-915 MHz and 935-960 MHz, or portions thereof, in China, India, Indonesia, Japan, Korea (Rep. of), Malaysia, the Philippines and Thailand are identified for use by high-altitude platform stations as International Mobile Telecommunications (IMT) base stations (HIBS). This identification does not preclude the use of these frequency bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. Resolution **213 (WRC-23)** shall apply. HIBS shall not claim protection from existing primary services. No. **5.43A** does not apply, see *resolves* 2 of Resolution **213 (WRC-23)**. Such use of HIBS in the frequency bands 698-728 MHz and 830-835 MHz is limited to reception by HIBS. (WRC-23)

5.315 (SUP - WRC-15)

5.316 (SUP - WRC-15)

5.316A (SUP - WRC-15)

5.316B In Region 1, the allocation to the mobile, except aeronautical mobile, service in the frequency band 790-862 MHz is subject to agreement obtained under No. **9.21** with respect to the aeronautical radionavigation service in countries mentioned in No. **5.312**. For countries party to the GE06 Agreement, the use of stations of the mobile service is also subject to the successful application of the procedures of that Agreement. Resolutions **224 (Rev.WRC-23)** and **749 (Rev.WRC-23)** shall apply, as appropriate. (WRC-23)

5.317 *Additional allocation*: in Region 2 (except Brazil, the United States and Mexico), the frequency band 806-890 MHz is also allocated to the mobile-satellite service on a primary basis, subject to agreement obtained under No. **9.21**. The use of this service is intended for operation within national boundaries. (WRC-15)

5.317A The parts of the frequency band 698-960 MHz in Region 2 and the frequency bands 694-790 MHz in Region 1 and 790-960 MHz in Regions 1 and 3 which are allocated to the mobile service on a primary basis are identified for use by administrations wishing to implement International Mobile Telecommunications (IMT) – see Resolutions **224 (Rev.WRC-23)**, **760 (Rev.WRC-23)** and **749 (Rev.WRC-23)**, where applicable. This identification does not preclude the use of these frequency bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. (WRC-23)

5.318 *Additional allocation*: in Canada, the United States and Mexico, the bands 849-851 MHz and 894-896 MHz are also allocated to the aeronautical mobile service on a primary basis, for public correspondence with aircraft. The use of the band 849-851 MHz is limited to transmissions from aeronautical stations and the use of the band 894-896 MHz is limited to transmissions from aircraft stations.

5.319 *Additional allocation*: in Belarus, the Russian Federation and Ukraine, the bands 806-840 MHz (Earth-to-space) and 856-890 MHz (space-to-Earth) are also allocated to the mobile-satellite, except aeronautical mobile-satellite (R), service. The use of these bands by this service shall not cause harmful interference to, or claim protection from, services in other countries operating in accordance with the Table of Frequency Allocations and is subject to special agreements between the administrations concerned.

5.320 *Additional allocation*: in Region 3, the bands 806-890 MHz and 942-960 MHz are also allocated to the mobile-satellite, except aeronautical mobile-satellite (R), service on a primary basis, subject to agreement obtained under No. **9.21**. The use of this service is limited to operation within national boundaries. In seeking such agreement, appropriate protection shall be afforded to services operating in accordance with the Table, to ensure that no harmful interference is caused to such services.

5.321 (SUP - WRC-07)

5.322 In Region 1, in the frequency band 862-960 MHz, stations of the broadcasting service shall be operated only in the African Broadcasting Area (see Nos. **5.10** to **5.13**) excluding Algeria, Burundi, Djibouti, Egypt, Spain, Lesotho, Libya, Morocco, Malawi, Namibia, Nigeria, South Africa, Tanzania, Zimbabwe and Zambia, subject to agreement obtained under No. **9.21**. (WRC-23)

5.323 *Additional allocation:* in Armenia, Azerbaijan, Belarus, the Russian Federation, Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan and Ukraine, the frequency band 862-960 MHz, in Bulgaria the frequency bands 862-880 MHz and 915-925 MHz, and in Romania the frequency bands 862-880 MHz and 915-925 MHz, are also allocated to the aeronautical radionavigation service on a primary basis. Such use is subject to agreement obtained under No. **9.21** with administrations concerned and limited to ground-based radiobeacons in operation on 27 October 1997 until the end of their lifetime. (WRC-19)

890-1 300 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
890-942 FIXED MOBILE except aeronautical mobile 5.312B 5.317A BROADCASTING 5.322 Radiolocation 5.323	**890-902** FIXED MOBILE except aeronautical mobile 5.312B 5.317A Radiolocation 5.325 5.318 **902-928** FIXED Amateur Mobile except aeronautical mobile 5.312B 5.325A 5.326 Radiolocation 5.325 5.150 **928-942** FIXED MOBILE except aeronautical mobile 5.312B 5.317A Radiolocation 5.325	**890-942** FIXED MOBILE 5.314A 5.317A BROADCASTING Radiolocation 5.327
942-960 FIXED MOBILE except aeronautical mobile 5.312B 5.317A BROADCASTING 5.322 5.323	**942-960** FIXED MOBILE 5.312B 5.317A	**942-960** FIXED MOBILE 5.314A 5.317A BROADCASTING 5.320
960-1 164	AERONAUTICAL MOBILE (R) 5.327A AERONAUTICAL RADIONAVIGATION 5.328 5.328AA	
1 164-1 215	AERONAUTICAL RADIONAVIGATION 5.328 RADIONAVIGATION-SATELLITE (space-to-Earth) (space-to-space) 5.328B 5.328A	
1 215-1 240	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION RADIONAVIGATION-SATELLITE (space-to-Earth) (space-to-space) 5.328B 5.329 5.329A SPACE RESEARCH (active) 5.330 5.331 5.332	
1 240-1 300	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION RADIONAVIGATION-SATELLITE (space-to-Earth) (space-to-space) 5.328B 5.329 5.329A SPACE RESEARCH (active) Amateur 5.282 5.330 5.331 5.332 5.332A 5.335 5.335A	

5.324 Not used.

5.325 *Different category of service*: in the United States, the allocation of the band 890-942 MHz to the radiolocation service is on a primary basis (see No. **5.33**), subject to agreement obtained under No. **9.21**.

5.325A *Different category of service:* in Argentina, Brazil, Costa Rica, Cuba, Dominican Republic, El Salvador, Ecuador, the French overseas departments and communities in Region 2, Guatemala, Paraguay, Uruguay and Venezuela, the frequency band 902-928 MHz is allocated to the land mobile service on a primary basis. In Mexico, the frequency band 902-928 MHz is allocated to the mobile, except aeronautical mobile, service on a primary basis. In Colombia, the frequency band 902-915 MHz is allocated to the land mobile service on a primary basis. (WRC-23)

5.326 *Different category of service*: in Chile, the band 903-905 MHz is allocated to the mobile, except aeronautical mobile, service on a primary basis, subject to agreement obtained under No. **9.21**.

5.327 *Different category of service*: in Australia, the allocation of the band 915-928 MHz to the radiolocation service is on a primary basis (see No. **5.33**).

5.327A The use of the frequency band 960-1 164 MHz by the aeronautical mobile (R) service is limited to systems that operate in accordance with recognized international aeronautical standards. Such use shall be in accordance with Resolution **417 (Rev.WRC-15)**. (WRC-15)

5.328 The use of the band 960-1 215 MHz by the aeronautical radionavigation service is reserved on a worldwide basis for the operation and development of airborne electronic aids to air navigation and any directly associated ground-based facilities. (WRC-2000)

5.328A Stations in the radionavigation-satellite service in the band 1 164-1 215 MHz shall operate in accordance with the provisions of Resolution **609 (Rev.WRC-07)** and shall not claim protection from stations in the aeronautical radionavigation service in the band 960-1 215 MHz. No. **5.43A** does not apply. The provisions of No. **21.18** shall apply. (WRC-07)

5.328AA The frequency band 1 087.7-1 092.3 MHz is also allocated to the aeronautical mobile-satellite (R) service (Earth-to-space) on a primary basis, limited to the space station reception of Automatic Dependent Surveillance-Broadcast (ADS-B) emissions from aircraft transmitters that operate in accordance with recognized international aeronautical standards. Stations operating in the aeronautical mobile-satellite (R) service shall not claim protection from stations operating in the aeronautical radionavigation service. Resolution **425 (Rev.WRC-19)** shall apply. (WRC-19)

5.328B The use of the bands 1 164-1 300 MHz, 1 559-1 610 MHz and 5 010-5 030 MHz by systems and networks in the radionavigation-satellite service for which complete coordination or notification information, as appropriate, is received by the Radiocommunication Bureau after 1 January 2005 is subject to the application of the provisions of Nos. **9.12**, **9.12A** and **9.13**. Resolution **610 (WRC-03)**[*] shall also apply; however, in the case of radionavigation-satellite service (space-to-space) networks and systems, Resolution **610 (WRC-03)**[*] shall only apply to transmitting space stations. In accordance with No. **5.329A**, for systems and networks in the radionavigation-satellite service (space-to-space) in the bands 1 215-1 300 MHz and 1 559-1 610 MHz, the provisions of Nos. **9.7**, **9.12**, **9.12A** and **9.13** shall only apply with respect to other systems and networks in the radionavigation-satellite service (space-to-space). (WRC-07)

5.329 Use of the radionavigation-satellite service in the frequency band 1 215-1 300 MHz shall be subject to the condition that no harmful interference is caused to, and no protection is claimed from, the radionavigation service authorized under No. **5.331**. Furthermore, the use of the radionavigation-satellite service in the frequency band 1 215-1 300 MHz shall be subject to the condition that no harmful interference is caused to the radiolocation service. No. **5.43** shall not apply in respect of the radiolocation service. Resolution **608 (Rev.WRC-19)** shall apply. (WRC-19)

5.329A Use of systems in the radionavigation-satellite service (space-to-space) operating in the bands 1 215-1 300 MHz and 1 559-1 610 MHz is not intended to provide safety service applications, and shall not impose any additional constraints on radionavigation-satellite service (space-to-Earth) systems or on other services operating in accordance with the Table of Frequency Allocations. (WRC-07)

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[*] *Note by the Secretariat:* This Resolution was revised by WRC-19.

5.330 *Additional allocation:* in Angola, Saudi Arabia, Bahrain, Bangladesh, Cameroon, China, Djibouti, Egypt, the United Arab Emirates, Eritrea, Ethiopia, Guyana, India, Indonesia, Iran (Islamic Republic of), Iraq, Israel, Japan, Jordan, Kuwait, Nepal, Oman, Pakistan, Palestine*, the Philippines, Qatar, the Syrian Arab Republic, Somalia, Sudan, South Sudan, Chad, Togo and Yemen, the frequency band 1 215-1 300 MHz is also allocated to the fixed and mobile services on a primary basis. (WRC-23)

5.331 *Additional allocation:* in Algeria, Germany, Saudi Arabia, Australia, Austria, Bahrain, Belarus, Belgium, Benin, Bosnia and Herzegovina, Brazil, Burkina Faso, Burundi, Cameroon, China, Korea (Rep. of), Croatia, Denmark, Djibouti, Egypt, the United Arab Emirates, Estonia, the Russian Federation, Finland, France, Ghana, Greece, Guinea, Equatorial Guinea, Hungary, India, Indonesia, Iran (Islamic Republic of), Iraq, Ireland, Israel, Jordan, Kenya, Kuwait, Lesotho, Latvia, Lebanon, Liechtenstein, Lithuania, Luxembourg, North Macedonia, Madagascar, Mali, Mauritania, Montenegro, Nigeria, Norway, Oman, Pakistan, Palestine*, the Kingdom of the Netherlands, Poland, Portugal, Qatar, the Syrian Arab Republic, Türkiye, Dem. People's Rep. of Korea, Slovakia, the United Kingdom, Serbia, Slovenia, Somalia, Sudan, South Sudan, Sri Lanka, South Africa, Sweden, Switzerland, Thailand, Togo, Venezuela and Viet Nam, the frequency band 1 215-1 300 MHz is also allocated to the radionavigation service on a primary basis. In Canada and the United States, the frequency band 1 240-1 300 MHz is also allocated to the radionavigation service, and use of the radionavigation service shall be limited to the aeronautical radionavigation service. (WRC-23)

5.332 In the band 1 215-1 260 MHz, active spaceborne sensors in the Earth exploration-satellite and space research services shall not cause harmful interference to, claim protection from, or otherwise impose constraints on operation or development of the radiolocation service, the radionavigation-satellite service and other services allocated on a primary basis. (WRC-2000)

5.332A Administrations authorizing operation of the amateur and amateur-satellite services in the frequency band 1 240-1 300 MHz, or portions thereof, shall ensure that the amateur and amateur-satellite services do not cause harmful interference to radionavigation-satellite service (space-to-Earth) receivers in accordance with No. **5.29** (see the most recent version of Recommendation ITU-R M.2164). The authorizing administration, upon receipt of a report of harmful interference caused by a station of the amateur or amateur-satellite services, shall take all necessary steps to rapidly eliminate such interference. (WRC-23)

5.333 (SUP - WRC-97)

5.334 *Additional allocation:* in Canada and the United States, the band 1 350-1 370 MHz is also allocated to the aeronautical radionavigation service on a primary basis. (WRC-03)

5.335 In Canada and the United States in the band 1 240-1 300 MHz, active spaceborne sensors in the Earth exploration-satellite and space research services shall not cause interference to, claim protection from, or otherwise impose constraints on operation or development of the aeronautical radionavigation service. (WRC-97)

5.335A In the band 1 260-1 300 MHz, active spaceborne sensors in the Earth exploration-satellite and space research services shall not cause harmful interference to, claim protection from, or otherwise impose constraints on operation or development of the radiolocation service and other services allocated by footnotes on a primary basis. (WRC-2000)

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* Pursuant to Resolution 99 (Rev. Dubai, 2018) of the Plenipotentiary Conference and taking into account the Israeli-Palestinian Interim Agreement of 28 September 1995.

1 300-1 525 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
1 300-1 350	RADIOLOCATION AERONAUTICAL RADIONAVIGATION 5.337 RADIONAVIGATION-SATELLITE (Earth-to-space) 5.149 5.337A	
1 350-1 400 FIXED MOBILE RADIOLOCATION 5.149 5.338 5.338A 5.339	**1 350-1 400** RADIOLOCATION 5.338A 5.149 5.334 5.339	
1 400-1 427	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.341	
1 427-1 429	SPACE OPERATION (Earth-to-space) FIXED MOBILE except aeronautical mobile 5.341A 5.341B 5.341C 5.338A 5.341	
1 429-1 452 FIXED MOBILE except aeronautical mobile 5.341A 5.338A 5.341 5.342	**1 429-1 452** FIXED MOBILE 5.341B 5.341C 5.343 5.338A 5.341	
1 452-1 492 FIXED MOBILE except aeronautical mobile 5.346 BROADCASTING BROADCASTING-SATELLITE 5.208B 5.341 5.342 5.345	**1 452-1 492** FIXED MOBILE 5.341B 5.343 5.346A BROADCASTING BROADCASTING-SATELLITE 5.208B 5.341 5.344 5.345	
1 492-1 518 FIXED MOBILE except aeronautical mobile 5.341A 5.341 5.342	**1 492-1 518** FIXED MOBILE 5.341B 5.343 5.341 5.344	**1 492-1 518** FIXED MOBILE 5.341C 5.341
1 518-1 525 FIXED MOBILE except aeronautical mobile MOBILE-SATELLITE (space-to-Earth) 5.348 5.348A 5.348B 5.351A 5.341 5.342	**1 518-1 525** FIXED MOBILE 5.343 MOBILE-SATELLITE (space-to-Earth) 5.348 5.348A 5.348B 5.351A 5.341 5.344	**1 518-1 525** FIXED MOBILE MOBILE-SATELLITE (space-to-Earth) 5.348 5.348A 5.348B 5.351A 5.341

5.336 Not used.

5.337 The use of the bands 1 300-1 350 MHz, 2 700-2 900 MHz and 9 000-9 200 MHz by the aeronautical radionavigation service is restricted to ground-based radars and to associated airborne transponders which transmit only on frequencies in these bands and only when actuated by radars operating in the same band.

5.337A The use of the band 1 300-1 350 MHz by earth stations in the radionavigation-satellite service and by stations in the radiolocation service shall not cause harmful interference to, nor constrain the operation and development of, the aeronautical-radionavigation service. (WRC-2000)

5.338 In Kyrgyzstan, Slovakia and Turkmenistan, existing installations of the radionavigation service may continue to operate in the band 1 350-1 400 MHz. (WRC-12)

5.338A In the frequency bands 1 350-1 400 MHz, 1 427-1 452 MHz, 22.55-23.55 GHz, 24.25-27.5 GHz, 30-31.3 GHz, 49.7-50.2 GHz, 50.4-50.9 GHz, 51.4-52.4 GHz, 52.4-52.6 GHz, 81-86 GHz and 92-94 GHz, Resolution **750 (Rev.WRC-19)** applies. (WRC-19)

5.339 The bands 1 370-1 400 MHz, 2 640-2 655 MHz, 4 950-4 990 MHz and 15.20-15.35 GHz are also allocated to the space research (passive) and Earth exploration-satellite (passive) services on a secondary basis.

5.339A (SUP - WRC-07)

5.340 All emissions are prohibited in the following bands:

1 400-1 427 MHz,	
2 690-2 700 MHz,	except those provided for by No. **5.422**,
10.68-10.7 GHz,	except those provided for by No. **5.483**,
15.35-15.4 GHz,	except those provided for by No. **5.511**,
23.6-24 GHz,	
31.3-31.5 GHz,	
31.5-31.8 GHz,	in Region 2,
48.94-49.04 GHz,	from airborne stations
50.2-50.4 GHz[2],	
52.6-54.25 GHz,	
86-92 GHz,	
100-102 GHz,	
109.5-111.8 GHz,	
114.25-116 GHz,	
148.5-151.5 GHz,	
164-167 GHz,	
182-185 GHz,	
190-191.8 GHz,	
200-209 GHz,	
226-231.5 GHz,	
250-252 GHz. (WRC-03)	

5.341 In the bands 1 400-1 727 MHz, 101-120 GHz and 197-220 GHz, passive research is being conducted by some countries in a programme for the search for intentional emissions of extraterrestrial origin.

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[2] **5.340.1** The allocation to the Earth exploration-satellite service (passive) and the space research service (passive) in the band 50.2-50.4 GHz should not impose undue constraints on the use of the adjacent bands by the primary allocated services in those bands. (WRC-97)

5.341A In Region 1, the frequency bands 1 427-1 452 MHz and 1 492-1 518 MHz are identified for use by administrations wishing to implement International Mobile Telecommunications (IMT) in accordance with Resolution **223 (Rev.WRC-15)***. This identification does not preclude the use of these frequency bands by any other application of the services to which it is allocated and does not establish priority in the Radio Regulations. The use of IMT stations is subject to agreement obtained under No. **9.21** with respect to the aeronautical mobile service used for aeronautical telemetry in accordance with No. **5.342**. (WRC-15)

5.341B In Region 2, the frequency band 1 427-1 518 MHz is identified for use by administrations wishing to implement International Mobile Telecommunications (IMT) in accordance with Resolution **223 (Rev.WRC-15)***. This identification does not preclude the use of this frequency band by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. (WRC-15)

5.341C The frequency bands 1 427-1 452 MHz and 1 492-1 518 MHz are identified for use by administrations in Region 3 wishing to implement International Mobile Telecommunications (IMT) in accordance with Resolution **223 (Rev.WRC-15)***. The use of these frequency bands by the above administrations for the implementation of IMT in the frequency bands 1 429-1 452 MHz and 1 492-1 518 MHz is subject to agreement obtained under No. **9.21** from countries using stations of the aeronautical mobile service. This identification does not preclude the use of these frequency bands by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. (WRC-15)

5.342 *Additional allocation:* in Armenia, Azerbaijan, Belarus, the Russian Federation, Uzbekistan, Kyrgyzstan and Ukraine, the frequency band 1 429-1 535 MHz is also allocated to the aeronautical mobile service on a primary basis, exclusively for the purposes of aeronautical telemetry within the national territory. As of 1 April 2007, the use of the frequency band 1 452-1 492 MHz is subject to agreement between the administrations concerned. (WRC-15)

5.343 In Region 2, the use of the band 1 435-1 535 MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile service.

5.344 *Alternative allocation:* in the United States, the band 1 452-1 525 MHz is allocated to the fixed and mobile services on a primary basis (see also No. **5.343**).

5.345 Use of the frequency band 1 452-1 492 MHz by the broadcasting-satellite service, and by the broadcasting service, is limited to digital audio broadcasting and is subject to the provisions of Resolution **528 (Rev.WRC-19)**. (WRC-19)

5.346 In Algeria, Angola, Saudi Arabia, Bahrain, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Congo (Rep. of the), Côte d'Ivoire, Djibouti, Egypt, United Arab Emirates, Eswatini, Gabon, Gambia, Ghana, Guinea, Iraq, Jordan, Kenya, Kuwait, Lesotho, Lebanon, Liberia, Madagascar, Malawi, Mali, Morocco, Mauritius, Mauritania, Mozambique, Namibia, Niger, Nigeria, Oman, Uganda, Palestine**, Qatar, Dem. Rep. of the Congo, Rwanda, Senegal, Seychelles, Somalia, Sudan, South Sudan, South Africa, Tanzania, Chad, Togo, Tunisia, Zambia, and Zimbabwe, the frequency band 1 452-1 492 MHz is identified for use by administrations listed above wishing to implement International Mobile Telecommunications (IMT) in accordance with Resolution **223 (Rev.WRC-23)**. This identification does not preclude the use of this frequency band by any other application of the services to which it is allocated and does not establish priority in the Radio Regulations. The use of this frequency band for the implementation of IMT is subject to agreement obtained under No. **9.21** with respect to the aeronautical mobile service used for aeronautical telemetry in accordance with No. **5.342**. See also Resolution **761 (Rev.WRC-19)**. (WRC-23)

5.346A The frequency band 1 452-1 492 MHz is identified for use by administrations in Region 3 wishing to implement International Mobile Telecommunications (IMT) in accordance with Resolution **223 (Rev.WRC-19)*** and Resolution **761 (Rev.WRC-19)**. The use of this frequency band by the above administrations for the implementation of IMT is subject to agreement obtained under No. **9.21** from countries using stations of the aeronautical mobile service. This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. (WRC-19)

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* *Note by the Secretariat:* This Resolution was revised by WRC-19 and WRC-23.

** The use by Palestine of the allocation to the mobile service in the frequency band 1 452-1 492 MHz identified for IMT is noted, pursuant to Resolution 99 (Rev. Dubai, 2018) of the Plenipotentiary Conference and taking into account the Israeli-Palestinian Interim Agreement of 28 September 1995.

*** *Note by the Secretariat:* This Resolution was revised by WRC-23.

5.347 (SUP - WRC-07)

5.347A* (SUP - WRC-07)

5.348 The use of the band 1 518-1 525 MHz by the mobile-satellite service is subject to coordination under No. **9.11A**. In the band 1 518-1 525 MHz stations in the mobile-satellite service shall not claim protection from the stations in the fixed service. No. **5.43A** does not apply. (WRC-03)

5.348A In the band 1 518-1 525 MHz, the coordination threshold in terms of the power flux-density levels at the surface of the Earth in application of No. **9.11A** for space stations in the mobile-satellite (space-to-Earth) service, with respect to the land mobile service use for specialized mobile radios or used in conjunction with public switched telecommunication networks (PSTN) operating within the territory of Japan, shall be –150 dB(W/m^2) in any 4 kHz band for all angles of arrival, instead of those given in Table 5-2 of Appendix **5**. In the band 1 518-1 525 MHz stations in the mobile-satellite service shall not claim protection from stations in the mobile service in the territory of Japan. No. **5.43A** does not apply. (WRC-03)

5.348B In the band 1 518-1 525 MHz, stations in the mobile-satellite service shall not claim protection from aeronautical mobile telemetry stations in the mobile service in the territory of the United States (see Nos. **5.343** and **5.344**) and in the countries listed in No. **5.342**. No. **5.43A** does not apply. (WRC-03)

5.348C (SUP - WRC-07)

* *Note by the Secretariat:* This provision has been modified by WRC-07, and subsequently renumbered No. **5.208B** in order to preserve the sequential order.

1 525-1 610 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
1 525-1 530 SPACE OPERATION (space-to-Earth) FIXED MOBILE-SATELLITE (space-to-Earth) 5.208B 5.351A Earth exploration-satellite Mobile except aeronautical mobile 5.349 5.341 5.342 5.350 5.351 5.352A 5.354	**1 525-1 530** SPACE OPERATION (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) 5.208B 5.351A Earth exploration-satellite Fixed Mobile 5.343 5.341 5.351 5.354	**1 525-1 530** SPACE OPERATION (space-to-Earth) FIXED MOBILE-SATELLITE (space-to-Earth) 5.208B 5.351A Earth exploration-satellite Mobile 5.349 5.341 5.351 5.352A 5.354
1 530-1 535 SPACE OPERATION (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) 5.208B 5.351A 5.353A Earth exploration-satellite Fixed Mobile except aeronautical mobile 5.341 5.342 5.351 5.354	**1 530-1 535** SPACE OPERATION (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) 5.208B 5.351A 5.353A Earth exploration-satellite Fixed Mobile 5.343 5.341 5.351 5.354	
1 535-1 559	MOBILE-SATELLITE (space-to-Earth) 5.208B 5.351A 5.341 5.351 5.353A 5.354 5.355 5.356 5.357 5.357A 5.359 5.362A	
1 559-1 610	AERONAUTICAL RADIONAVIGATION RADIONAVIGATION-SATELLITE (space-to-Earth) (space-to-space) 5.208B 5.328B 5.329A 5.341	

5.349 *Different category of service:* in Saudi Arabia, Azerbaijan, Bahrain, Cameroon, Djibouti, Egypt, Iran (Islamic Republic of), Iraq, Israel, Kuwait, Lebanon, North Macedonia, Morocco, Qatar, Syrian Arab Republic, Kyrgyzstan, Turkmenistan and Yemen, the allocation of the frequency band 1 525-1 530 MHz to the mobile, except aeronautical mobile, service is on a primary basis (see No. **5.33**). (WRC-23)

5.350 *Additional allocation:* in Kyrgyzstan and Turkmenistan, the frequency band 1 525-1 530 MHz is also allocated to the aeronautical mobile service on a primary basis. (WRC-19)

5.351 The bands 1 525-1 544 MHz, 1 545-1 559 MHz, 1 626.5-1 645.5 MHz and 1 646.5-1 660.5 MHz shall not be used for feeder links of any service. In exceptional circumstances, however, an earth station at a specified fixed point in any of the mobile-satellite services may be authorized by an administration to communicate via space stations using these bands.

5.351A For the use of the frequency bands 1 518-1 544 MHz, 1 545-1 559 MHz, 1 610-1 645.5 MHz, 1 646.5-1 660.5 MHz, 1 668-1 675 MHz, 1 980-2 010 MHz, 2 170-2 200 MHz, 2 483.5-2 520 MHz and 2 670-2 690 MHz by the mobile-satellite service, see Resolutions **212 (Rev.WRC-23)** and **225 (Rev.WRC-23)**. (WRC-23)

5.352 (SUP - WRC-97)

5.352A In the frequency band 1 525-1 530 MHz, stations in the mobile-satellite service, except stations in the maritime mobile-satellite service, shall not cause harmful interference to, or claim protection from, stations of the fixed service in Algeria, Saudi Arabia, Egypt, Guinea, India, Israel, Italy, Jordan, Kuwait, Mali, Morocco, Mauritania, Nigeria, Oman, Pakistan, the Philippines, Qatar, Syrian Arab Republic, Viet Nam and Yemen notified prior to 1 April 1998. (WRC-19)

5.353 (SUP - WRC-97)

5.353A In applying the procedures of Section II of Article **9** to the mobile-satellite service in the frequency bands 1 530-1 544 MHz and 1 626.5-1 645.5 MHz, priority shall be given to accommodating the spectrum requirements for distress, urgency and safety communications of the global maritime distress and safety system (GMDSS). Maritime mobile-satellite distress, urgency and safety communications shall have priority access and immediate availability over all other mobile satellite communications operating within a network. Mobile-satellite systems shall not cause unacceptable interference to, or claim protection from, distress, urgency and safety communications of the GMDSS. Account shall be taken of the priority of safety-related communications in the other mobile-satellite services. The provisions of Resolution **222 (Rev.WRC-23)** shall apply. (WRC-23)

5.354 The use of the bands 1 525-1 559 MHz and 1 626.5-1 660.5 MHz by the mobile-satellite services is subject to coordination under No. **9.11A**.

5.355 *Additional allocation:* in Bahrain, Bangladesh, Congo (Rep. of the), Djibouti, Egypt, Eritrea, Iraq, Israel, Kuwait, Qatar, Syrian Arab Republic, Somalia, Sudan, South Sudan, Chad, Togo and Yemen, the bands 1 540-1 559 MHz, 1 610-1 645.5 MHz and 1 646.5-1 660 MHz are also allocated to the fixed service on a secondary basis. (WRC-12)

5.356 The use of the band 1 544-1 545 MHz by the mobile-satellite service (space-to-Earth) is limited to distress and safety communications (see Article **31**).

5.357 Transmissions in the band 1 545-1 555 MHz from terrestrial aeronautical stations directly to aircraft stations, or between aircraft stations, in the aeronautical mobile (R) service are also authorized when such transmissions are used to extend or supplement the satellite-to-aircraft links.

5.357A In applying the procedures of Section II of Article **9** to the mobile-satellite service in the frequency bands 1 545-1 555 MHz and 1 646.5-1 656.5 MHz, priority shall be given to accommodating the spectrum requirements of the aeronautical mobile-satellite (R) service providing transmission of messages with priority 1 to 6 in Article **44**. Aeronautical mobile-satellite (R) service communications with priority 1 to 6 in Article **44** shall have priority access and immediate availability, by pre-emption if necessary, over all other mobile-satellite communications operating within a network. Mobile-satellite systems shall not cause unacceptable interference to, or claim protection from, aeronautical mobile-satellite (R) service communications with priority 1 to 6 in Article **44**. Account shall be taken of the priority of safety-related communications in the other mobile-satellite services. The provisions of Resolution **222 (Rev.WRC-23)** shall apply. (WRC-23)

5.358 (SUP - WRC-97)

5.359 *Additional allocation:* in Germany, Saudi Arabia, Armenia, Azerbaijan, Belarus, Cameroon, the Russian Federation, Georgia, Guinea, Guinea-Bissau, Jordan, Kazakhstan, Kuwait, Lithuania, Mauritania, Uganda, Uzbekistan, Pakistan, Poland, the Syrian Arab Republic, Kyrgyzstan, the Dem. People's Rep. of Korea, Romania, Tajikistan, Tunisia and Turkmenistan, the frequency bands 1 550-1 559 MHz, 1 610-1 645.5 MHz and 1 646.5-1 660 MHz are also allocated to the fixed service on a primary basis. Administrations are urged to make all practicable efforts to avoid the implementation of new fixed-service stations in these frequency bands. (WRC-23)

5.360 to **5.362** (SUP - WRC-97)

5.362A In the United States, in the bands 1 555-1 559 MHz and 1 656.5-1 660.5 MHz, the aeronautical mobile-satellite (R) service shall have priority access and immediate availability, by pre-emption if necessary, over all other mobile-satellite communications operating within a network. Mobile-satellite systems shall not cause unacceptable interference to, or claim protection from, aeronautical mobile-satellite (R) service communications with priority 1 to 6 in Article **44**. Account shall be taken of the priority of safety-related communications in the other mobile-satellite services. (WRC-97)

5.362B (SUP - WRC-15)

5.362C (SUP - WRC-15)

5.363 (SUP - WRC-07)

1 610-1 660 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
1 610-1 610.6 MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION 5.341 5.355 5.359 5.364 5.366 5.367 5.368 5.369 5.371 5.372	**1 610-1 610.6** MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION RADIODETERMINATION-SATELLITE (Earth-to-space) 5.341 5.364 5.366 5.367 5.368 5.370 5.372	**1 610-1 610.6** MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION Radiodetermination-satellite (Earth-to-space) 5.369 5.341 5.355 5.359 5.364 5.366 5.367 5.368 5.372
1 610.6-1 613.8 MOBILE-SATELLITE (Earth-to-space) 5.351A RADIO ASTRONOMY AERONAUTICAL RADIONAVIGATION 5.149 5.341 5.355 5.359 5.364 5.366 5.367 5.368 5.369 5.371 5.372	**1 610.6-1 613.8** MOBILE-SATELLITE (Earth-to-space) 5.351A RADIO ASTRONOMY AERONAUTICAL RADIONAVIGATION RADIODETERMINATION-SATELLITE (Earth-to-space) 5.149 5.341 5.364 5.366 5.367 5.368 5.370 5.372	**1 610.6-1 613.8** MOBILE-SATELLITE (Earth-to-space) 5.351A RADIO ASTRONOMY AERONAUTICAL RADIONAVIGATION Radiodetermination-satellite (Earth-to-space) 5.369 5.149 5.341 5.355 5.359 5.364 5.366 5.367 5.368 5.372
1 613.8-1 621.35 MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION Mobile-satellite (space-to-Earth) 5.208B 5.341 5.355 5.359 5.364 5.365 5.366 5.367 5.368 5.369 5.371 5.372 5.372A	**1 613.8-1 621.35** MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION RADIODETERMINATION-SATELLITE (Earth-to-space) Mobile-satellite (space-to-Earth) 5.208B 5.341 5.364 5.365 5.366 5.367 5.368 5.370 5.372 5.372A	**1 613.8-1 621.35** MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION Mobile-satellite (space-to-Earth) 5.208B Radiodetermination-satellite (Earth-to-space) 5.369 5.341 5.355 5.359 5.364 5.365 5.366 5.367 5.368 5.372 5.372A
1 621.35-1 626.5 MARITIME MOBILE-SATELLITE (space-to-Earth) 5.373 5.373A MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION Mobile-satellite (space-to-Earth) except maritime mobile satellite (space-to-Earth) 5.208B 5.341 5.355 5.359 5.364 5.365 5.366 5.367 5.368 5.369 5.371 5.372	**1 621.35-1 626.5** MARITIME MOBILE-SATELLITE (space-to-Earth) 5.373 5.373A MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION RADIODETERMINATION-SATELLITE (Earth-to-space) Mobile-satellite (space-to-Earth) except maritime mobile satellite (space-to-Earth) 5.208B 5.341 5.364 5.365 5.366 5.367 5.368 5.370 5.372	**1 621.35-1 626.5** MARITIME MOBILE-SATELLITE (space-to-Earth) 5.373 5.373A MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION Mobile-satellite (space-to-Earth) except maritime mobile satellite (space-to-Earth) Radiodetermination-satellite (Earth-to-space) 5.369 5.208B 5.341 5.355 5.359 5.364 5.365 5.366 5.367 5.368 5.372
1 626.5-1 660	MOBILE-SATELLITE (Earth-to-space) 5.351A 5.341 5.351 5.353A 5.354 5.355 5.357A 5.359 5.362A 5.374 5.375 5.376	

5.364 The use of the band 1 610-1 626.5 MHz by the mobile-satellite service (Earth-to-space) and by the radiodetermination-satellite service (Earth-to-space) is subject to coordination under No. **9.11A**. A mobile earth station operating in either of the services in this band shall not produce a peak e.i.r.p. density in excess of –15 dB(W/4 kHz) in the part of the band used by systems operating in accordance with the provisions of No. **5.366** (to which No. **4.10** applies), unless otherwise agreed by the affected administrations. In the part of the band where such systems are not operating, the mean e.i.r.p. density of a mobile earth station shall not exceed –3 dB(W/4 kHz). Stations of the mobile-satellite service shall not claim protection from stations in the aeronautical radionavigation service, stations operating in accordance with the provisions of No. **5.366** and stations in the fixed service operating in accordance with the provisions of No. **5.359**. Administrations responsible for the coordination of mobile-satellite networks shall make all practicable efforts to ensure protection of stations operating in accordance with the provisions of No. **5.366**.

5.365 The use of the band 1 613.8-1 626.5 MHz by the mobile-satellite service (space-to-Earth) is subject to coordination under No. **9.11A**.

5.366 The band 1 610-1 626.5 MHz is reserved on a worldwide basis for the use and development of airborne electronic aids to air navigation and any directly associated ground-based or satellite-borne facilities. Such satellite use is subject to agreement obtained under No. **9.21**.

5.367 *Additional allocation*: The frequency band 1 610-1 626.5 MHz is also allocated to the aeronautical mobile-satellite (R) service on a primary basis, subject to agreement obtained under No. **9.21**. (WRC-12)

5.368 The provisions of No. **4.10** do not apply with respect to the radiodetermination-satellite and mobile-satellite services in the frequency band 1 610-1 626.5 MHz. However, No. **4.10** applies in the frequency band 1 610-1 626.5 MHz with respect to the aeronautical radionavigation-satellite service when operating in accordance with No. **5.366**, the aeronautical mobile-satellite (R) service when operating in accordance with No. **5.367**, and in the frequency bands 1 614.4225-1 618.725 MHz or 1 616.3-1 620.38 MHz (Earth-to-space) (see *resolves* 5 of Resolution **365 (WRC-23)**) and 1 621.35-1 626.5 MHz with respect to the maritime mobile-satellite service when used for the global maritime distress and safety system (GMDSS). In applying the procedure of Section II of Article **9**, the provisions of No. **4.10** do not apply for the frequency bands 1 614.4225-1 618.725 MHz or 1 616.3-1 620.38 MHz (Earth-to-space) (see *resolves* 5 of Resolution **365 (WRC-23)**) and 2 483.59-2 499.91 MHz (space-to-Earth) for the maritime mobile-satellite service when used for the GMDSS with satellite networks or systems for which complete coordination information has been received by the Radiocommunication Bureau before 20 November 2023. Resolution **365 (WRC-23)** applies. (WRC-23)

5.369 *Different category of service:* in Angola, Australia, China, Eritrea, Ethiopia, India, Iran (Islamic Republic of), Israel, Lebanon, Liberia, Madagascar, Mali, Pakistan, Papua New Guinea, Syrian Arab Republic, the Dem. Rep. of the Congo, Sudan, South Sudan, Togo and Zambia, the allocation of the band 1 610-1 626.5 MHz to the radiodetermination-satellite service (Earth-to-space) is on a primary basis (see No. **5.33**), subject to agreement obtained under No. **9.21** from countries not listed in this provision. (WRC-12)

5.370 *Different category of service:* in Venezuela, the allocation to the radiodetermination-satellite service in the band 1 610-1 626.5 MHz (Earth-to-space) is on a secondary basis.

5.371 *Additional allocation:* in Region 1, the band 1 610-1 626.5 MHz (Earth-to-space) is also allocated to the radiodetermination-satellite service on a secondary basis, subject to agreement obtained under No. **9.21**. (WRC-12)

5.372 Harmful interference shall not be caused to stations of the radio astronomy service using the frequency band 1 610.6-1 613.8 MHz by stations of the radiodetermination-satellite and mobile-satellite services (No. **29.13** applies). The equivalent power flux-density (epfd) produced in the frequency band 1 610.6-1 613.8 MHz by all space stations of a non-geostationary-satellite system in the mobile-satellite service (space-to-Earth) operating in frequency band 1 613.8-1 626.5 MHz shall be in compliance with the protection criteria provided in Recommendations ITU-R RA.769-2 and ITU-R RA.1513-2, using the methodology given in Recommendation ITU-R M.1583-1, and the radio astronomy antenna pattern described in Recommendation ITU-R RA.1631-0. (WRC-19)

5.372A The maritime mobile-satellite service in the frequency bands 1 614.4225-1 618.725 MHz or 1 616.3-1 620.38 MHz (Earth-to-space) (see *resolves* 5 of Resolution **365 (WRC-23)**) and 2 483.59-2 499.91 MHz (space-to-Earth) when they are used for the global maritime distress and safety system (GMDSS) is limited to the geostationary-satellite networks identified in Resolution **365 (WRC-23)** and their associated earth stations located within a service area from 75°E to 135°E longitude and from 10°N to 55°N latitude. Resolution **365 (WRC-23)** applies. (WRC-23)

5.373 Maritime mobile earth stations receiving in the frequency band 1 621.35-1 626.5 MHz shall not impose additional constraints on earth stations operating in the maritime mobile-satellite service or maritime earth stations of the radiodetermination-satellite service operating in accordance with the Radio Regulations in the frequency band 1 610-1 621.35 MHz or on earth stations operating in the maritime mobile-satellite service operating in accordance with the Radio Regulations in the frequency band 1 626.5-1 660.5 MHz, unless otherwise agreed between the notifying administrations. (WRC-19)

5.373A Maritime mobile earth stations receiving in the frequency band 1 621.35-1 626.5 MHz shall not impose constraints on the assignments of earth stations of the mobile-satellite service (Earth-to-space) and the radiodetermination-satellite service (Earth-to-space) in the frequency band 1 621.35-1 626.5 MHz in networks for which complete coordination information has been received by the Radiocommunication Bureau before 28 October 2019. (WRC-19)

5.374 Mobile earth stations in the mobile-satellite service operating in the bands 1 631.5-1 634.5 MHz and 1 656.5-1 660 MHz shall not cause harmful interference to stations in the fixed service operating in the countries listed in No. **5.359**. (WRC-97)

5.375 The use of the frequency band 1 645.5-1 646.5 MHz by the mobile-satellite service (Earth-to-space) and for inter-satellite links is limited to distress, urgency and safety communications (see Article **31**). (WRC-23)

5.376 Transmissions in the band 1 646.5-1 656.5 MHz from aircraft stations in the aeronautical mobile (R) service directly to terrestrial aeronautical stations, or between aircraft stations, are also authorized when such transmissions are used to extend or supplement the aircraft-to-satellite links.

1 660-1 710 MHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>1 660-1 660.5</td><td colspan="2">MOBILE-SATELLITE (Earth-to-space) 5.351A
RADIO ASTRONOMY
5.149 5.341 5.351 5.354 5.362A 5.376A</td></tr>
<tr><td>1 660.5-1 668</td><td colspan="2">RADIO ASTRONOMY
SPACE RESEARCH (passive)
Fixed
Mobile except aeronautical mobile
5.149 5.341 5.379 5.379A</td></tr>
<tr><td>1 668-1 668.4</td><td colspan="2">MOBILE-SATELLITE (Earth-to-space) 5.351A 5.379B 5.379C
RADIO ASTRONOMY
SPACE RESEARCH (passive)
Fixed
Mobile except aeronautical mobile
5.149 5.341 5.379 5.379A</td></tr>
<tr><td>1 668.4-1 670</td><td colspan="2">METEOROLOGICAL AIDS
FIXED
MOBILE except aeronautical mobile
MOBILE-SATELLITE (Earth-to-space) 5.351A 5.379B 5.379C
RADIO ASTRONOMY
5.149 5.341 5.379D 5.379E</td></tr>
<tr><td>1 670-1 675</td><td colspan="2">METEOROLOGICAL AIDS
FIXED
METEOROLOGICAL-SATELLITE (space-to-Earth)
MOBILE
MOBILE-SATELLITE (Earth-to-space) 5.351A 5.379B
5.341 5.379D 5.379E 5.380A</td></tr>
<tr><td>1 675-1 690</td><td colspan="2">METEOROLOGICAL AIDS
FIXED
METEOROLOGICAL-SATELLITE (space-to-Earth)
MOBILE except aeronautical mobile
5.341</td></tr>
<tr><td>1 690-1 700
METEOROLOGICAL AIDS
METEOROLOGICAL-SATELLITE (space-to-Earth)
Fixed
Mobile except aeronautical mobile
5.289 5.341 5.382</td><td colspan="2">1 690-1 700
METEOROLOGICAL AIDS
METEOROLOGICAL-SATELLITE (space-to-Earth)
5.289 5.341 5.381</td></tr>
<tr><td colspan="2">1 700-1 710
FIXED
METEOROLOGICAL-SATELLITE (space-to-Earth)
MOBILE except aeronautical mobile
5.289 5.341</td><td>1 700-1 710
FIXED
METEOROLOGICAL-SATELLITE (space-to-Earth)
MOBILE except aeronautical mobile
5.289 5.341 5.384</td></tr>
</table>

5.376A Mobile earth stations operating in the band 1 660-1 660.5 MHz shall not cause harmful interference to stations in the radio astronomy service. (WRC-97)

5.377 (SUP - WRC-03)

5.378 Not used.

5.379 *Additional allocation:* in Bangladesh, India, Indonesia, Nigeria and Pakistan, the band 1 660.5-1 668.4 MHz is also allocated to the meteorological aids service on a secondary basis.

5.379A Administrations are urged to give all practicable protection in the band 1 660.5-1 668.4 MHz for future research in radio astronomy, particularly by eliminating air-to-ground transmissions in the meteorological aids service in the band 1 664.4-1 668.4 MHz as soon as practicable.

5.379B The use of the frequency band 1 668-1 675 MHz by the mobile-satellite service is subject to coordination under No. **9.11A**. (WRC-23)

5.379C In order to protect the radio astronomy service in the band 1 668-1 670 MHz, the aggregate power flux-density values produced by mobile earth stations in a network of the mobile-satellite service operating in this band shall not exceed –181 dB(W/m^2) in 10 MHz and –194 dB(W/m^2) in any 20 kHz at any radio astronomy station recorded in the Master International Frequency Register, for more than 2% of integration periods of 2 000 s. (WRC-03)

5.379D For sharing of the frequency band 1 668.4-1 675 MHz between the mobile-satellite service and the fixed and mobile services, Resolution **744 (Rev.WRC-23)** shall apply. (WRC-23)

5.379E In the band 1 668.4-1 675 MHz, stations in the mobile-satellite service shall not cause harmful interference to stations in the meteorological aids service in China, Iran (Islamic Republic of), Japan and Uzbekistan. In the band 1 668.4-1 675 MHz, administrations are urged not to implement new systems in the meteorological aids service and are encouraged to migrate existing meteorological aids service operations to other bands as soon as practicable. (WRC-03)

5.380 (SUP - WRC-07)

5.380A In the band 1 670-1 675 MHz, stations in the mobile-satellite service shall not cause harmful interference to, nor constrain the development of, existing earth stations in the meteorological-satellite service notified before 1 January 2004. Any new assignment to these earth stations in this band shall also be protected from harmful interference from stations in the mobile-satellite service. (WRC-07)

5.381 *Additional allocation:* in Afghanistan, Cuba, India, Iran (Islamic Republic of) and Pakistan, the band 1 690-1 700 MHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis, and in the Dem. People's Rep. of Korea the frequency band 1 690-1 700 MHz is also allocated to the fixed service on a primary basis (see No. **5.33**) and to the mobile, except aeronautical mobile, service on a secondary basis. (WRC-23)

5.382 *Different category of service:* in Saudi Arabia, Armenia, Azerbaijan, Bahrain, Belarus, Congo (Rep. of the), Egypt, the United Arab Emirates, Eritrea, Ethiopia, the Russian Federation, Guinea, Iraq, Israel, Jordan, Kazakhstan, Kuwait, Lebanon, North Macedonia, Mauritania, Moldova, Mongolia, Oman, Uzbekistan, Poland, Qatar, the Syrian Arab Republic, Kyrgyzstan, Somalia, Tajikistan, Turkmenistan, Ukraine and Yemen, the allocation of the frequency band 1 690-1 700 MHz to the fixed and mobile, except aeronautical mobile, services is on a primary basis (see No. **5.33**). (WRC-23)

5.383 Not used.

5.384 *Additional allocation:* in India, Indonesia and Japan, the band 1 700-1 710 MHz is also allocated to the space research service (space-to-Earth) on a primary basis. (WRC-97)

1 710-2 170 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
1 710-1 930 FIXED MOBILE 5.384A 5.388 5.388A 5.149 5.341 5.385 5.386 5.387		
1 930-1 970 FIXED MOBILE 5.388 5.388A	**1 930-1 970** FIXED MOBILE 5.388 5.388A Mobile-satellite (Earth-to-space)	**1 930-1 970** FIXED MOBILE 5.388 5.388A
1 970-1 980 FIXED MOBILE 5.388 5.388A		
1 980-2 010 FIXED MOBILE 5.388 MOBILE-SATELLITE (Earth-to-space) 5.351A 5.389A 5.389B 5.389F		
2 010-2 025 FIXED MOBILE 5.388 5.388A	**2 010-2 025** FIXED MOBILE 5.388 MOBILE-SATELLITE (Earth-to-space) 5.389C 5.389E	**2 010-2 025** FIXED MOBILE 5.388 5.388A
2 025-2 110 SPACE OPERATION (Earth-to-space) (space-to-space) EARTH EXPLORATION-SATELLITE (Earth-to-space) (space-to-space) FIXED MOBILE 5.391 SPACE RESEARCH (Earth-to-space) (space-to-space) 5.392		
2 110-2 120 FIXED MOBILE 5.388 5.388A SPACE RESEARCH (deep space) (Earth-to-space)		
2 120-2 160 FIXED MOBILE 5.388 5.388A	**2 120-2 160** FIXED MOBILE 5.388 5.388A Mobile-satellite (space-to-Earth)	**2 120-2 160** FIXED MOBILE 5.388 5.388A
2 160-2 170 FIXED MOBILE 5.388 5.388A	**2 160-2 170** FIXED MOBILE 5.388 MOBILE-SATELLITE (space-to-Earth) 5.389C 5.389E	**2 160-2 170** FIXED MOBILE 5.388 5.388A

5.384A The frequency bands 1 710-1 885 MHz, 2 300-2 400 MHz and 2 500-2 690 MHz, or portions thereof, are identified for use by administrations wishing to implement International Mobile Telecommunications (IMT) in accordance with Resolution **223 (Rev.WRC-15)**[*]. This identification does not preclude the use of these frequency bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. (WRC-15)

5.385 *Additional allocation:* the band 1 718.8-1 722.2 MHz is also allocated to the radio astronomy service on a secondary basis for spectral line observations. (WRC-2000)

5.386 *Additional allocation:* the frequency band 1 750-1 850 MHz is also allocated to the space operation (Earth-to-space) and space research (Earth-to-space) services in Region 2 (except in Mexico), in Australia, Guam, India, Indonesia and Japan on a primary basis, subject to agreement obtained under No. **9.21**, having particular regard to troposcatter systems. (WRC-15)

5.387 *Additional allocation:* in Belarus, Georgia, Kyrgyzstan, Romania, Tajikistan and Turkmenistan, the frequency band 1 770-1 790 MHz is also allocated to the meteorological-satellite service on a primary basis, subject to agreement obtained under No. **9.21**. (WRC-23)

5.388 The frequency bands 1 885-2 025 MHz and 2 110-2 200 MHz are intended for use, on a worldwide basis, by administrations wishing to implement International Mobile Telecommunications (IMT). Such use does not preclude the use of these frequency bands by other services to which they are allocated. The frequency bands should be made available for IMT in accordance with Resolution **212 (Rev.WRC-23)** (see also Resolution **223 (Rev.WRC-23)**). (WRC-23)

5.388A The frequency bands 1 710-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz in Regions 1 and 3 and the frequency bands 1 710-1 980 MHz and 2 110-2 160 MHz in Region 2 are identified for the use by high altitude platform stations as International Mobile Telecommunications (IMT) base stations (HIBS). This identification does not preclude the use of these frequency bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. Resolution **221 (Rev.WRC-23)** shall apply. HIBS shall not claim protection from existing primary services. No. **5.43A** does not apply. Such use of HIBS in the frequency bands 1 710-1 785 MHz in Regions 1 and 2, and 1 710-1 815 MHz in Region 3 is limited to reception by HIBS, and in the frequency band 2 110-2 170 MHz is limited to transmission from HIBS. (WRC-23)

5.388B (SUP - WRC-23)

5.389 Not used.

5.389A The use of the frequency bands 1 980-2 010 MHz and 2 170-2 200 MHz by the mobile-satellite service is subject to coordination under No. **9.11A** and to the provisions of Resolution **716 (Rev.WRC-23)**. (WRC-23)

5.389B The use of the frequency band 1 980-1 990 MHz by the mobile-satellite service shall not cause harmful interference to or constrain the development of the fixed and mobile services in Argentina, Brazil, Canada, Chile, Ecuador, the United States, Honduras, Jamaica, Mexico, Paraguay, Peru, Suriname, Trinidad and Tobago, Uruguay and Venezuela. (WRC-19)

5.389C The use of the frequency bands 2 010-2 025 MHz and 2 160-2 170 MHz in Region 2 by the mobile-satellite service is subject to coordination under No. **9.11A** and to the provisions of Resolution **716 (Rev.WRC-23)**. (WRC-23)

5.389D (SUP - WRC-03)

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[*] *Note by the Secretariat:* This Resolution was revised by WRC-19 and WRC-23.

5.389E The use of the bands 2 010-2 025 MHz and 2 160-2 170 MHz by the mobile-satellite service in Region 2 shall not cause harmful interference to or constrain the development of the fixed and mobile services in Regions 1 and 3.

5.389F In Algeria, Cabo Verde, Egypt, Iran (Islamic Republic of), Mali, Syrian Arab Republic and Tunisia, the use of the frequency bands 1 980-2 010 MHz and 2 170-2 200 MHz by the mobile-satellite service shall neither cause harmful interference to the fixed and mobile services brought into use prior to 1 January 2005, nor hamper the development of those services, nor shall the former service request protection from the latter services. (WRC-23)

5.390 (SUP - WRC-07)

5.391 In making assignments to the mobile service in the frequency bands 2 025-2 110 MHz and 2 200-2 290 MHz, administrations shall not introduce high-density mobile systems, as described in Recommendation ITU-R SA.1154-0, and shall take that Recommendation into account for the introduction of any other type of mobile system. (WRC-15)

5.392 Administrations are urged to take all practicable measures to ensure that space-to-space transmissions between two or more non-geostationary satellites, in the space research, space operations and Earth exploration-satellite services in the bands 2 025-2 110 MHz and 2 200-2 290 MHz, shall not impose any constraints on Earth-to-space, space-to-Earth and other space-to-space transmissions of those services and in those bands between geostationary and non-geostationary satellites.

5.392A (SUP - WRC-07)

2 170-2 520 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
2 170-2 200	FIXED MOBILE 5.388 MOBILE-SATELLITE (space-to-Earth) 5.351A 5.389A 5.389F	
2 200-2 290	SPACE OPERATION (space-to-Earth) (space-to-space) EARTH EXPLORATION-SATELLITE (space-to-Earth) (space-to-space) FIXED MOBILE 5.391 SPACE RESEARCH (space-to-Earth) (space-to-space) 5.392	
2 290-2 300	FIXED MOBILE except aeronautical mobile SPACE RESEARCH (deep space) (space-to-Earth)	
2 300-2 450 FIXED MOBILE 5.384A Amateur Radiolocation 5.150 5.282 5.395	**2 300-2 450** FIXED MOBILE 5.384A RADIOLOCATION Amateur 5.150 5.282 5.393 5.394	
2 450-2 483.5 FIXED MOBILE Radiolocation 5.150	**2 450-2 483.5** FIXED MOBILE RADIOLOCATION 5.150	
2 483.5-2 500 FIXED MOBILE MOBILE-SATELLITE (space-to-Earth) 5.351A RADIODETERMINATION-SATELLITE (space-to-Earth) 5.398 Radiolocation 5.398A 5.150 5.368 5.372A 5.399 5.401 5.402	**2 483.5-2 500** FIXED MOBILE MOBILE-SATELLITE (space-to-Earth) 5.351A RADIOLOCATION RADIODETERMINATION-SATELLITE (space-to-Earth) 5.398 5.150 5.368 5.372A 5.402	**2 483.5-2 500** FIXED MOBILE MOBILE-SATELLITE (space-to-Earth) 5.351A RADIOLOCATION RADIODETERMINATION-SATELLITE (space-to-Earth) 5.398 5.150 5.368 5.372A 5.401 5.402
2 500-2 520 FIXED 5.410 MOBILE except aeronautical mobile 5.384A 5.409A 5.412	**2 500-2 520** FIXED 5.410 FIXED-SATELLITE (space-to-Earth) 5.415 MOBILE except aeronautical mobile 5.384A 5.409A	**2 500-2 520** FIXED 5.410 FIXED-SATELLITE (space-to-Earth) 5.415 MOBILE except aeronautical mobile 5.384A 5.409A MOBILE-SATELLITE (space-to-Earth) 5.351A 5.407 5.414 5.414A 5.404

5.393 *Additional allocation:* in Canada, the United States and India, the frequency band 2 310-2 360 MHz is also allocated to the broadcasting-satellite service (sound) and complementary terrestrial sound broadcasting service on a primary basis. Such use is limited to digital audio broadcasting and is subject to the provisions of Resolution **528 (Rev.WRC-19)**, with the exception of *resolves* 3 in regard to the limitation on broadcasting-satellite systems in the upper 25 MHz. Complementary terrestrial sound broadcasting stations shall be subject to bilateral coordination with neighbouring countries prior to their bringing into use. (WRC-19)

5.394 In the United States, the use of the frequency band 2 360-2 395 MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile services. In Canada, the use of the frequency band 2 360-2 400 MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile services. (WRC-23)

5.395 In France and Türkiye, the use of the band 2 310-2 360 MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile service. (WRC-23)

5.396 (SUP - WRC-19)

5.397 (SUP - WRC-12)

5.398 In respect of the radiodetermination-satellite service in the band 2 483.5-2 500 MHz, the provisions of No. **4.10** do not apply.

5.398A *Different category of service:* in Armenia, Azerbaijan, Belarus, the Russian Federation, Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan and Ukraine, the band 2 483.5-2 500 MHz is allocated on a primary basis to the radiolocation service. The radiolocation stations in these countries shall not cause harmful interference to, or claim protection from, stations of the fixed, mobile and mobile-satellite services operating in accordance with the Radio Regulations in the frequency band 2 483.5-2 500 MHz. (WRC-12)

5.399 Except for cases referred to in No. **5.401**, stations of the radiodetermination-satellite service operating in the frequency band 2 483.5-2 500 MHz for which notification information is received by the Bureau after 17 February 2012, and the service area of which includes Armenia, Azerbaijan, Belarus, the Russian Federation, Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan and Ukraine, shall not cause harmful interference to, and shall not claim protection from stations of the radiolocation service operating in these countries in accordance with No. **5.398A**. (WRC-12)

5.400 (SUP - WRC-12)

5.401 In Angola, Australia, Bangladesh, China, Eritrea, Eswatini, Ethiopia, India, Lebanon, Liberia, Libya, Madagascar, Mali, Pakistan, Papua New Guinea, Syrian Arab Republic, Dem. Rep. of the Congo, Sudan, Togo and Zambia, the frequency band 2 483.5-2 500 MHz was already allocated on a primary basis to the radiodetermination-satellite service before WRC-12, subject to agreement obtained under No. **9.21** from countries not listed in this provision. Systems in the radiodetermination-satellite service for which complete coordination information has been received by the Radiocommunication Bureau before 18 February 2012 will retain their regulatory status, as of the date of receipt of the coordination request information. (WRC-19)

5.402 The use of the band 2 483.5-2 500 MHz by the mobile-satellite and the radiodetermination-satellite services is subject to the coordination under No. **9.11A**. Administrations are urged to take all practicable steps to prevent harmful interference to the radio astronomy service from emissions in the 2 483.5-2 500 MHz band, especially those caused by second-harmonic radiation that would fall into the 4 990-5 000 MHz band allocated to the radio astronomy service worldwide.

5.403 Subject to agreement obtained under No. **9.21**, the band 2 520-2 535 MHz may also be used for the mobile-satellite (space-to-Earth), except aeronautical mobile-satellite, service for operation limited to within national boundaries. The provisions of No. **9.11A** apply. (WRC-07)

5.404 *Additional allocation:* in India and Iran (Islamic Republic of), the band 2 500-2 516.5 MHz may also be used for the radiodetermination-satellite service (space-to-Earth) for operation limited to within national boundaries, subject to agreement obtained under No. **9.21**.

5.405 (SUP - WRC-12)

5.406 Not used.

5.407 In the band 2 500-2 520 MHz, the power flux-density at the surface of the Earth from space stations operating in the mobile-satellite (space-to-Earth) service shall not exceed –152 dB(W/(m^2 · 4 kHz)) in Argentina, unless otherwise agreed by the administrations concerned.

5.408 (SUP - WRC-2000)

5.409 (SUP - WRC-07)

5.409A The frequency band 2 500-2 690 MHz in Regions 1 and 2, and the frequency band 2 500-2 655 MHz in Region 3 are identified for use by high-altitude platform stations as International Mobile Telecommunications (IMT) base stations (HIBS). This identification does not preclude the use of these frequency bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. Resolution **218 (WRC-23)** shall apply. HIBS shall not claim protection from existing primary services. No. **5.43A** does not apply. Such use of HIBS in the frequency bands 2 500-2 510 MHz in Regions 1 and 2, and 2 500-2 535 MHz in Region 3 is limited to reception by HIBS. (WRC-23)

5.410 The band 2 500-2 690 MHz may be used for tropospheric scatter systems in Region 1, subject to agreement obtained under No. **9.21**. No. **9.21** does not apply to tropospheric scatter links situated entirely outside Region 1. Administrations shall make all practicable efforts to avoid developing new tropospheric scatter systems in this band. When planning new tropospheric scatter radio-relay links in this band, all possible measures shall be taken to avoid directing the antennas of these links towards the geostationary-satellite orbit. (WRC-12)

5.411 (SUP - WRC-07)

5.412 *Alternative allocation:* in Kyrgyzstan and Turkmenistan, the band 2 500-2 690 MHz is allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-12)

5.413 In the design of systems in the broadcasting-satellite service in the bands between 2 520 MHz and 2 670 MHz, administrations are urged to take all necessary steps to protect the radio astronomy service in the band 2 690-2 700 MHz. (WRC-23)

5.414 The allocation of the frequency band 2 500-2 520 MHz to the mobile-satellite service (space-to-Earth) is subject to coordination under No. **9.11A**. (WRC-07)

5.414A In Japan and India, the use of the bands 2 500-2 520 MHz and 2 520-2 535 MHz, under No. **5.403**, by a satellite network in the mobile-satellite service (space-to-Earth) is limited to operation within national boundaries and subject to the application of No. **9.11A**. The following pfd values shall be used as a threshold for coordination under No. **9.11A**, for all conditions and for all methods of modulation, in an area of 1 000 km around the territory of the administration notifying the mobile-satellite service network:

-136 dB(W/(m^2 · MHz)) for $0° \le \theta \le 5°$

$-136 + 0.55\,(\theta - 5)$ dB(W/(m^2 · MHz)) for $5° < \theta \le 25°$

-125 dB(W/(m^2 · MHz)) for $25° < \theta \le 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees. Outside this area Table **21-4** of Article **21** shall apply. Furthermore, the coordination thresholds in Table 5-2 of Annex 1 to Appendix **5** of the Radio Regulations (Edition of 2004), in conjunction with the applicable provisions of Articles **9** and **11** associated with No. **9.11A**, shall apply to systems for which complete notification information has been received by the Radiocommunication Bureau by 14 November 2007 and that have been brought into use by that date. (WRC-07)

5.415 The use of the bands 2 500-2 690 MHz in Region 2 and 2 500-2 535 MHz and 2 655-2 690 MHz in Region 3 by the fixed-satellite service is limited to national and regional systems, subject to agreement obtained under No. **9.21**, giving particular attention to the broadcasting-satellite service in Region 1. (WRC-07)

5.415A *Additional allocation*: in India and Japan, subject to agreement obtained under No. **9.21**, the band 2 520-2 535 MHz may also be used for the aeronautical mobile-satellite service (space-to-Earth) for operation limited to within their national boundaries. (WRC-23)

2 520-2 700 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
2 520-2 655 FIXED 5.410 MOBILE except aeronautical mobile 5.384A 5.409A BROADCASTING-SATELLITE 5.413 5.416 5.339 5.412 5.418B 5.418C	**2 520-2 655** FIXED 5.410 FIXED-SATELLITE (space-to-Earth) 5.415 MOBILE except aeronautical mobile 5.384A 5.409A BROADCASTING-SATELLITE 5.413 5.416 5.339 5.418B 5.418C	**2 520-2 535** FIXED 5.410 FIXED-SATELLITE (space-to-Earth) 5.415 MOBILE except aeronautical mobile 5.384A 5.409A BROADCASTING-SATELLITE 5.413 5.416 5.403 5.414A 5.415A **2 535-2 655** FIXED 5.410 MOBILE except aeronautical mobile 5.384A 5.409A BROADCASTING-SATELLITE 5.413 5.416 5.339 5.418 5.418A 5.418B 5.418C
2 655-2 670 FIXED 5.410 MOBILE except aeronautical mobile 5.384A 5.409A BROADCASTING-SATELLITE 5.208B 5.413 5.416 Earth exploration-satellite (passive) Radio astronomy Space research (passive) 5.149 5.412	**2 655-2 670** FIXED 5.410 FIXED-SATELLITE (Earth-to-space) (space-to-Earth) 5.415 MOBILE except aeronautical mobile 5.384A 5.409A BROADCASTING-SATELLITE 5.413 5.416 Earth exploration-satellite (passive) Radio astronomy Space research (passive) 5.149 5.208B	**2 655-2 670** FIXED 5.410 FIXED-SATELLITE (Earth-to-space) 5.415 MOBILE except aeronautical mobile 5.384A BROADCASTING-SATELLITE 5.208B 5.413 5.416 Earth exploration-satellite (passive) Radio astronomy Space research (passive) 5.149 5.420
2 670-2 690 FIXED 5.410 MOBILE except aeronautical mobile 5.384A 5.409A Earth exploration-satellite (passive) Radio astronomy Space research (passive) 5.149 5.412	**2 670-2 690** FIXED 5.410 FIXED-SATELLITE (Earth-to-space) (space-to-Earth) 5.208B 5.415 MOBILE except aeronautical mobile 5.384A 5.409A Earth exploration-satellite (passive) Radio astronomy Space research (passive) 5.149	**2 670-2 690** FIXED 5.410 FIXED-SATELLITE (Earth-to-space) 5.415 MOBILE except aeronautical mobile 5.384A MOBILE-SATELLITE (Earth-to-space) 5.351A 5.419 Earth exploration-satellite (passive) Radio astronomy Space research (passive) 5.149
2 690-2 700	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.422	

5.416 The use of the band 2 520-2 670 MHz by the broadcasting-satellite service is limited to national and regional systems for community reception, subject to agreement obtained under No. **9.21**. The provisions of No. **9.19** shall be applied by administrations in this band in their bilateral and multilateral negotiations. (WRC-07)

5.417 (SUP - WRC-2000)

5.417A (SUP - WRC-15)

5.417B (SUP - WRC-15)

5.417C (SUP - WRC-15)

5.417D (SUP - WRC-15)

5.418 *Additional allocation:* in India, the frequency band 2 535-2 655 MHz is also allocated to the broadcasting-satellite service (sound) and complementary terrestrial broadcasting service on a primary basis. Such use is limited to digital audio broadcasting and is subject to the provisions of Resolution **528 (Rev.WRC-19)**. The provisions of No. **5.416** and Table **21-4** of Article **21** do not apply to this additional allocation. Use of non-geostationary-satellite systems in the broadcasting-satellite service (sound) is subject to Resolution **539 (Rev.WRC-19)**. Geostationary broadcasting-satellite service (sound) systems for which complete Appendix **4** coordination information has been received after 1 June 2005 are limited to systems intended for national coverage. The power flux-density at the Earth's surface produced by emissions from a geostationary broadcasting-satellite service (sound) space station operating in the frequency band 2 630-2 655 MHz, and for which complete Appendix **4** coordination information has been received after 1 June 2005, shall not exceed the following limits, for all conditions and for all methods of modulation:

-130 dB(W/(m^2 · MHz))	for $0° \le \theta \le 5°$
$-130 + 0.4\,(\theta - 5)$ dB(W/(m^2 · MHz))	for $5° < \theta \le 25°$
-122 dB(W/(m^2 · MHz))	for $25° < \theta \le 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees. These limits may be exceeded on the territory of any country whose administration has so agreed. As an exception to the limits above, the pfd value of −122 dB(W/(m^2 · MHz)) shall be used as a threshold for coordination under No. **9.11** in an area of 1 500 km around the territory of the administration notifying the broadcasting-satellite service (sound) system.

In addition, an administration listed in this provision shall not have simultaneously two overlapping frequency assignments, one under this provision and the other under No. **5.416** for systems for which complete Appendix **4** coordination information has been received after 1 June 2005. (WRC-19)

5.418A In certain Region 3 countries listed in No. **5.418**, use of the band 2 630-2 655 MHz by non-geostationary-satellite systems in the broadcasting-satellite service (sound) for which complete Appendix **4** coordination information, or notification information, has been received after 2 June 2000, is subject to the application of the provisions of No. **9.12A**, in respect of geostationary-satellite networks for which complete Appendix **4** coordination information, or notification information, is considered to have been received after 2 June 2000, and No. **22.2** does not apply. No. **22.2** shall continue to apply with respect to geostationary-satellite networks for which complete Appendix **4** coordination information, or notification information, is considered to have been received before 3 June 2000. (WRC-03)

5.418B Use of the band 2 630-2 655 MHz by non-geostationary-satellite systems in the broadcasting-satellite service (sound), pursuant to No. **5.418**, for which complete Appendix **4** coordination information, or notification information, has been received after 2 June 2000, is subject to the application of the provisions of No. **9.12**. (WRC-03)

5.418C Use of the band 2 630-2 655 MHz by geostationary-satellite networks for which complete Appendix **4** coordination information, or notification information, has been received after 2 June 2000 is subject to the application of the provisions of No. **9.13** with respect to non-geostationary-satellite systems in the broadcasting-satellite service (sound), pursuant to No. **5.418** and No. **22.2** does not apply. (WRC-03)

5.419 The use of the frequency band 2 670-2 690 MHz by the mobile-satellite service is subject to coordination under No. **9.11A**. (WRC-23)

5.420 The band 2 655-2 670 MHz may also be used for the mobile-satellite (Earth-to-space), except aeronautical mobile-satellite, service for operation limited to within national boundaries, subject to agreement obtained under No. **9.21**. The coordination under No. **9.11A** applies. (WRC-07)

5.420A (SUP - WRC-07)

5.421 (SUP - WRC-03)

5.422 *Additional allocation:* in Saudi Arabia, Armenia, Azerbaijan, Bahrain, Belarus, Brunei Darussalam, Congo (Rep. of the), Côte d'Ivoire, Cuba, Djibouti, Egypt, the United Arab Emirates, Eritrea, Ethiopia, Gabon, Georgia, Guinea, Guinea-Bissau, Iran (Islamic Republic of), Iraq, Israel, Jordan, Kuwait, Lebanon, Mauritania, Mongolia, Montenegro, Nigeria, Oman, Pakistan, the Philippines, Qatar, Syrian Arab Republic, Kyrgyzstan, the Dem. Rep. of the Congo, Romania, Somalia, Tajikistan, Tunisia, Turkmenistan, Ukraine and Yemen, the band 2 690-2 700 MHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. Such use is limited to equipment in operation by 1 January 1985. (WRC-12)

2 700-3 600 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
2 700-2 900	AERONAUTICAL RADIONAVIGATION 5.337 Radiolocation 5.423 5.424	
2 900-3 100	RADIOLOCATION 5.424A RADIONAVIGATION 5.426 5.425 5.427	
3 100-3 300	RADIOLOCATION Earth exploration-satellite (active) Space research (active) 5.149 5.428	
3 300-3 400 RADIOLOCATION 5.149 5.429 5.429A 5.429B 5.430	**3 300-3 400** MOBILE except aeronautical mobile 5.429G RADIOLOCATION Amateur Fixed 5.149 5.429C 5.429D	**3 300-3 400** RADIOLOCATION Amateur 5.149 5.429 5.429E 5.429F
3 400-3 600 FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.430A Radiolocation 5.431	**3 400-3 500** FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.431A 5.431B Amateur Radiolocation 5.433 5.282	**3 400-3 500** FIXED FIXED-SATELLITE (space-to-Earth) Amateur Mobile 5.432 5.432B Radiolocation 5.433 5.282 5.432A
	3 500-3 600 FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.431B Radiolocation 5.433	**3 500-3 600** FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.433A Radiolocation 5.433

5.423 In the band 2 700-2 900 MHz, ground-based radars used for meteorological purposes are authorized to operate on a basis of equality with stations of the aeronautical radionavigation service.

5.424 *Additional allocation:* in Canada, the band 2 850-2 900 MHz is also allocated to the maritime radionavigation service, on a primary basis, for use by shore-based radars.

5.424A In the band 2 900-3 100 MHz, stations in the radiolocation service shall not cause harmful interference to, nor claim protection from, radar systems in the radionavigation service. (WRC-03)

5.425 In the band 2 900-3 100 MHz, the use of the shipborne interrogator-transponder (SIT) system shall be confined to the sub-band 2 930 -2 950 MHz.

5.426 The use of the band 2 900-3 100 MHz by the aeronautical radionavigation service is limited to ground-based radars.

5.427 In the bands 2 900-3 100 MHz and 9 300-9 500 MHz, the response from radar transponders shall not be capable of being confused with the response from radar beacons (racons) and shall not cause interference to ship or aeronautical radars in the radionavigation service, having regard, however, to No. **4.9**.

5.428 *Additional allocation:* in Kyrgyzstan and Turkmenistan, the frequency band 3 100-3 300 MHz is also allocated to the radionavigation service on a primary basis. (WRC-19)

5.429 *Additional allocation:* in Saudi Arabia, Bahrain, Bangladesh, Benin, Brunei Darussalam, Cambodia, Cameroon, China, Congo (Rep. of the), Korea (Rep. of), Côte d'Ivoire, Djibouti, Egypt, the United Arab Emirates, India, Indonesia, Iran (Islamic Republic of), Iraq, Japan, Jordan, Kenya, Kuwait, Lao P.D.R., Lebanon, Libya, Malaysia, Mongolia, Myanmar, New Zealand, Oman, Uganda, Pakistan, Palestine*, Qatar, the Syrian Arab Republic, the Dem. Rep. of the Congo, the Dem. People's Rep. of Korea, Singapore, Somalia, Sudan, Thailand, Viet Nam and Yemen, the frequency band 3 300-3 400 MHz is also allocated to the fixed and mobile services on a primary basis. Mongolia, New Zealand and the countries bordering the Mediterranean shall not claim protection for their fixed and mobile services from the radiolocation service. (WRC-23)

5.429A *Additional allocation*: in Angola, Botswana, Burkina Faso, Burundi, Cabo Verde, Central African Republic, Comoros, Djibouti, Eritrea, Eswatini, Ethiopia, Gambia, Ghana, Guinea, Guinea-Bissau, Equatorial Guinea, Lesotho, Liberia, Madagascar, Malawi, Mauritius, Mauritania, Mozambique, Namibia, Niger, Nigeria, Palestine*, the Dem. Rep. of the Congo, Rwanda, Sao Tomé and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Sudan, South Africa, Tanzania, Chad, Togo, Zambia and Zimbabwe, the frequency band 3 300-3 400 MHz is allocated to the mobile, except aeronautical mobile, service on a primary basis. Stations in the mobile service operating in the frequency band 3 300-3 400 MHz shall not cause harmful interference to, or claim protection from, stations operating in the radiolocation service. (WRC-23)

5.429B In the following countries of Region 1: Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Comoros, Congo (Rep. of the), Côte d'Ivoire, Djibouti, Egypt, Eritrea, Eswatini, Ethiopia, Gambia, Ghana, Guinea, Guinea-Bissau, Equatorial Guinea, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mauritius, Mauritania, Mongolia, Mozambique, Namibia, Niger, Nigeria, Uganda, the Dem. Rep. of the Congo, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, Sudan, South Sudan, South Africa, Tanzania, Chad, Togo, Zambia and Zimbabwe, the frequency band 3 300-3 400 MHz is identified for the implementation of International Mobile Telecommunications (IMT). The use of this frequency band shall be in accordance with Resolution **223 (Rev.WRC-23)**. The use of the frequency band 3 300-3 400 MHz by IMT stations in the mobile service shall not cause harmful interference to, or claim protection from, systems in the radiolocation service, and administrations wishing to implement IMT shall obtain the agreement of neighbouring countries to protect operations within the radiolocation service. This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. (WRC-23)

5.429C *Different category of service*: in Argentina, Brazil, Cuba, the Dominican Republic, Guatemala, Mexico, Paraguay and Uruguay, the frequency band 3 300-3 400 MHz is allocated to the fixed service on a primary basis. Stations in the fixed service operating in the frequency band 3 300-3 400 MHz shall not cause harmful interference to, or claim protection from, stations operating in the radiolocation service. (WRC-23)

5.429D In Region 2, the use of the mobile, except aeronautical mobile, service in the frequency band 3 300-3 400 MHz is identified for the implementation of International Mobile Telecommunications (IMT). Such use shall be in accordance with Resolution **223 (Rev.WRC-23)**. The use of the frequency band 3 300-3 400 MHz by IMT stations in the mobile service shall not cause harmful interference to, or claim protection from, systems in the radiolocation service, and administrations wishing to implement IMT shall obtain the agreement of neighbouring countries to protect operations within the radiolocation service. This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. (WRC-23)

5.429E *Additional allocation*: in Papua New Guinea, the frequency band 3 300-3 400 MHz is allocated to the mobile, except aeronautical mobile, service on a primary basis. Stations in the mobile service operating in the frequency band 3 300-3 400 MHz shall not cause harmful interference to, or claim protection from, stations operating in the radiolocation service. (WRC-15)

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* Pursuant to Resolution 99 (Rev. Dubai, 2018) of the Plenipotentiary Conference, and taking into account the Israeli-Palestinian Interim Agreement of 28 September 1995.

5.429F In the following countries in Region 3: Cambodia, India, Indonesia, Lao P.D.R., Pakistan, the Philippines, Singapore and Viet Nam, the use of the frequency band 3 300-3 400 MHz is identified for the implementation of International Mobile Telecommunications (IMT). Such use shall be in accordance with Resolution **223 (Rev.WRC-23)**. The use of the frequency band 3 300-3 400 MHz by IMT stations in the mobile service shall not cause harmful interference to, or claim protection from, systems in the radiolocation service. Before an administration brings into use a base or mobile station of an IMT system in this frequency band, it shall seek agreement under No. **9.21** with neighbouring countries to protect the radiolocation service. This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. (WRC-23)

5.429G Stations in the mobile, except aeronautical mobile, service operating in the frequency band 3 300-3 400 MHz in Region 2 shall not cause harmful interference to, or claim protection from, systems operating in the radiolocation service. (WRC-23)

5.430 *Additional allocation:* in Kyrgyzstan and Turkmenistan, the frequency band 3 300-3 400 MHz is also allocated to the radionavigation service on a primary basis. (WRC-19)

5.430A The allocation of the frequency band 3 400-3 600 MHz to the mobile, except aeronautical mobile, service is subject to agreement obtained under No. **9.21**. This frequency band is identified for International Mobile Telecommunications (IMT). This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. The provisions of Nos. **9.17** and **9.18** shall also apply in the coordination phase. Before an administration brings into use a (base or mobile) station of the mobile service in this frequency band, it shall ensure that the power flux-density (pfd) produced at 3 m above ground does not exceed −154.5 dB(W/(m^2 · 4 kHz)) for more than 20% of time at the border of the territory of any other administration. This limit may be exceeded on the territory of any country whose administration has so agreed. In order to ensure that the pfd limit at the border of the territory of any other administration is met, the calculations and verification shall be made, taking into account all relevant information, with the mutual agreement of both administrations (the administration responsible for the terrestrial station and the administration responsible for the earth station) and with the assistance of the Bureau if so requested. In case of disagreement, calculation and verification of the pfd shall be made by the Bureau, taking into account the information referred to above. Stations of the mobile service in the frequency band 3 400-3 600 MHz shall not claim more protection from space stations than that provided in Table **21-4** of the Radio Regulations (Edition of 2004). (WRC-15)

5.431 *Additional allocation:* in Germany, the frequency band 3 400-3 475 MHz is also allocated to the amateur service on a secondary basis. (WRC-19)

5.431A In Region 2, the allocation of the frequency band 3 400-3 500 MHz to the mobile, except aeronautical mobile, service on a primary basis is subject to agreement obtained under No. **9.21**. (WRC-15)

5.431B In Region 2, the frequency band 3 400-3 600 MHz is identified for use by administrations wishing to implement International Mobile Telecommunications (IMT). This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. At the stage of coordination the provisions of Nos. **9.17** and **9.18** also apply. Before an administration brings into use a base or mobile station of an IMT system, it shall seek agreement under No. **9.21** with other administrations and ensure that the power flux-density (pfd) produced at 3 m above ground does not exceed −154.5 dB(W/(m^2 · 4 kHz)) for more than 20% of time at the border of the territory of any other administration. This limit may be exceeded on the territory of any country whose administration has so agreed. In order to ensure that the pfd limit at the border of the territory of any other administration is met, the calculations and verification shall be made, taking into account all relevant information, with the mutual agreement of both administrations (the administration responsible for the terrestrial station and the administration responsible for the earth station), with the assistance of the Bureau if so requested. In case of disagreement, the calculation and verification of the pfd shall be made by the Bureau, taking into account the information referred to above. Stations of the mobile service, including IMT systems, in the frequency band 3 400-3 600 MHz shall not claim more protection from space stations than that provided in Table **21-4** of the Radio Regulations (Edition of 2004). (WRC-15)

5.432 *Different category of service:* in Korea (Rep. of), Japan, Pakistan and the Dem. People's Rep. of Korea, the allocation of the frequency band 3 400-3 500 MHz to the mobile, except aeronautical mobile, service is on a primary basis (see No. **5.33**). (WRC-19)

5.432A In Korea (Rep. of), Japan, Pakistan and the Dem. People's Rep. of Korea, the frequency band 3 400-3 500 MHz is identified for International Mobile Telecommunications (IMT). This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. At the stage of coordination the provisions of Nos. **9.17** and **9.18** also apply. Before an administration brings into use a (base or mobile) station of the mobile service in this frequency band it shall ensure that the power flux-density (pfd) produced at 3 m above ground does not exceed −154.5 dB(W/(m^2 · 4 kHz)) for more than 20% of time at the border of the territory of any other administration. This limit may be exceeded on the territory of any country whose administration has so agreed. In order to ensure that the pfd limit at the border of the territory of any other administration is met, the calculations and verification shall be made, taking into account all relevant information, with the mutual agreement of both administrations (the administration responsible for the terrestrial station and the administration responsible for the earth station), with the assistance of the Bureau if so requested. In case of disagreement, the calculation and verification of the pfd shall be made by the Bureau, taking into account the information referred to above. Stations of the mobile service in the frequency band 3 400-3 500 MHz shall not claim more protection from space stations than that provided in Table **21-4** of the Radio Regulations (Edition of 2004). (WRC-19)

5.432B *Different category of service:* in Australia, Bangladesh, Brunei Darussalam, China, French overseas communities of Region 3, India, Indonesia, Iran (Islamic Republic of), Malaysia, New Zealand, the Philippines, Singapore and Thailand, the frequency band 3 400-3 500 MHz is allocated to the mobile, except aeronautical mobile, service on a primary basis, subject to agreement obtained under No. **9.21** with other administrations and is identified for International Mobile Telecommunications (IMT). This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. At the stage of coordination the provisions of Nos. **9.17** and **9.18** also apply. Before an administration brings into use a (base or mobile) station of the mobile service in this frequency band it shall ensure that the power flux-density (pfd) produced at 3 m above ground does not exceed −154.5 dB(W/(m^2 · 4 kHz)) for more than 20% of time at the border of the territory of any other administration. This limit may be exceeded on the territory of any country whose administration has so agreed. In order to ensure that the pfd limit at the border of the territory of any other administration is met, the calculations and verification shall be made, taking into account all relevant information, with the mutual agreement of both administrations (the administration responsible for the terrestrial station and the administration responsible for the earth station), with the assistance of the Bureau if so requested. In case of disagreement, the calculation and verification of the pfd shall be made by the Bureau, taking into account the information referred to above. Stations of the mobile service in the frequency band 3 400-3 500 MHz shall not claim more protection from space stations than that provided in Table **21-4** of the Radio Regulations (Edition of 2004). (WRC-19)

5.433 In Regions 2 and 3, in the band 3 400-3 600 MHz the radiolocation service is allocated on a primary basis. However, all administrations operating radiolocation systems in this band are urged to cease operations by 1985. Thereafter, administrations shall take all practicable steps to protect the fixed-satellite service and coordination requirements shall not be imposed on the fixed-satellite service.

5.433A In Australia, Bangladesh, Brunei Darussalam, China, French overseas communities of Region 3, Korea (Rep. of), India, Indonesia, Iran (Islamic Republic of), Japan, New Zealand, Pakistan, the Philippines, the Dem. People's Rep. of Korea and Singapore, the frequency band 3 500-3 600 MHz is identified for International Mobile Telecommunications (IMT). This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. At the stage of coordination the provisions of Nos. **9.17** and **9.18** also apply. Before an administration brings into use a (base or mobile) station of the mobile service in this frequency band it shall ensure that the power flux-density (pfd) produced at 3 m above ground does not exceed −154.5 dB(W/(m^2 · 4 kHz)) for more than 20% of time at the border of the territory of any other administration. This limit may be exceeded on the territory of any country whose administration has so agreed. In order to ensure that the pfd limit at the border of the territory of any other administration is met, the calculations and verification shall be made, taking into account all relevant information, with the mutual agreement of both administrations (the administration responsible for the terrestrial station and the administration responsible for the earth station), with the assistance of the Bureau if so requested. In case of disagreement, the calculation and verification of the pfd shall be made by the Bureau, taking into account the information referred to above. Stations of the mobile service in the frequency band 3 500-3 600 MHz shall not claim more protection from space stations than that provided in Table **21-4** of the Radio Regulations (Edition of 2004). (WRC-23)

3 600-4 800 MHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td rowspan="2">3 600-3 800
FIXED
FIXED-SATELLITE (space-to-Earth)
MOBILE except aeronautical mobile 5.433B 5.434A 5.434B 5.435A</td><td>3 600-3 700
FIXED
FIXED-SATELLITE (space-to-Earth)
MOBILE except aeronautical mobile 5.434
Radiolocation 5.433</td><td>3 600-3 700
FIXED
FIXED-SATELLITE (space-to-Earth)
MOBILE except aeronautical mobile
Radiolocation 5.435</td></tr>
<tr><td rowspan="2">3 800-4 200
FIXED
FIXED-SATELLITE (space-to-Earth)
Mobile</td><td colspan="2">3 700-4 200
FIXED
FIXED-SATELLITE (space-to-Earth)
MOBILE except aeronautical mobile 5.435B</td></tr>
<tr><td>4 200-4 400</td><td colspan="2">AERONAUTICAL MOBILE (R) 5.436
AERONAUTICAL RADIONAVIGATION 5.438
5.437 5.439 5.440</td></tr>
<tr><td>4 400-4 500</td><td colspan="2">FIXED
MOBILE 5.440A</td></tr>
<tr><td>4 500-4 800</td><td colspan="2">FIXED
FIXED-SATELLITE (space-to-Earth) 5.441
MOBILE 5.440A</td></tr>
</table>

5.433B In Angola, Botswana, Guinea, Lesotho, Malawi and South Sudan, the frequency band 3 600-3 700 MHz is identified for International Mobile Telecommunications (IMT). This identification does not preclude the use of the frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. The conditions of No. **5.434A** shall apply. (WRC-23)

5.434 In Region 2, the frequency band 3 600-3 700 MHz is identified for use by administrations wishing to implement International Mobile Telecommunications (IMT). This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. Administrations wishing to implement IMT shall obtain the agreement of neighbouring countries to ensure the protection of the fixed-satellite service (space-to-Earth). (WRC-23)

5.434A The use of the frequency band 3 600-3 800 MHz by the mobile, except aeronautical mobile, service on a primary basis in Region 1 is subject to agreement obtained under No. **9.21** if the power flux-density (pfd) limit below is exceeded. The provisions of Nos. **9.17** and **9.18** shall also apply in the coordination phase. Before an administration in Region 1 brings into use a station in the mobile service in the frequency band 3 600-3 800 MHz, for the protection of stations in the fixed and fixed-satellite services, it shall ensure that the pfd produced at 3 m above ground does not exceed -154.5 dB(W/(m^2 · 4 kHz)) for more than 20% of the time at the border of the territory of any other administration. Stations in the mobile service operating in the frequency band 3 600-3 800 MHz shall not claim more protection from space stations than that provided in Table **21-4** of the Radio Regulations. (WRC-23)

5.434B In Algeria, Saudi Arabia, Azerbaijan, Bahrain, Belarus, Benin, Burkina Faso, Burundi, Cameroon, Central African Rep., Comoros, Congo (Rep. of the), Côte d'Ivoire, Djibouti, Egypt, United Arab Emirates, Eswatini, Gabon, Gambia, Ghana, Guinea, Iraq, Jordan, Kazakhstan, Kenya, Kuwait, Lebanon, Liberia, Libya, Madagascar, Mali, Morocco, Mauritius, Mauritania, Mozambique, Namibia, Niger, Nigeria, Oman, Uganda, Uzbekistan, Palestine*, Qatar, the Syrian Arab Republic, the Dem. Rep. of the Congo, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Somalia, Sudan, South Africa, Tanzania, Chad, Togo, Tunisia, Yemen, Zambia and Zimbabwe, the frequency band 3 600-3 800 MHz is identified for International Mobile Telecommunications (IMT). This identification does not preclude the use of the frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. The conditions of No. **5.434A** shall apply. (WRC-23)

5.435 In Japan, in the band 3 620-3 700 MHz, the radiolocation service is excluded.

5.435A *Different category of service:* In Angola, Botswana, Guinea, Lesotho, Malawi and South Sudan, the frequency band 3 700-3 800 MHz is allocated to the mobile service on a secondary basis. (WRC-23)

5.435B In the Bahamas, Belize, Brazil, Canada, Colombia, Costa Rica, United States, Guatemala, the French overseas departments and communities in Region 2, Greenland, the overseas countries and territories within the Kingdom of the Netherlands in Region 2, Paraguay, Peru, Trinidad and Tobago and Uruguay, the frequency band 3 700-3 800 MHz is identified for use by any of these administrations wishing to implement International Mobile Telecommunications (IMT). This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. Administrations wishing to implement IMT shall obtain the agreement of neighbouring countries to ensure the protection of the fixed-satellite service (space-to-Earth). (WRC-23)

5.436 Use of the frequency band 4 200-4 400 MHz by stations in the aeronautical mobile (R) service is reserved exclusively for wireless avionics intra-communication systems that operate in accordance with recognized international aeronautical standards. Such use shall be in accordance with Resolution **424 (Rev.WRC-23)**. (WRC-23)

5.437 Passive sensing in the Earth exploration-satellite and space research services may be authorized in the frequency band 4 200-4 400 MHz on a secondary basis. (WRC-15)

5.438 Use of the frequency band 4 200-4 400 MHz by the aeronautical radionavigation service is reserved exclusively for radio altimeters installed on board aircraft and for the associated transponders on the ground. (WRC-15)

5.439 *Additional allocation:* in Iran (Islamic Republic of), the band 4 200-4 400 MHz is also allocated to the fixed service on a secondary basis. (WRC-12)

5.440 The standard frequency and time signal-satellite service may be authorized to use the frequency 4 202 MHz for space-to-Earth transmissions and the frequency 6 427 MHz for Earth-to-space transmissions. Such transmissions shall be confined within the limits of ± 2 MHz of these frequencies, subject to agreement obtained under No. **9.21**.

5.440A In Region 2 (except Brazil, Cuba, French overseas departments and communities, Guatemala, Paraguay, Uruguay and Venezuela), and in Australia, the band 4 400-4 940 MHz may be used for aeronautical mobile telemetry for flight testing by aircraft stations (see No. **1.83**). Such use shall be in accordance with Resolution **416 (WRC-07)** and shall not cause harmful interference to, nor claim protection from, the fixed-satellite and fixed services. Any such use does not preclude the use of this band by other mobile service applications or by other services to which this band is allocated on a co-primary basis and does not establish priority in the Radio Regulations. (WRC-07)

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* Pursuant to Resolution 99 (Rev. Dubai, 2018) of the Plenipotentiary Conference, and taking into account the Israeli-Palestinian Interim Agreement of 28 September 1995.

5.441 The use of the bands 4 500-4 800 MHz (space-to-Earth), 6 725-7 025 MHz (Earth-to-space) by the fixed-satellite service shall be in accordance with the provisions of Appendix **30B**. The use of the bands 10.7-10.95 GHz (space-to-Earth), 11.2-11.45 GHz (space-to-Earth) and 12.75-13.25 GHz (Earth-to-space) by geostationary-satellite systems in the fixed-satellite service shall be in accordance with the provisions of Appendix **30B**. The use of the bands 10.7-10.95 GHz (space-to-Earth), 11.2-11.45 GHz (space-to-Earth) and 12.75-13.25 GHz (Earth-to-space) by a non-geostationary-satellite system in the fixed-satellite service is subject to application of the provisions of No. **9.12** for coordination with other non-geostationary-satellite systems in the fixed-satellite service. Non-geostationary-satellite systems in the fixed-satellite service shall not claim protection from geostationary-satellite networks in the fixed-satellite service operating in accordance with the Radio Regulations, irrespective of the dates of receipt by the Bureau of the complete coordination or notification information, as appropriate, for the non-geostationary-satellite systems in the fixed-satellite service and of the complete coordination or notification information, as appropriate, for the geostationary-satellite networks, and No. **5.43A** does not apply. Non-geostationary-satellite systems in the fixed-satellite service in the above bands shall be operated in such a way that any unacceptable interference that may occur during their operation shall be rapidly eliminated. (WRC-2000)

4 800-5 250 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
4 800-4 990	FIXED MOBILE 5.440A 5.441A 5.441B 5.442 Radio astronomy 5.443 5.149 5.339	
4 990-5 000	FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY Space research (passive) 5.149	
5 000-5 010	AERONAUTICAL MOBILE-SATELLITE (R) 5.443AA AERONAUTICAL RADIONAVIGATION RADIONAVIGATION-SATELLITE (Earth-to-space)	
5 010-5 030	AERONAUTICAL MOBILE-SATELLITE (R) 5.443AA AERONAUTICAL RADIONAVIGATION RADIONAVIGATION-SATELLITE (space-to-Earth) (space-to-space) 5.328B 5.443B	
5 030-5 091	AERONAUTICAL MOBILE (R) 5.443C AERONAUTICAL MOBILE-SATELLITE (R) 5.443D AERONAUTICAL RADIONAVIGATION 5.444	
5 091-5 150	FIXED-SATELLITE (Earth-to-space) 5.444A AERONAUTICAL MOBILE 5.444B AERONAUTICAL MOBILE-SATELLITE (R) 5.443AA AERONAUTICAL RADIONAVIGATION 5.444	
5 150-5 250	FIXED-SATELLITE (Earth-to-space) 5.447A MOBILE except aeronautical mobile 5.446A 5.446B AERONAUTICAL RADIONAVIGATION 5.446 5.446C 5.446D 5.447 5.447B 5.447C	

5.441A In Brazil, Paraguay and Uruguay, the frequency band 4 800-4 900 MHz, or portions thereof, is identified for the implementation of International Mobile Telecommunications (IMT). This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. The use of this frequency band for the implementation of IMT is subject to agreement obtained with neighbouring countries, and IMT stations shall not claim protection from stations of other applications of the mobile service. Such use shall be in accordance with Resolution **223 (Rev.WRC-19)***. (WRC-19)

* *Note by the Secretariat:* This Resolution was revised by WRC-23.

5.441B In Angola, Argentina, Armenia, Azerbaijan, Benin, Botswana, Brazil, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Chile, China, Colombia, Congo (Rep. of the), Côte d'Ivoire, Djibouti, Eswatini, Russian Federation, Gabon, Ghana, Guinea, Iran (Islamic Republic of), Iraq, Kazakhstan, Lao P.D.R., Lesotho, Liberia, Madagascar, Malawi, Mali, Mongolia, Namibia, Niger, Uganda, Uzbekistan, the Dem. Rep. of the Congo, Kyrgyzstan, the Dem. People's Rep. of Korea, South Sudan, South Africa, Chad, Togo, Viet Nam, Zambia and Zimbabwe, the frequency band 4 800-4 990 MHz, or portions thereof, is identified for use by administrations wishing to implement International Mobile Telecommunications (IMT). This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. The use of IMT stations is subject to agreement obtained under No. **9.21** with concerned administrations, and IMT stations shall not claim protection from stations of other applications of the mobile service. In addition, before an administration brings into use an IMT station in the mobile service, it shall ensure that the power flux-density (pfd) produced by this station does not exceed −155 dB(W/(m^2 · 1 MHz)) produced up to 19 km above sea level at 20 km from the coast, defined as the low-water mark, as officially recognized by the coastal State. Resolution **223 (Rev.WRC-23)** applies. (WRC-23)

5.442 In the frequency bands 4 825-4 835 MHz and 4 950-4 990 MHz, the allocation to the mobile service is restricted to the mobile, except aeronautical mobile, service. In Region 2 (except Brazil, Cuba, Guatemala, Mexico, Paraguay, Uruguay and Venezuela), and in Australia, the frequency band 4 825-4 835 MHz is also allocated to the aeronautical mobile service, limited to aeronautical mobile telemetry for flight testing by aircraft stations. Such use shall be in accordance with Resolution **416 (WRC-07)** and shall not cause harmful interference to the fixed service. (WRC-15)

5.443 *Different category of service:* in Argentina, Australia and Canada, the allocation of the bands 4 825-4 835 MHz and 4 950-4 990 MHz to the radio astronomy service is on a primary basis (see No. **5.33**).

5.443A (SUP - WRC-03)

5.443AA In the frequency bands 5 000-5 030 MHz and 5 091-5 150 MHz, the aeronautical mobile-satellite (R) service is subject to agreement obtained under No. **9.21**. The use of these bands by the aeronautical mobile-satellite (R) service is limited to internationally standardized aeronautical systems. (WRC-12)

5.443B In order not to cause harmful interference to the microwave landing system operating above 5 030 MHz, the aggregate power flux-density produced at the Earth's surface in the frequency band 5 030-5 150 MHz by all the space stations within any radionavigation-satellite service system (space-to-Earth) operating in the frequency band 5 010-5 030 MHz shall not exceed −124.5 dB(W/m^2) in a 150 kHz band. In order not to cause harmful interference to the radio astronomy service in the frequency band 4 990-5 000 MHz, radionavigation-satellite service systems operating in the frequency band 5 010-5 030 MHz shall comply with the limits in the frequency band 4 990-5 000 MHz defined in Resolution **741 (Rev.WRC-15)**. (WRC-15)

5.443C The use of the frequency band 5 030-5 091 MHz by the aeronautical mobile (R) service is limited to internationally standardized aeronautical systems. Unwanted emissions from the aeronautical mobile (R) service in the frequency band 5 030-5 091 MHz shall be limited to protect RNSS system downlinks in the adjacent 5 010-5 030 MHz band. Until such time that an appropriate value is established in a relevant ITU-R Recommendation, the e.i.r.p. density limit of −75 dBW/MHz in the frequency band 5 010-5 030 MHz for any AM(R)S station unwanted emission should be used. (WRC-12)

5.443D In the frequency band 5 030-5 091 MHz, the aeronautical mobile-satellite (R) service is subject to coordination under No. **9.11A**. The use of this frequency band by the aeronautical mobile-satellite (R) service is limited to internationally standardized aeronautical systems. (WRC-12)

5.444 The frequency band 5 030-5 150 MHz is to be used for the operation of the international standard system (microwave landing system) for precision approach and landing. In the frequency band 5 030-5 091 MHz, the requirements of this system shall have priority over other uses of this frequency band. For the use of the frequency band 5 091-5 150 MHz, No. **5.444A** and Resolution **114 (Rev.WRC-15)** apply. (WRC-15)

5.444A The use of the allocation to the fixed-satellite service (Earth-to-space) in the frequency band 5 091-5 150 MHz is limited to feeder links of non-geostationary satellite systems in the mobile-satellite service and is subject to coordination under No. **9.11A**. The use of the frequency band 5 091-5 150 MHz by feeder links of non-geostationary satellite systems in the mobile-satellite service shall be subject to application of Resolution **114 (Rev.WRC-15)**. Moreover, to ensure that the aeronautical radionavigation service is protected from harmful interference, coordination is required for feeder-link earth stations of the non-geostationary satellite systems in the mobile-satellite service which are separated by less than 450 km from the territory of an administration operating ground stations in the aeronautical radionavigation service. (WRC-15)

5.444B The use of the frequency band 5 091-5 150 MHz by the aeronautical mobile service is limited to:

– systems operating in the aeronautical mobile (R) service and in accordance with international aeronautical standards, limited to surface applications at airports. Such use shall be in accordance with Resolution **748 (Rev.WRC-19)**;

– aeronautical telemetry transmissions from aircraft stations (see No. **1.83**) in accordance with Resolution **418 (Rev.WRC-19)**. (WRC-19)

5.445 Not used.

5.446 *Additional allocation:* in the countries listed in No. **5.369**, the frequency band 5 150-5 216 MHz is also allocated to the radiodetermination-satellite service (space-to-Earth) on a primary basis, subject to agreement obtained under No. **9.21**. In Region 2 (except in Mexico), the frequency band is also allocated to the radiodetermination-satellite service (space-to-Earth) on a primary basis. In Regions 1 and 3, except those countries listed in No. **5.369** and Bangladesh, the frequency band is also allocated to the radiodetermination-satellite service (space-to-Earth) on a secondary basis. The use by the radiodetermination-satellite service is limited to feeder links in conjunction with the radiodetermination-satellite service operating in the frequency bands 1 610-1 626.5 MHz and/or 2 483.5-2 500 MHz. The total power flux-density at the Earth's surface shall in no case exceed −159 dB(W/m^2) in any 4 kHz band for all angles of arrival. (WRC-15)

5.446A The use of the frequency bands 5 150-5 350 MHz and 5 470-5 725 MHz by the stations in the mobile, except aeronautical mobile, service shall be in accordance with Resolution **229 (Rev.WRC-23)**. (WRC-23)

5.446B In the band 5 150-5 250 MHz, stations in the mobile service shall not claim protection from earth stations in the fixed-satellite service. No. **5.43A** does not apply to the mobile service with respect to fixed-satellite service earth stations. (WRC-03)

5.446C *Additional allocation:* in Region 1 (except in Algeria, Saudi Arabia, Bahrain, Egypt, United Arab Emirates, Iraq, Jordan, Kuwait, Lebanon, Morocco, Oman, Qatar, Syrian Arab Republic, Sudan, South Sudan and Tunisia), the frequency band 5 150-5 250 MHz is also allocated to the aeronautical mobile service on a primary basis, limited to aeronautical telemetry transmissions from aircraft stations (see No. **1.83**), in accordance with Resolution **418 (Rev.WRC-19)**. These stations shall not claim protection from other stations operating in accordance with Article **5**. No. **5.43A** does not apply. (WRC-19)

5.446D *Additional allocation:* in Brazil, the band 5 150-5 250 MHz is also allocated to the aeronautical mobile service on a primary basis, limited to aeronautical telemetry transmissions from aircraft stations (see No. **1.83**), in accordance with Resolution **418 (Rev.WRC-19)**. (WRC-19)

5.447 *Additional allocation:* in Côte d'Ivoire, Egypt, Lebanon, the Syrian Arab Republic and Tunisia, the frequency band 5 150-5 250 MHz is also allocated to the mobile service, on a primary basis, subject to agreement obtained under No. **9.21**. In this case, the provisions of Resolution **229 (Rev.WRC-23)** do not apply. (WRC-23)

5.447A The allocation to the fixed-satellite service (Earth-to-space) in the band 5 150-5 250 MHz is limited to feeder links of non-geostationary-satellite systems in the mobile-satellite service and is subject to coordination under No. **9.11A**.

5.447B *Additional allocation*: the band 5 150-5 216 MHz is also allocated to the fixed-satellite service (space-to-Earth) on a primary basis. This allocation is limited to feeder links of non-geostationary-satellite systems in the mobile-satellite service and is subject to provisions of No. **9.11A**. The power flux-density at the Earth's surface produced by space stations of the fixed-satellite service operating in the space-to-Earth direction in the band 5 150-5 216 MHz shall in no case exceed –164 dB(W/m^2) in any 4 kHz band for all angles of arrival.

5.447C Administrations responsible for fixed-satellite service networks in the band 5 150-5 250 MHz operated under Nos. **5.447A** and **5.447B** shall coordinate on an equal basis in accordance with No. **9.11A** with administrations responsible for non-geostationary-satellite networks operated under No. **5.446** and brought into use prior to 17 November 1995. Satellite networks operated under No. **5.446** brought into use after 17 November 1995 shall not claim protection from, and shall not cause harmful interference to, stations of the fixed-satellite service operated under Nos. **5.447A** and **5.447B**.

5 250-5 570 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
5 250-5 255	EARTH EXPLORATION-SATELLITE (active) MOBILE except aeronautical mobile 5.446A 5.447F RADIOLOCATION SPACE RESEARCH 5.447D 5.447E 5.448 5.448A	
5 255-5 350	EARTH EXPLORATION-SATELLITE (active) MOBILE except aeronautical mobile 5.446A 5.447F RADIOLOCATION SPACE RESEARCH (active) 5.447E 5.448 5.448A	
5 350-5 460	EARTH EXPLORATION-SATELLITE (active) 5.448B RADIOLOCATION 5.448D AERONAUTICAL RADIONAVIGATION 5.449 SPACE RESEARCH (active) 5.448C	
5 460-5 470	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION 5.448D RADIONAVIGATION 5.449 SPACE RESEARCH (active) 5.448B	
5 470-5 570	EARTH EXPLORATION-SATELLITE (active) MOBILE except aeronautical mobile 5.446A 5.450A RADIOLOCATION 5.450B MARITIME RADIONAVIGATION SPACE RESEARCH (active) 5.448B 5.450 5.451	

5.447D The allocation of the band 5 250-5 255 MHz to the space research service on a primary basis is limited to active spaceborne sensors. Other uses of the band by the space research service are on a secondary basis. (WRC-97)

5.447E *Additional allocation:* The frequency band 5 250-5 350 MHz is also allocated to the fixed service on a primary basis in the following countries in Region 3: Australia, Korea (Rep. of), India, Indonesia, Iran (Islamic Republic of), Japan, Malaysia, Papua New Guinea, the Philippines, Dem. People's Rep. of Korea, Sri Lanka, Thailand and Viet Nam. The use of this frequency band by the fixed service is intended for the implementation of fixed wireless access systems and shall comply with Recommendation ITU-R F.1613-0. In addition, the fixed service shall not claim protection from the radiodetermination, Earth exploration-satellite (active) and space research (active) services, but the provisions of No. **5.43A** do not apply to the fixed service with respect to the Earth exploration-satellite (active) and space research (active) services. After implementation of fixed wireless access systems in the fixed service with protection for the existing radiodetermination systems, no more stringent constraints should be imposed on the fixed wireless access systems by future radiodetermination implementations. (WRC-15)

5.447F In the frequency band 5 250-5 350 MHz, stations in the mobile service shall not claim protection from the radiolocation service, the Earth exploration-satellite service (active) and the space research service (active). The radiolocation service, the Earth exploration-satellite service (active) and the space research service (active) shall not impose more stringent conditions upon the mobile service than those stipulated in Resolution **229 (Rev.WRC-23)**. (WRC-23)

5.448 *Additional allocation:* in Kyrgyzstan, Romania and Turkmenistan, the frequency band 5 250-5 350 MHz is also allocated to the radionavigation service on a primary basis. (WRC-19)

5.448A The Earth exploration-satellite (active) and space research (active) services in the frequency band 5 250-5 350 MHz shall not claim protection from the radiolocation service. No. **5.43A** does not apply. (WRC-03)

5.448B The Earth exploration-satellite service (active) operating in the band 5 350-5 570 MHz and space research service (active) operating in the band 5 460-5 570 MHz shall not cause harmful interference to the aeronautical radionavigation service in the band 5 350-5 460 MHz, the radionavigation service in the band 5 460-5 470 MHz and the maritime radionavigation service in the band 5 470-5 570 MHz. (WRC-03)

5.448C The space research service (active) operating in the band 5 350-5 460 MHz shall not cause harmful interference to nor claim protection from other services to which this band is allocated. (WRC-03)

5.448D In the frequency band 5 350-5 470 MHz, stations in the radiolocation service shall not cause harmful interference to, nor claim protection from, radar systems in the aeronautical radionavigation service operating in accordance with No. **5.449**. (WRC-03)

5.449 The use of the band 5 350-5 470 MHz by the aeronautical radionavigation service is limited to airborne radars and associated airborne beacons.

5.450 *Additional allocation:* in Austria, Azerbaijan, Iran (Islamic Republic of), Kyrgyzstan, Romania, Turkmenistan and Ukraine, the band 5 470-5 650 MHz is also allocated to the aeronautical radionavigation service on a primary basis. (WRC-12)

5.450A In the frequency band 5 470-5 725 MHz, stations in the mobile service shall not claim protection from radiodetermination services. The radiodetermination services shall not impose more stringent conditions upon the mobile service than those stipulated in Resolution **229 (Rev.WRC-23)**. (WRC-23)

5.450B In the frequency band 5 470-5 650 MHz, stations in the radiolocation service, except ground-based radars used for meteorological purposes in the band 5 600-5 650 MHz, shall not cause harmful interference to, nor claim protection from, radar systems in the maritime radionavigation service. (WRC-03)

5.451 *Additional allocation:* in the United Kingdom, the band 5 470-5 850 MHz is also allocated to the land mobile service on a secondary basis. The power limits specified in Nos. **21.2**, **21.3**, **21.4** and **21.5** shall apply in the band 5 725-5 850 MHz.

5 570-6 700 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
5 570-5 650	MOBILE except aeronautical mobile 5.446A 5.450A RADIOLOCATION 5.450B MARITIME RADIONAVIGATION 5.450 5.451 5.452	
5 650-5 725	MOBILE except aeronautical mobile 5.446A 5.450A RADIOLOCATION Amateur Space research (deep space) 5.454 5.282 5.451 5.453 5.455	
5 725-5 830 FIXED-SATELLITE (Earth-to-space) RADIOLOCATION Amateur 5.150 5.451 5.453 5.455	**5 725-5 830** RADIOLOCATION Amateur 5.150 5.453 5.455	
5 830-5 850 FIXED-SATELLITE (Earth-to-space) RADIOLOCATION Amateur Amateur-satellite (space-to-Earth) 5.150 5.451 5.453 5.455	**5 830-5 850** RADIOLOCATION Amateur Amateur-satellite (space-to-Earth) 5.150 5.453 5.455	
5 850-5 925 FIXED FIXED-SATELLITE (Earth-to-space) MOBILE 5.150	**5 850-5 925** FIXED FIXED-SATELLITE (Earth-to-space) MOBILE Amateur Radiolocation 5.150	**5 850-5 925** FIXED FIXED-SATELLITE (Earth-to-space) MOBILE Radiolocation 5.150
5 925-6 700	FIXED 5.457 FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B MOBILE 5.457C 5.457D 5.457E 5.457F 5.149 5.440 5.458	

5.452 Between 5 600 MHz and 5 650 MHz, ground-based radars used for meteorological purposes are authorized to operate on a basis of equality with stations of the maritime radionavigation service.

5.453 *Additional allocation:* in Saudi Arabia, Bahrain, Bangladesh, Brunei Darussalam, Cameroon, China, Congo (Rep. of the), Korea (Rep. of), Côte d'Ivoire, Djibouti, Egypt, the United Arab Emirates, Eswatini, Gabon, Guinea, Equatorial Guinea, India, Indonesia, Iran (Islamic Republic of), Iraq, Japan, Jordan, Kenya, Kuwait, Lebanon, Libya, Madagascar, Malaysia, Niger, Nigeria, Oman, Uganda, Pakistan, the Philippines, Qatar, the Syrian Arab Republic, the Dem. People's Rep. of Korea, Singapore, Somalia, Sri Lanka, Tanzania, Chad, Thailand, Togo, Viet Nam and Yemen, the frequency band 5 650-5 850 MHz is also allocated to the fixed and mobile services on a primary basis. In this case, the provisions of Resolution **229** (**Rev.WRC-23**) do not apply. In addition, in Afghanistan, Angola, Benin, Bhutan, Botswana, Burkina Faso, Burundi, Dem. Rep. of the Congo, Fiji, Ghana, Kiribati, Lesotho, Malawi, Maldives, Mauritius, Micronesia, Mongolia, Mozambique, Myanmar, Namibia, Nauru, New Zealand, Papua New Guinea, Rwanda, Solomon Islands, South Sudan, South Africa, Tonga, Vanuatu, Zambia and Zimbabwe, the frequency band 5 725-5 850 MHz is allocated to the fixed service on a primary basis, and stations operating in the fixed service shall not cause harmful interference to and shall not claim protection from other primary services in the frequency band. (WRC-23)

5.454 *Different category of service:* in Azerbaijan, the Russian Federation, Georgia, Kyrgyzstan, Tajikistan and Turkmenistan, the allocation of the band 5 670-5 725 MHz to the space research service is on a primary basis (see No. **5.33**). (WRC-12)

5.455 *Additional allocation:* in Armenia, Azerbaijan, Belarus, Cuba, the Russian Federation, Georgia, Hungary, Kazakhstan, Moldova, Uzbekistan, Kyrgyzstan, Romania, Tajikistan, Turkmenistan and Ukraine, the frequency band 5 670-5 850 MHz is also allocated to the fixed service on a primary basis. (WRC-19)

5.456 (SUP - WRC-15)

5.457 In Australia, Burkina Faso, Cote d'Ivoire, Mali and Nigeria, the allocation to the fixed service in the bands 6 440-6 520 MHz (HAPS-to-ground direction) and 6 560-6 640 MHz (ground-to-HAPS direction) may also be used by gateway links for high-altitude platform stations (HAPS) within the territory of these countries. Such use is limited to operation in HAPS gateway links and shall not cause harmful interference to, and shall not claim protection from, existing services, and shall be in compliance with Resolution **150 (WRC-12)**. Existing services shall not be constrained in future development by HAPS gateway links. The use of HAPS gateway links in these bands requires explicit agreement with other administrations whose territories are located within 1 000 kilometres from the border of an administration intending to use the HAPS gateway links. (WRC-12)

5.457A In the frequency bands 5 925-6 425 MHz and 14-14.5 GHz, earth stations located on board vessels may communicate with space stations of the fixed-satellite service. Such use shall be in accordance with Resolution **902 (Rev.WRC-23)**. In the frequency band 5 925-6 425 MHz, earth stations located on board vessels and communicating with space stations of the fixed-satellite service may employ transmit antennas with minimum diameter of 1.2 m and operate without prior agreement of any administration if located at least 330 km away from the low-water mark as officially recognized by the coastal State. All other provisions of Resolution **902 (Rev.WRC-23)** shall apply. (WRC-23)

5.457B In the frequency bands 5 925-6 425 MHz and 14-14.5 GHz, earth stations located on board vessels may operate with the characteristics and under the conditions contained in Resolution **902 (Rev.WRC-23)** in Algeria, Saudi Arabia, Bahrain, Comoros, Djibouti, Egypt, United Arab Emirates, Jordan, Kuwait, Libya, Morocco, Mauritania, Oman, Qatar, the Syrian Arab Republic, Sudan, Tunisia and Yemen, in the maritime mobile-satellite service on a secondary basis. Such use shall be in accordance with Resolution **902 (Rev.WRC-23)**. (WRC-23)

5.457C In Region 2 (except Brazil, Cuba, French overseas departments and communities, Guatemala, Mexico, Paraguay, Uruguay and Venezuela), the frequency band 5 925-6 700 MHz may be used for aeronautical mobile telemetry for flight testing by aircraft stations (see No. **1.83**). Such use shall be in accordance with Resolution **416 (WRC-07)** and shall not cause harmful interference to, or claim protection from, the fixed-satellite and fixed services. Any such use does not preclude the use of this frequency band by other mobile service applications or by other services to which this frequency band is allocated on a co-primary basis and does not establish priority in the Radio Regulations. (WRC-15)

5.457D In Cambodia, Lao P.D.R. and the Maldives, the frequency band 6 425-7 025 MHz is identified for the terrestrial component of International Mobile Telecommunications (IMT). This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. Resolution **220 (WRC-23)** applies. (WRC-23)

5.457E The frequency bands 6 425-7 125 MHz in Region 1 and 7 025-7 125 MHz in Region 3 are identified for use by administrations wishing to implement the terrestrial component of International Mobile Telecommunications (IMT). This identification does not preclude the use of these frequency bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. Resolution **220 (WRC-23)** applies.

The frequency bands are also used for the implementation of wireless access systems (WAS), including radio local area networks (RLANs). (WRC-23)

5.457F In Brazil and Mexico, the frequency band 6 425-7 125 MHz is identified for the terrestrial component of International Mobile Telecommunications (IMT). The use of this frequency band for the implementation of IMT is subject to seeking agreement under No. **9.21** with neighbouring countries. This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. Resolution **220 (WRC-23)** applies.

The frequency band is also used for the implementation of wireless access systems (WAS), including radio local area networks (RLANs). (WRC-23)

5.458 In the band 6 425-7 075 MHz, passive microwave sensor measurements are carried out over the oceans. In the band 7 075-7 250 MHz, passive microwave sensor measurements are carried out. Administrations should bear in mind the needs of the Earth exploration-satellite (passive) and space research (passive) services in their future planning of the bands 6 425-7 075 MHz and 7 075-7 250 MHz.

6 700-7 250 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
6 700-7 075	FIXED FIXED-SATELLITE (Earth-to-space) (space-to-Earth) 5.441 MOBILE 5.457D 5.457E 5.457F 5.458 5.458A 5.458B	
7 075-7 145	FIXED MOBILE 5.457E 5.457F 5.458 5.459	
7 145-7 190	FIXED MOBILE SPACE RESEARCH (deep space) (Earth-to-space) 5.458 5.459	
7 190-7 235	EARTH EXPLORATION-SATELLITE (Earth-to-space) 5.460A 5.460B FIXED MOBILE SPACE RESEARCH (Earth-to-space) 5.460 5.458 5.459	
7 235-7 250	EARTH EXPLORATION-SATELLITE (Earth-to-space) 5.460A FIXED MOBILE 5.458	

5.458A In making assignments in the band 6 700-7 075 MHz to space stations of the fixed-satellite service, administrations are urged to take all practicable steps to protect spectral line observations of the radio astronomy service in the band 6 650-6 675.2 MHz from harmful interference from unwanted emissions.

5.458B The space-to-Earth allocation to the fixed-satellite service in the band 6 700-7 075 MHz is limited to feeder links for non-geostationary satellite systems of the mobile-satellite service and is subject to coordination under No. **9.11A**. The use of the band 6 700-7 075 MHz (space-to-Earth) by feeder links for non-geostationary satellite systems in the mobile-satellite service is not subject to No. **22.2**.

5.458C (SUP - WRC-15)

5.459 *Additional allocation:* in the Russian Federation, the frequency bands 7 100-7 155 MHz and 7 190-7 235 MHz are also allocated to the space operation service (Earth-to-space) on a primary basis, subject to agreement obtained under No. **9.21**. In the frequency band 7 190-7 235 MHz, with respect to the Earth exploration-satellite service (Earth-to-space), No. **9.21** does not apply. (WRC-15)

5.460 No emissions from space research service (Earth-to-space) systems intended for deep space shall be effected in the frequency band 7 190-7 235 MHz. Geostationary satellites in the space research service operating in the frequency band 7 190-7 235 MHz shall not claim protection from existing and future stations of the fixed and mobile services and No. **5.43A** does not apply. (WRC-15)

5.460A The use of the frequency band 7 190-7 250 MHz (Earth-to-space) by the Earth exploration-satellite service shall be limited to tracking, telemetry and command for the operation of spacecraft. Space stations operating in the Earth exploration-satellite service (Earth-to-space) in the frequency band 7 190-7 250 MHz shall not claim protection from existing and future stations in the fixed and mobile services, and No. **5.43A** does not apply. No. **9.17** applies. Additionally, to ensure protection of the existing and future deployment of fixed and mobile services, the location of earth stations supporting spacecraft in the Earth exploration-satellite service in non-geostationary orbits or geostationary orbit shall maintain a separation distance of at least 10 km and 50 km, respectively, from the respective border(s) of neighbouring countries, unless a shorter distance is otherwise agreed between the corresponding administrations. (WRC-15)

5.460B Space stations on the geostationary orbit operating in the Earth exploration-satellite service (Earth-to-space) in the frequency band 7 190-7 235 MHz shall not claim protection from existing and future stations of the space research service, and No. **5.43A** does not apply. (WRC-15)

7 250-8 500 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
7 250-7 300	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE 5.461	
7 300-7 375	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.461	
7 375-7 450	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile MARITIME MOBILE-SATELLITE (space-to-Earth) 5.461AA 5.461AB 5.461AC	
7 450-7 550	FIXED FIXED-SATELLITE (space-to-Earth) METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile MARITIME MOBILE-SATELLITE (space-to-Earth) 5.461AA 5.461AB 5.461A 5.461AC	
7 550-7 750	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile MARITIME MOBILE-SATELLITE (space-to-Earth) 5.461AA 5.461AB 5.461AC	
7 750-7 900	FIXED METEOROLOGICAL-SATELLITE (space-to-Earth) 5.461B MOBILE except aeronautical mobile	
7 900-8 025	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE 5.461	
8 025-8 175	EARTH EXPLORATION-SATELLITE (space-to-Earth) FIXED FIXED-SATELLITE (Earth-to-space) MOBILE 5.463 5.462A	
8 175-8 215	EARTH EXPLORATION-SATELLITE (space-to-Earth) FIXED FIXED-SATELLITE (Earth-to-space) METEOROLOGICAL-SATELLITE (Earth-to-space) MOBILE 5.463 5.462A	
8 215-8 400	EARTH EXPLORATION-SATELLITE (space-to-Earth) FIXED FIXED-SATELLITE (Earth-to-space) MOBILE 5.463 5.462A	
8 400-8 500	FIXED MOBILE except aeronautical mobile SPACE RESEARCH (space-to-Earth) 5.465 5.466	

5.461 *Additional allocation:* the frequency bands 7 250-7 375 MHz (space-to-Earth) and 7 900-8 025 MHz (Earth-to-space) are also allocated to the mobile-satellite service on a primary basis, subject to agreement obtained under No. **9.21**, with the exception that No. **9.21** shall not apply to the geostationary-satellite networks in the mobile-satellite service for which complete coordination information is received by the Bureau as of 1 January 2025 with respect to non-geostationary-satellite systems for which complete coordination or notification information, according to the case, is received by the Bureau as of 1 January 2025. Non-geostationary-satellite systems for which complete coordination or notification information, according to the case, is received by the Bureau as of 1 January 2025 shall not cause unacceptable interference to and shall not claim protection from geostationary-satellite networks in the mobile-satellite service operating in accordance with these Regulations. No. **5.43A** does not apply. (WRC-23)

5.461A The use of the band 7 450-7 550 MHz by the meteorological-satellite service (space-to-Earth) is limited to geostationary-satellite systems. (WRC-23)

5.461AA The use of the frequency band 7 375-7 750 MHz by the maritime mobile-satellite service is limited to geostationary-satellite networks. (WRC-15)

5.461AB In the frequency band 7 375-7 750 MHz, earth stations in the maritime mobile-satellite service shall not claim protection from, nor constrain the use and development of, stations in the fixed and mobile, except aeronautical mobile, services. No. **5.43A** does not apply. (WRC-15)

5.461AC In the frequency band 7 375-7 750 MHz, non-geostationary-satellite systems operating in the fixed-satellite service for which complete coordination or notification information, according to the case, is received by the Bureau as of 1 January 2025 shall not cause unacceptable interference to and shall not claim protection from geostationary-satellite networks in the maritime mobile-satellite service operating in accordance with these Regulations. No. **5.43A** does not apply. (WRC-23)

5.461B The use of the band 7 750-7 900 MHz by the meteorological-satellite service (space-to-Earth) is limited to non-geostationary satellite systems. (WRC-12)

5.462 (SUP - WRC-97)

5.462A In Regions 1 and 3 (except for Japan), in the band 8 025-8 400 MHz, the Earth exploration-satellite service using geostationary satellites shall not produce a power flux-density in excess of the following values for angles of arrival (θ), without the consent of the affected administration:

-135 dB(W/m^2) in a 1 MHz band	for $0 \leq \theta < 5°$	
$-135 + 0.5\,(\theta - 5)$ dB(W/m^2) in a 1 MHz band	for $5 \leq \theta < 25°$	
-125 dB(W/m^2) in a 1 MHz band	for $25 \leq \theta \leq 90°$	(WRC-12)

5.463 Aircraft stations are not permitted to transmit in the band 8 025-8 400 MHz. (WRC-97)

5.464 (SUP - WRC-97)

5.465 In the space research service, the use of the band 8 400-8 450 MHz is limited to deep space.

5.466 *Different category of service:* in Singapore and Sri Lanka, the allocation of the band 8 400-8 500 MHz to the space research service is on a secondary basis (see No. **5.32**). (WRC-12)

8 500-10 000 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
8 500-8 550	RADIOLOCATION 5.468 5.469	
8 550-8 650	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH (active) 5.468 5.469 5.469A	
8 650-8 750	RADIOLOCATION 5.468 5.469	
8 750-8 850	RADIOLOCATION AERONAUTICAL RADIONAVIGATION 5.470 5.471	
8 850-9 000	RADIOLOCATION MARITIME RADIONAVIGATION 5.472 5.473	
9 000-9 200	RADIOLOCATION AERONAUTICAL RADIONAVIGATION 5.337 5.471 5.473A	
9 200-9 300	EARTH EXPLORATION-SATELLITE (active) 5.474A 5.474B 5.474C RADIOLOCATION MARITIME RADIONAVIGATION 5.472 5.473 5.474 5.474D	
9 300-9 500	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION RADIONAVIGATION 5.475 SPACE RESEARCH (active) 5.427 5.474 5.475A 5.475B 5.476A	
9 500-9 800	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION RADIONAVIGATION SPACE RESEARCH (active) 5.476A	
9 800-9 900	RADIOLOCATION Earth exploration-satellite (active) Fixed 5.477 Space research (active) 5.478 5.478A 5.478B	
9 900-10 000	EARTH EXPLORATION-SATELLITE (active) 5.474A 5.474B 5.474C RADIOLOCATION Fixed 5.477 5.474D 5.478 5.479	

5.467 (SUP - WRC-03)

5.468 *Additional allocation:* in Saudi Arabia, Bahrain, Bangladesh, Brunei Darussalam, Burundi, Cameroon, China, Congo (Rep. of the), Djibouti, Egypt, the United Arab Emirates, Eswatini, Gabon, Guyana, Indonesia, Iran (Islamic Republic of), Iraq, Jamaica, Jordan, Kenya, Kuwait, Lebanon, Libya, Malaysia, Mali, Morocco, Mauritania, Nepal, Nigeria, Oman, Uganda, Pakistan, Qatar, Syrian Arab Republic, the Dem. People's Rep. of Korea, Senegal, Singapore, Somalia, Sudan, Chad, Togo, Tunisia and Yemen, the frequency band 8 500-8 750 MHz is also allocated to the fixed and mobile services on a primary basis. (WRC-19)

5.469 *Additional allocation:* in Armenia, Azerbaijan, Belarus, the Russian Federation, Georgia, Hungary, Lithuania, Uzbekistan, Poland, Kyrgyzstan, the Czech Rep., Romania, Tajikistan, Turkmenistan and Ukraine, the frequency band 8 500-8 750 MHz is also allocated to the land mobile and radionavigation services on a primary basis. (WRC-23)

5.469A In the band 8 550-8 650 MHz, stations in the Earth exploration-satellite service (active) and space research service (active) shall not cause harmful interference to, or constrain the use and development of, stations of the radiolocation service. (WRC-97)

5.470 The use of the band 8 750-8 850 MHz by the aeronautical radionavigation service is limited to airborne Doppler navigation aids on a centre frequency of 8 800 MHz.

5.471 *Additional allocation:* in Algeria, Germany, Bahrain, Belgium, China, Egypt, the United Arab Emirates, France, Greece, Indonesia, Iran (Islamic Republic of), Libya, the Netherlands, Qatar and Sudan, the frequency bands 8 825-8 850 MHz and 9 000-9 200 MHz are also allocated to the maritime radionavigation service, on a primary basis, for use by shore-based radars only. (WRC-15)

5.472 In the bands 8 850-9 000 MHz and 9 200-9 225 MHz, the maritime radionavigation service is limited to shore-based radars.

5.473 *Additional allocation:* in Armenia, Austria, Azerbaijan, Belarus, Cuba, the Russian Federation, Georgia, Hungary, Uzbekistan, Poland, Kyrgyzstan, Romania, Tajikistan, Turkmenistan and Ukraine, the frequency bands 8 850-9 000 MHz and 9 200-9 300 MHz are also allocated to the radionavigation service on a primary basis. (WRC-19)

5.473A In the band 9 000-9 200 MHz, stations operating in the radiolocation service shall not cause harmful interference to, nor claim protection from, systems identified in No. **5.337** operating in the aeronautical radionavigation service, or radar systems in the maritime radionavigation service operating in this band on a primary basis in the countries listed in No. **5.471**. (WRC-07)

5.474 In the band 9 200-9 500 MHz, search and rescue transponders (SART) may be used, having due regard to the appropriate ITU-R Recommendation (see also Article **31**).

5.474A The use of the frequency bands 9 200-9 300 MHz and 9 900-10 400 MHz by the Earth exploration-satellite service (active) is limited to systems requiring necessary bandwidth greater than 600 MHz that cannot be fully accommodated within the frequency band 9 300-9 900 MHz. Such use is subject to agreement to be obtained under No. **9.21** from Algeria, Saudi Arabia, Bahrain, Egypt, Indonesia, Iran (Islamic Republic of), Lebanon and Tunisia. An administration that has not replied under No. **9.52** is considered as not having agreed to the coordination request. In this case, the notifying administration of the satellite system operating in the Earth exploration-satellite service (active) may request the assistance of the Bureau under Sub-Section IID of Article **9**. (WRC-15)

5.474B Stations operating in the Earth exploration-satellite (active) service shall comply with Recommendation ITU-R RS.2066-0. (WRC-15)

5.474C Stations operating in the Earth exploration-satellite (active) service shall comply with Recommendation ITU-R RS.2065-0. (WRC-15)

5.474D Stations in the Earth exploration-satellite service (active) shall not cause harmful interference to, or claim protection from, stations of the maritime radionavigation and radiolocation services in the frequency band 9 200-9 300 MHz, the radionavigation and radiolocation services in the frequency band 9 900-10 000 MHz and the radiolocation service in the frequency band 10.0-10.4 GHz. (WRC-15)

5.475 The use of the band 9 300-9 500 MHz by the aeronautical radionavigation service is limited to airborne weather radars and ground-based radars. In addition, ground-based radar beacons in the aeronautical radionavigation service are permitted in the band 9 300-9 320 MHz on condition that harmful interference is not caused to the maritime radionavigation service. (WRC-07)

5.475A The use of the band 9 300-9 500 MHz by the Earth exploration-satellite service (active) and the space research service (active) is limited to systems requiring necessary bandwidth greater than 300 MHz that cannot be fully accommodated within the 9 500-9 800 MHz band. (WRC-07)

5.475B In the band 9 300-9 500 MHz, stations operating in the radiolocation service shall not cause harmful interference to, nor claim protection from, radars operating in the radionavigation service in conformity with the Radio Regulations. Ground-based radars used for meteorological purposes have priority over other radiolocation uses. (WRC-07)

5.476 (SUP - WRC-07)

5.476A In the band 9 300-9 800 MHz, stations in the Earth exploration-satellite service (active) and space research service (active) shall not cause harmful interference to, nor claim protection from, stations of the radionavigation and radiolocation services. (WRC-07)

5.477 *Different category of service:* in Algeria, Saudi Arabia, Bahrain, Bangladesh, Brunei Darussalam, Cameroon, Djibouti, Egypt, the United Arab Emirates, Eritrea, Ethiopia, Guyana, India, Indonesia, Iran (Islamic Republic of), Iraq, Jamaica, Japan, Jordan, Kuwait, Lebanon, Liberia, Malaysia, Nigeria, Oman, Uganda, Pakistan, Qatar, Syrian Arab Republic, the Dem. People's Rep. of Korea, Singapore, Somalia, Sudan, South Sudan, Trinidad and Tobago, and Yemen, the allocation of the frequency band 9 800-10 000 MHz to the fixed service is on a primary basis (see No. **5.33**). (WRC-15)

5.478 *Additional allocation:* in Azerbaijan, Kyrgyzstan, Romania, Turkmenistan and Ukraine, the frequency band 9 800-10 000 MHz is also allocated to the radionavigation service on a primary basis. (WRC-19)

5.478A The use of the band 9 800-9 900 MHz by the Earth exploration-satellite service (active) and the space research service (active) is limited to systems requiring necessary bandwidth greater than 500 MHz that cannot be fully accommodated within the 9 300-9 800 MHz band. (WRC-07)

5.478B In the band 9 800-9 900 MHz, stations in the Earth exploration-satellite service (active) and space research service (active) shall not cause harmful interference to, nor claim protection from stations of the fixed service to which this band is allocated on a secondary basis. (WRC-07)

5.479 The band 9 975-10 025 MHz is also allocated to the meteorological-satellite service on a secondary basis for use by weather radars.

10-10.7 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
10-10.4 EARTH EXPLORATION-SATELLITE (active) 5.474A 5.474B 5.474C FIXED MOBILE RADIOLOCATION Amateur 5.474D 5.479	**10-10.4** EARTH EXPLORATION-SATELLITE (active) 5.474A 5.474B 5.474C RADIOLOCATION Amateur 5.474D 5.479 5.480 5.480A	**10-10.4** EARTH EXPLORATION-SATELLITE (active) 5.474A 5.474B 5.474C FIXED MOBILE RADIOLOCATION Amateur 5.474D 5.479
10.4-10.45 FIXED MOBILE RADIOLOCATION Amateur	**10.4-10.45** RADIOLOCATION Amateur 5.480 5.480A	**10.4-10.45** FIXED MOBILE RADIOLOCATION Amateur
10.45-10.5 RADIOLOCATION Amateur Amateur-satellite 5.481	**10.45-10.5** RADIOLOCATION Amateur Amateur-satellite 5.480A 5.481	**10.45-10.5** RADIOLOCATION Amateur Amateur-satellite 5.481
10.5-10.55 FIXED MOBILE Radiolocation	**10.5-10.55** FIXED MOBILE RADIOLOCATION	
10.55-10.6	FIXED MOBILE except aeronautical mobile Radiolocation	
10.6-10.68	EARTH EXPLORATION-SATELLITE (passive) FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY SPACE RESEARCH (passive) Radiolocation 5.149 5.482 5.482A	
10.68-10.7	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.483	

5.480 *Additional allocation:* in Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba, the Dominican Republic, El Salvador, Ecuador, Guatemala, Honduras, Jamaica, Mexico, Paraguay, the overseas countries and territories within the Kingdom of the Netherlands in Region 2, Peru, Suriname and Uruguay, the frequency band 10-10.45 GHz is also allocated to the fixed and mobile services on a primary basis. In Venezuela, the frequency band 10-10.45 GHz is also allocated to the fixed service on a primary basis. (WRC-23)

5.480A In the following countries in Region 2: Brazil, Colombia, Costa Rica, Cuba, the Dominican Republic, Ecuador, Guatemala, Jamaica, Mexico, Paraguay, Peru and Uruguay, the frequency band 10-10.5 GHz is identified for the implementation of the terrestrial component of International Mobile Telecommunications (IMT). The implementation of this identification in Mexico is subject to seeking agreement with the United States under No. **9.21**. The use of the frequency band 10-10.5 GHz by IMT stations in the mobile service shall not claim protection from systems in the radiolocation service. This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. Resolution **219 (WRC-23)** applies. (WRC-23)

5.481 *Additional allocation*: in Algeria, Germany, Angola, Brazil, China, Colombia, Costa Rica, Côte d'Ivoire, Cuba, Djibouti, the Dominican Republic, Egypt, El Salvador, Ecuador, Spain, Guatemala, Hungary, Jamaica, Japan, Kenya, Morocco, Mexico, Nigeria, Oman, Uzbekistan, Pakistan, Palestine*, Paraguay, Peru, the Dem. People's Rep. of Korea, Romania, Somalia, Suriname, Tunisia and Uruguay, the frequency band 10.45-10.5 GHz is also allocated to the fixed and mobile services on a primary basis. (WRC-23)

5.482 In the band 10.6-10.68 GHz, the power delivered to the antenna of stations of the fixed and mobile, except aeronautical mobile, services shall not exceed −3 dBW. This limit may be exceeded, subject to agreement obtained under No. **9.21**. However, in Algeria, Saudi Arabia, Armenia, Azerbaijan, Bahrain, Bangladesh, Belarus, Egypt, United Arab Emirates, Georgia, India, Indonesia, Iran (Islamic Republic of), Iraq, Jordan, Kazakhstan, Kuwait, Lebanon, Libya, Morocco, Mauritania, Moldova, Nigeria, Oman, Uzbekistan, Pakistan, Philippines, Qatar, Syrian Arab Republic, Kyrgyzstan, Singapore, Tajikistan, Tunisia, Turkmenistan and Viet Nam, this restriction on the fixed and mobile, except aeronautical mobile, services is not applicable. (WRC-07)

5.482A For sharing of the band 10.6-10.68 GHz between the Earth exploration-satellite (passive) service and the fixed and mobile, except aeronautical mobile, services, Resolution **751 (WRC-07)** applies. (WRC-07)

5.483 *Additional allocation:* in Saudi Arabia, Armenia, Azerbaijan, Bahrain, Belarus, China, Colombia, Korea (Rep. of), Egypt, the United Arab Emirates, Georgia, Iran (Islamic Republic of), Iraq, Israel, Jordan, Kazakhstan, Kuwait, Lebanon, Mongolia, Qatar, Kyrgyzstan, the Dem. People's Rep. of Korea, Tajikistan, Turkmenistan and Yemen, the frequency band 10.68-10.7 GHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. Such use is limited to equipment in operation by 1 January 1985. (WRC-19)

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* Pursuant to Resolution 99 (Rev. Dubai, 2018) of the Plenipotentiary Conference, and taking into account the Israeli-Palestinian Interim Agreement of 28 September 1995.

10.7-11.7 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
10.7-10.95 FIXED FIXED-SATELLITE (space-to-Earth) 5.441 (Earth-to-space) 5.484 MOBILE except aeronautical mobile	**10.7-10.95** FIXED FIXED-SATELLITE (space-to-Earth) 5.441 MOBILE except aeronautical mobile	
10.95-11.2 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B (Earth-to-space) 5.484 MOBILE except aeronautical mobile	**10.95-11.2** FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B MOBILE except aeronautical mobile	
11.2-11.45 FIXED FIXED-SATELLITE (space-to-Earth) 5.441 (Earth-to-space) 5.484 MOBILE except aeronautical mobile	**11.2-11.45** FIXED FIXED-SATELLITE (space-to-Earth) 5.441 MOBILE except aeronautical mobile	
11.45-11.7 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B (Earth-to-space) 5.484 MOBILE except aeronautical mobile	**11.45-11.7** FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B MOBILE except aeronautical mobile	

5.484 In Region 1, the use of the band 10.7-11.7 GHz by the fixed-satellite service (Earth-to-space) is limited to feeder links for the broadcasting-satellite service.

5.484A The use of the frequency bands 10.95-11.2 GHz (space-to-Earth), 11.45-11.7 GHz (space-to-Earth), 11.7-12.2 GHz (space-to-Earth) in Region 2, 12.2-12.75 GHz (space-to-Earth) in Region 3, 12.5-12.75 GHz (space-to-Earth) in Region 1, 13.75-14.5 GHz (Earth-to-space), 17.3-17.7 GHz (space-to-Earth) in Region 2, 17.8-18.6 GHz (space-to-Earth), 19.7-20.2 GHz (space-to-Earth), 27.5-28.6 GHz (Earth-to-space), 29.5-30 GHz (Earth-to-space) by a non-geostationary-satellite system in the fixed-satellite service is subject to application of the provisions of No. **9.12** for coordination with other non-geostationary-satellite systems in the fixed-satellite service. Non-geostationary-satellite systems in the fixed-satellite service shall not claim protection from geostationary-satellite networks in the fixed-satellite service operating in accordance with the Radio Regulations, irrespective of the dates of receipt by the Bureau of the complete coordination or notification information, as appropriate, for the non-geostationary-satellite systems in the fixed-satellite service and of the complete coordination or notification information, as appropriate, for the geostationary-satellite networks, and No. **5.43A** does not apply. Non-geostationary-satellite systems in the fixed-satellite service in the above bands shall be operated in such a way that any unacceptable interference that may occur during their operation shall be rapidly eliminated. In Region 2, No. **22.2** shall continue to apply in the frequency band 17.3-17.7 GHz. (WRC-23)

5.484B Resolution **155 (WRC-15)*** shall apply. (WRC-15)

* *Note by the Secretariat:* This Resolution was revised by WRC-19.

11.7-13.4 GHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td rowspan="3">11.7-12.5
FIXED
MOBILE except aeronautical mobile
BROADCASTING
BROADCASTING-SATELLITE 5.492

5.487 5.487A</td><td>11.7-12.1
FIXED 5.486
FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B 5.488
Mobile except aeronautical mobile
5.485</td><td rowspan="2">11.7-12.2
FIXED
MOBILE except aeronautical mobile
BROADCASTING
BROADCASTING-SATELLITE 5.492

5.487 5.487A</td></tr>
<tr><td>12.1-12.2
FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B 5.488
5.485 5.489</td></tr>
<tr><td>12.2-12.7
FIXED
MOBILE except aeronautical mobile
BROADCASTING
BROADCASTING-SATELLITE 5.492

5.487A 5.488 5.490</td><td>12.2-12.5
FIXED
FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B
MOBILE except aeronautical mobile
BROADCASTING
5.487</td></tr>
<tr><td>12.5-12.75
FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B (Earth-to-space)

5.494 5.495 5.496</td><td>12.7-12.75
FIXED
FIXED-SATELLITE (Earth-to-space)
MOBILE except aeronautical mobile</td><td>12.5-12.75
FIXED
FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B
MOBILE except aeronautical mobile
BROADCASTING-SATELLITE 5.493</td></tr>
<tr><td>12.75-13.25</td><td colspan="2">FIXED
FIXED-SATELLITE (Earth-to-space) 5.441 5.496A
MOBILE
Space research (deep space) (space-to-Earth)</td></tr>
<tr><td>13.25-13.4</td><td colspan="2">EARTH EXPLORATION-SATELLITE (active)
AERONAUTICAL RADIONAVIGATION 5.497
SPACE RESEARCH (active)
5.498A 5.499</td></tr>
</table>

5.485 In Region 2, in the band 11.7-12.2 GHz, transponders on space stations in the fixed-satellite service may be used additionally for transmissions in the broadcasting-satellite service, provided that such transmissions do not have a maximum e.i.r.p. greater than 53 dBW per television channel and do not cause greater interference or require more protection from interference than the coordinated fixed-satellite service frequency assignments. With respect to the space services, this band shall be used principally for the fixed-satellite service.

5.486 *Different category of service:* in the United States, the allocation of the frequency band 11.7-12.1 GHz to the fixed service is on a secondary basis (see No. **5.32**). (WRC-15)

5.487 In the band 11.7-12.5 GHz in Regions 1 and 3, the fixed, fixed-satellite, mobile, except aeronautical mobile, and broadcasting services, in accordance with their respective allocations, shall not cause harmful interference to, or claim protection from, broadcasting-satellite stations operating in accordance with the Regions 1 and 3 Plan in Appendix **30**. (WRC-03)

5.487A *Additional allocation:* in Region 1, the band 11.7-12.5 GHz, in Region 2, the band 12.2-12.7 GHz and, in Region 3, the band 11.7-12.2 GHz, are also allocated to the fixed-satellite service (space-to-Earth) on a primary basis, limited to non-geostationary systems and subject to application of the provisions of No. **9.12** for coordination with other non-geostationary-satellite systems in the fixed-satellite service. Non-geostationary-satellite systems in the fixed-satellite service shall not claim protection from geostationary-satellite networks in the broadcasting-satellite service operating in accordance with the Radio Regulations, irrespective of the dates of receipt by the Bureau of the complete coordination or notification information, as appropriate, for the non-geostationary-satellite systems in the fixed-satellite service and of the complete coordination or notification information, as appropriate, for the geostationary-satellite networks, and No. **5.43A** does not apply. Non-geostationary-satellite systems in the fixed-satellite service in the above bands shall be operated in such a way that any unacceptable interference that may occur during their operation shall be rapidly eliminated. (WRC-03)

5.488 The use of the band 11.7-12.2 GHz by geostationary-satellite networks in the fixed-satellite service in Region 2 is subject to application of the provisions of No. **9.14** for coordination with stations of terrestrial services in Regions 1, 2 and 3. For the use of the band 12.2-12.7 GHz by the broadcasting-satellite service in Region 2, see Appendix **30**. (WRC-03)

5.489 *Additional allocation:* in Peru, the band 12.1-12.2 GHz is also allocated to the fixed service on a primary basis.

5.490 In Region 2, in the band 12.2-12.7 GHz, existing and future terrestrial radiocommunication services shall not cause harmful interference to the space services operating in conformity with the broadcasting-satellite Plan for Region 2 contained in Appendix **30**.

5.491 (SUP - WRC-03)

5.492 Assignments to stations of the broadcasting-satellite service which are in conformity with the appropriate regional Plan or included in the Regions 1 and 3 List in Appendix **30** may also be used for transmissions in the fixed-satellite service (space-to-Earth), provided that such transmissions do not cause more interference, or require more protection from interference, than the broadcasting-satellite service transmissions operating in conformity with the Plan or the List, as appropriate. (WRC-2000)

5.493 The broadcasting-satellite service in the band 12.5-12.75 GHz in Region 3 is limited to a power flux-density not exceeding –111 dB(W/(m^2 · 27 MHz)) for all conditions and for all methods of modulation at the edge of the service area. (WRC-97)

5.494 *Additional allocation:* in Algeria, Saudi Arabia, Bahrain, Cameroon, the Central African Rep., Congo (Rep. of the), Côte d'Ivoire, Djibouti, Egypt, the United Arab Emirates, Eritrea, Ethiopia, Gabon, Ghana, Guinea, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Madagascar, Mali, Morocco, Mongolia, Nigeria, Oman, Palestine[*], Qatar, the Syrian Arab Republic, the Dem. Rep. of the Congo, Somalia, Sudan, South Sudan, Chad, Togo and Yemen, the frequency band 12.5-12.75 GHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-23)

5.495 *Additional allocation:* in Greece, Monaco, Montenegro, Uganda and Tunisia, the frequency band 12.5-12.75 GHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a secondary basis. (WRC-19)

5.496 *Additional allocation:* in Austria, Azerbaijan, Kyrgyzstan and Turkmenistan, the band 12.5-12.75 GHz is also allocated to the fixed service and the mobile, except aeronautical mobile, service on a primary basis. However, stations in these services shall not cause harmful interference to fixed-satellite service earth stations of countries in Region 1 other than those listed in this footnote. Coordination of these earth stations is not required with stations of the fixed and mobile services of the countries listed in this footnote. The power flux-density limit at the Earth's surface given in Table **21-4** of Article **21**, for the fixed-satellite service shall apply on the territory of the countries listed in this footnote. (WRC-2000)

5.496A The frequency band 12.75-13.25 GHz (Earth-to-space) may be used by earth stations in motion, limited to earth stations on aircraft and vessels, communicating with geostationary space stations in the fixed-satellite service. Resolution **121 (WRC-23)** shall apply. (WRC-23)

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[*] Pursuant to Resolution 99 (Rev. Dubai, 2018) of the Plenipotentiary Conference, and taking into account the Israeli-Palestinian Interim Agreement of 28 September 1995.

5.497 The use of the band 13.25-13.4 GHz by the aeronautical radionavigation service is limited to Doppler navigation aids.

5.498 (SUP - WRC-97)

5.498A The Earth exploration-satellite (active) and space research (active) services operating in the band 13.25-13.4 GHz shall not cause harmful interference to, or constrain the use and development of, the aeronautical radionavigation service. (WRC-97)

5.499 *Additional allocation:* in Bangladesh and India, the band 13.25-14 GHz is also allocated to the fixed service on a primary basis. In Pakistan, the band 13.25-13.75 GHz is allocated to the fixed service on a primary basis. (WRC-12)

13.4-14 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
13.4-13.65 EARTH EXPLORATION-SATELLITE (active) FIXED-SATELLITE (space-to-Earth) 5.499A 5.499B RADIOLOCATION SPACE RESEARCH 5.499C 5.499D Standard frequency and time signal-satellite (Earth-to-space) 5.499E 5.500 5.501 5.501B	**13.4-13.65** EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH 5.499C 5.499D Standard frequency and time signal-satellite (Earth-to-space) 5.499 5.500 5.501 5.501B	
13.65-13.75	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH 5.501A Standard frequency and time signal-satellite (Earth-to-space) 5.499 5.500 5.501 5.501B	
13.75-14	FIXED-SATELLITE (Earth-to-space) 5.484A RADIOLOCATION Earth exploration-satellite Standard frequency and time signal-satellite (Earth-to-space) Space research 5.499 5.500 5.501 5.502 5.503	

5.499A The use of the frequency band 13.4-13.65 GHz by the fixed-satellite service (space-to-Earth) is limited to geostationary-satellite systems and is subject to agreement obtained under No. **9.21** with respect to satellite systems operating in the space research service (space-to-space) to relay data from space stations in the geostationary-satellite orbit to associated space stations in non-geostationary satellite orbits for which advance publication information has been received by the Bureau by 27 November 2015. (WRC-15)

5.499B Administrations shall not preclude the deployment and operation of transmitting earth stations in the standard frequency and time signal-satellite service (Earth-to-space) allocated on a secondary basis in the frequency band 13.4-13.65 GHz due to the primary allocation to FSS (space-to-Earth). (WRC-15)

5.499C The allocation of the frequency band 13.4-13.65 GHz to the space research service on a primary basis is limited to:

– satellite systems operating in the space research service (space-to-space) to relay data from space stations in the geostationary-satellite orbit to associated space stations in non-geostationary satellite orbits for which advance publication information has been received by the Bureau by 27 November 2015,

– active spaceborne sensors,

– satellite systems operating in the space research service (space-to-Earth) to relay data from space stations in the geostationary-satellite orbit to associated earth stations.

Other uses of the frequency band by the space research service are on a secondary basis. (WRC-15)

5.499D In the frequency band 13.4-13.65 GHz, satellite systems in the space research service (space-to-Earth) and/or the space research service (space-to-space) shall not cause harmful interference to, nor claim protection from, stations in the fixed, mobile, radiolocation and Earth exploration-satellite (active) services. (WRC-15)

5.499E In the frequency band 13.4-13.65 GHz, geostationary-satellite networks in the fixed-satellite service (space-to-Earth) shall not claim protection from space stations in the Earth exploration-satellite service (active) operating in accordance with these Regulations, and No. **5.43A** does not apply. The provisions of No. **22.2** do not apply to the Earth exploration-satellite service (active) with respect to the fixed-satellite service (space-to-Earth) in this frequency band. (WRC-15)

5.500 *Additional allocation:* in Algeria, Saudi Arabia, Bahrain, Brunei Darussalam, Cameroon, Djibouti, Egypt, the United Arab Emirates, Gabon, Indonesia, Iran (Islamic Republic of), Iraq, Israel, Jordan, Kuwait, Lebanon, Madagascar, Malaysia, Mali, Morocco, Mauritania, Niger, Nigeria, Oman, Qatar, the Syrian Arab Republic, Singapore, Somalia, Sudan, South Sudan, Chad and Tunisia, the frequency band 13.4-14 GHz is also allocated to the fixed and mobile services on a primary basis. In Pakistan, the frequency band 13.4-13.75 GHz is also allocated to the fixed and mobile services on a primary basis. (WRC-23)

5.501 *Additional allocation:* in Hungary, Japan, Kyrgyzstan, Romania and Turkmenistan, the frequency band 13.4-14 GHz is also allocated to the radionavigation service on a primary basis. (WRC-23)

5.501A The allocation of the frequency band 13.65-13.75 GHz to the space research service on a primary basis is limited to active spaceborne sensors. Other uses of the frequency band by the space research service are on a secondary basis. (WRC-15)

5.501B In the band 13.4-13.75 GHz, the Earth exploration-satellite (active) and space research (active) services shall not cause harmful interference to, or constrain the use and development of, the radiolocation service. (WRC-97)

5.502 In the band 13.75-14 GHz, an earth station of a geostationary fixed-satellite service network shall have a minimum antenna diameter of 1.2 m and an earth station of a non-geostationary fixed-satellite service system shall have a minimum antenna diameter of 4.5 m. In addition, the e.i.r.p., averaged over one second, radiated by a station in the radiolocation or radionavigation services shall not exceed 59 dBW for elevation angles above 2° and 65 dBW at lower angles. Before an administration brings into use an earth station in a geostationary-satellite network in the fixed-satellite service in this band with an antenna diameter smaller than 4.5 m, it shall ensure that the power flux-density produced by this earth station does not exceed:

– –115 dB(W/(m^2 · 10 MHz)) for more than 1% of the time produced at 36 m above sea level at the low water mark, as officially recognized by the coastal State;

– –115 dB(W/(m^2 · 10 MHz)) for more than 1% of the time produced 3 m above ground at the border of the territory of an administration deploying or planning to deploy land mobile radars in this band, unless prior agreement has been obtained.

For earth stations within the fixed-satellite service having an antenna diameter greater than or equal to 4.5 m, the e.i.r.p. of any emission should be at least 68 dBW and should not exceed 85 dBW. (WRC-03)

5.503 In the band 13.75-14 GHz, geostationary space stations in the space research service for which information for advance publication has been received by the Bureau prior to 31 January 1992 shall operate on an equal basis with stations in the fixed-satellite service; after that date, new geostationary space stations in the space research service will operate on a secondary basis. Until those geostationary space stations in the space research service for which information for advance publication has been received by the Bureau prior to 31 January 1992 cease to operate in this band:

– in the band 13.77-13.78 GHz, the e.i.r.p. density of emissions from any earth station in the fixed-satellite service operating with a space station in geostationary-satellite orbit shall not exceed:

i) $4.7D + 28$ dB(W/40 kHz), where D is the fixed-satellite service earth station antenna diameter (m) for antenna diameters equal to or greater than 1.2 m and less than 4.5 m;

ii) $49.2 + 20 \log(D/4.5)$ dB(W/40 kHz), where D is the fixed-satellite service earth station antenna diameter (m) for antenna diameters equal to or greater than 4.5 m and less than 31.9 m;

iii) 66.2 dB(W/40 kHz) for any fixed-satellite service earth station for antenna diameters (m) equal to or greater than 31.9 m;

iv) 56.2 dB(W/4 kHz) for narrow-band (less than 40 kHz of necessary bandwidth) fixed-satellite service earth station emissions from any fixed-satellite service earth station having an antenna diameter of 4.5 m or greater;

– the e.i.r.p. density of emissions from any earth station in the fixed-satellite service operating with a space station in **non-**geostationary-satellite orbit shall not exceed 51 dBW in the 6 MHz band from 13.772 to 13.778 GHz.

Automatic power control may be used to increase the e.i.r.p. density in these frequency ranges to compensate for rain attenuation, to the extent that the power flux-density at the fixed-satellite service space station does not exceed the value resulting from use by an earth station of an e.i.r.p. meeting the above limits in clear-sky conditions. (WRC-03)

5.503A (SUP - WRC-03)

14-14.5 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
14-14.25	FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.484B 5.506 5.506B RADIONAVIGATION 5.504 Mobile-satellite (Earth-to-space) 5.504B 5.504C 5.506A Space research 5.504A 5.505	
14.25-14.3	FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.484B 5.506 5.506B RADIONAVIGATION 5.504 Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.508A Space research 5.504A 5.505 5.508	
14.3-14.4 FIXED FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.484B 5.506 5.506B MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A Radionavigation-satellite 5.504A	**14.3-14.4** FIXED-SATELLITE (Earth-to-space) 5.457A 5.484A 5.484B 5.506 5.506B Mobile-satellite (Earth-to-space) 5.506A Radionavigation-satellite 5.504A	**14.3-14.4** FIXED FIXED-SATELLITE (Earth-to-space) 5.457A 5.484A 5.484B 5.506 5.506B MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A Radionavigation-satellite 5.504A
14.4-14.47	FIXED FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.484B 5.506 5.506B MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A Space research (space-to-Earth) 5.504A	
14.47-14.5	FIXED FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.506 5.506B MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A Radio astronomy 5.149 5.504A	

5.504 The use of the band 14-14.3 GHz by the radionavigation service shall be such as to provide sufficient protection to space stations of the fixed-satellite service.

5.504A In the band 14-14.5 GHz, aircraft earth stations in the secondary aeronautical mobile-satellite service may also communicate with space stations in the fixed-satellite service. The provisions of Nos. **5.29**, **5.30** and **5.31** apply. (WRC-03)

5.504B Aircraft earth stations operating in the aeronautical mobile-satellite service in the frequency band 14-14.5 GHz shall comply with the provisions of Annex 1, Part C of Recommendation ITU-R M.1643-0, with respect to any radio astronomy station performing observations in the 14.47-14.5 GHz frequency band located on the territory of Spain, France, India, Italy, the United Kingdom and South Africa. (WRC-15)

5.504C In the frequency band 14-14.25 GHz, the power flux-density produced on the territory of the countries of Saudi Arabia, Bahrain, Botswana, Côte d'Ivoire, Egypt, Guinea, India, Iran (Islamic Republic of), Kuwait, Nigeria, Oman, the Syrian Arab Republic and Tunisia by any aircraft earth station in the aeronautical mobile-satellite service shall not exceed the limits given in Annex 1, Part B of Recommendation ITU-R M.1643-0, unless otherwise specifically agreed by the affected administration(s). The provisions of this footnote in no way derogate the obligations of the aeronautical mobile-satellite service to operate as a secondary service in accordance with No. **5.29**. (WRC-15)

5.505 *Additional allocation:* in Algeria, Saudi Arabia, Bahrain, Botswana, Brunei Darussalam, Cameroon, China, Congo (Rep. of the), Korea (Rep. of), Djibouti, Egypt, the United Arab Emirates, Eswatini, Gabon, Guinea, India, Indonesia, Iran (Islamic Republic of), Iraq, Israel, Japan, Jordan, Kuwait, Lebanon, Malaysia, Mali, Morocco, Mauritania, Oman, the Philippines, Qatar, the Syrian Arab Republic, the Dem. People's Rep. of Korea, Singapore, Somalia, Sudan, South Sudan, Chad, Viet Nam and Yemen, the frequency band 14-14.3 GHz is also allocated to the fixed service on a primary basis. (WRC-19)

5.506 The band 14-14.5 GHz may be used, within the fixed-satellite service (Earth-to-space), for feeder links for the broadcasting-satellite service, subject to coordination with other networks in the fixed-satellite service. Such use of feeder links is reserved for countries outside Europe.

5.506A In the frequency band 14-14.5 GHz, ship earth stations with an equivalent isotropically radiated power (e.i.r.p.) greater than 21 dBW shall operate under the same conditions as earth stations located on board vessels, as provided in Resolution **902 (Rev.WRC-23)**. This footnote shall not apply to ship earth stations for which the complete Appendix **4** information has been received by the Bureau prior to 5 July 2003. (WRC-23)

5.506B Earth stations located on board vessels communicating with space stations in the fixed-satellite service may operate in the frequency band 14-14.5 GHz without the need for prior agreement from Cyprus and Malta, within the minimum distance given in Resolution **902 (Rev.WRC-23)** from these countries. (WRC-23)

5.507 Not used.

5.508 *Additional allocation:* in Germany, Italy, Libya, North Macedonia and the United Kingdom, the frequency band 14.25-14.3 GHz is also allocated to the fixed service on a primary basis. (WRC-23)

5.508A In the frequency band 14.25-14.3 GHz, the power flux-density produced on the territory of the countries of Saudi Arabia, Bahrain, Botswana, China, Côte d'Ivoire, Egypt, Guinea, India, Iran (Islamic Republic of), Italy, Kuwait, Nigeria, Oman, the Syrian Arab Republic, the United Kingdom and Tunisia by any aircraft earth station in the aeronautical mobile-satellite service shall not exceed the limits given in Annex 1, Part B of Recommendation ITU-R M.1643-0, unless otherwise specifically agreed by the affected administration(s). The provisions of this footnote in no way derogate the obligations of the aeronautical mobile-satellite service to operate as a secondary service in accordance with No. **5.29**. (WRC-23)

5.509 (SUP - WRC-07)

5.509A In the frequency band 14.3-14.5 GHz, the power flux-density produced on the territory of the countries of Saudi Arabia, Bahrain, Botswana, Cameroon, China, Côte d'Ivoire, Egypt, Gabon, Guinea, India, Iran (Islamic Republic of), Italy, Kuwait, Morocco, Nigeria, Oman, the Syrian Arab Republic, the United Kingdom, Sri Lanka, Tunisia and Viet Nam by any aircraft earth station in the aeronautical mobile-satellite service shall not exceed the limits given in Annex 1, Part B of Recommendation ITU-R M.1643-0, unless otherwise specifically agreed by the affected administration(s). The provisions of this footnote in no way derogate the obligations of the aeronautical mobile-satellite service to operate as a secondary service in accordance with No. **5.29**. (WRC-23)

14.5-15.4 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
14.5-14.75	FIXED FIXED-SATELLITE (Earth-to-space) 5.509B 5.509C 5.509D 5.509E 5.509F 5.510 MOBILE Space research 5.509G	
14.75-14.8 FIXED FIXED-SATELLITE (Earth-to-space) 5.510 MOBILE Space research 5.509G		**14.75-14.8** FIXED FIXED-SATELLITE (Earth-to-space) 5.509B 5.509C 5.509D 5.509E 5.509F 5.510 MOBILE Space research 5.509G
14.8-15.35	FIXED MOBILE SPACE RESEARCH 5.510A 5.339	
15.35-15.4	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.511	

5.509B The use of the frequency bands 14.5-14.75 GHz in countries listed in Resolution **163 (WRC-15)** and 14.5-14.8 GHz in countries listed in Resolution **164 (WRC-15)** by the fixed-satellite service (Earth-to-space) not for feeder links for the broadcasting-satellite service is limited to geostationary-satellites. (WRC-15)

5.509C For the use of the frequency bands 14.5-14.75 GHz in countries listed in Resolution **163 (WRC-15)** and 14.5-14.8 GHz in countries listed in Resolution **164 (WRC-15)** by the fixed-satellite service (Earth-to-space) not for feeder links for the broadcasting-satellite service, the fixed-satellite service earth stations shall have a minimum antenna diameter of 6 m and a maximum power spectral density of −44.5 dBW/Hz at the input of the antenna. The earth stations shall be notified at known locations on land. (WRC-15)

5.509D Before an administration brings into use an earth station in the fixed-satellite service (Earth-to-space) not for feeder links for the broadcasting-satellite service in the frequency bands 14.5-14.75 GHz (in countries listed in Resolution **163 (WRC-15)**) and 14.5-14.8 GHz (in countries listed in Resolution **164 (WRC-15)**), it shall ensure that the power flux-density produced by this earth station does not exceed −151.5 dB(W/(m^2 · 4 kHz)) produced at all altitudes from 0 m to 19 000 m above sea level at 22 km seaward from all coasts, defined as the low-water mark, as officially recognized by each coastal State. (WRC-15)

5.509E In the frequency bands 14.5-14.75 GHz in countries listed in Resolution **163 (WRC-15)** and 14.5-14.8 GHz in countries listed in Resolution **164 (WRC-15)**, the location of earth stations in the fixed-satellite service (Earth-to-space) not for feeder links for the broadcasting-satellite service shall maintain a separation distance of at least 500 km from the border(s) of other countries unless shorter distances are explicitly agreed by those administrations. No. **9.17** does not apply. When applying this provision, administrations should consider the relevant parts of these Regulations and the latest relevant ITU-R Recommendations. (WRC-23)

5.509F In the frequency bands 14.5-14.75 GHz in countries listed in Resolution **163 (WRC-15)** and 14.5-14.8 GHz in countries listed in Resolution **164 (WRC-15)**, earth stations in the fixed-satellite service (Earth-to-space) not for feeder links for the broadcasting-satellite service shall not constrain the future deployment of the fixed and mobile services. (WRC-23)

5.509G The frequency band 14.5-14.8 GHz is also allocated to the space research service on a primary basis. However, such use is limited to the satellite systems operating in the space research service (Earth-to-space) to relay data to space stations in the geostationary-satellite orbit from associated earth stations. Stations in the space research service shall not cause harmful interference to, or claim protection from, stations in the fixed and mobile services and in the fixed-satellite service limited to feeder links for the broadcasting-satellite service and associated space operations functions using the guardbands under Appendix **30A** and feeder links for the broadcasting-satellite service in Region 2. Other uses of this frequency band by the space research service are on a secondary basis. (WRC-15)

5.510 Except for use in accordance with Resolution **163 (WRC-15)** and Resolution **164 (WRC-15)**, the use of the frequency band 14.5-14.8 GHz by the fixed-satellite service (Earth-to-space) is limited to feeder links for the broadcasting-satellite service. This use is reserved for countries outside Europe. Uses other than feeder links for the broadcasting-satellite service are not authorized in Regions 1 and 2 in the frequency band 14.75-14.8 GHz. (WRC-15)

5.510A The allocation of the frequency band 14.8-15.35 GHz to the space research service on a primary basis is limited to satellite systems operating in the space-to-space, space-to-Earth and Earth-to-space directions at distances from the Earth of less than 2×10^6 km in accordance with Resolution **678 (WRC-23)**. Other uses of the frequency band by the space research service are on a secondary basis. The use of the frequency band 14.8-15.35 GHz by the space research service (space-to-Earth) (Earth-to-space) is on a secondary basis with respect to the terrestrial services in Algeria, Saudi Arabia, Bahrain, Korea (Rep. of), Egypt, the United Arab Emirates, the United States, India, Iraq, Japan, Kuwait, Libya, Morocco, Mauritania, Oman, Qatar, the Syrian Arab Republic, Tunisia and Yemen. (WRC-23)

5.511 *Additional allocation:* in Saudi Arabia, Bahrain, Cameroon, Djibouti, Egypt, the United Arab Emirates, Guinea, Iran (Islamic Republic of), Iraq, Israel, Kuwait, Lebanon, Oman, Pakistan, Qatar, the Syrian Arab Republic and Somalia, the frequency band 15.35-15.4 GHz is also allocated to the fixed and mobile services on a secondary basis. (WRC-23)

15.4-17.3 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
15.4-15.41	RADIOLOCATION 5.511E 5.511F AERONAUTICAL RADIONAVIGATION	
15.41-15.43 RADIOLOCATION 5.511E 5.511F AERONAUTICAL RADIONAVIGATION Aeronautical mobile (OR) 5.511G	**15.41-15.43** RADIOLOCATION 5.511E 5.511F AERONAUTICAL RADIONAVIGATION	**15.41-15.43** RADIOLOCATION 5.511E 5.511F AERONAUTICAL RADIONAVIGATION 5.511H
15.43-15.63 FIXED-SATELLITE (Earth-to-space) 5.511A RADIOLOCATION 5.511E 5.511F AERONAUTICAL RADIONAVIGATION Aeronautical mobile (OR) 5.511G 5.511C	**15.43-15.63** FIXED-SATELLITE (Earth-to-space) 5.511A RADIOLOCATION 5.511E 5.511F AERONAUTICAL RADIONAVIGATION 5.511C	**15.43-15.63** FIXED-SATELLITE (Earth-to-space) 5.511A RADIOLOCATION 5.511E 5.511F AERONAUTICAL RADIONAVIGATION 5.511C 5.511H
15.63-15.7 RADIOLOCATION 5.511E 5.511F AERONAUTICAL RADIONAVIGATION Aeronautical mobile (OR) 5.511G	**15.63-15.7** RADIOLOCATION 5.511E 5.511F AERONAUTICAL RADIONAVIGATION	**15.63-15.7** RADIOLOCATION 5.511E 5.511F AERONAUTICAL RADIONAVIGATION 5.511H
15.7-16.6	RADIOLOCATION 5.512 5.513	
16.6-17.1	RADIOLOCATION Space research (deep space) (Earth-to-space) 5.512 5.513	
17.1-17.2	RADIOLOCATION 5.512 5.513	
17.2-17.3	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH (active) 5.512 5.513 5.513A	

5.511A Use of the frequency band 15.43-15.63 GHz by the fixed-satellite service (Earth-to-space) is limited to feeder links of non-geostationary systems in the mobile-satellite service, subject to coordination under No. **9.11A**. (WRC-15)

5.511B (SUP - WRC-97)

5.511C Stations operating in the aeronautical radionavigation service shall limit the effective e.i.r.p. in accordance with Recommendation ITU-R S.1340-0. The minimum coordination distance required to protect the aeronautical radionavigation stations (No. **4.10** applies) from harmful interference from feeder-link earth stations and the maximum e.i.r.p. transmitted towards the local horizontal plane by a feeder-link earth station shall be in accordance with Recommendation ITU-R S.1340-0. (WRC-15)

5.511D (SUP - WRC-15)

5.511E In the frequency band 15.4-15.7 GHz, stations operating in the radiolocation service shall not cause harmful interference to, or claim protection from, stations operating in the aeronautical radionavigation service. (WRC-12)

5.511F In order to protect the radio astronomy service in the frequency band 15.35-15.4 GHz, radiolocation stations operating in the frequency band 15.4-15.7 GHz shall not exceed the power flux-density level of −156 dB(W/m^2) in a 50 MHz bandwidth in the frequency band 15.35-15.4 GHz, at any radio astronomy observatory site for more than 2 per cent of the time. (WRC-12)

5.511G Stations in the aeronautical mobile (OR) service operating in the frequency band 15.41-15.7 GHz shall not cause harmful interference to the radio astronomy service operating in the frequency band 15.35-15.4 GHz. The aggregate power flux-density (pfd) received from stations in the aeronautical mobile (OR) service operating in the frequency band 15.41-15.7 GHz at any radio astronomy station operating in the frequency band 15.35-15.4 GHz shall be in compliance with the protection criteria provided in Recommendations ITU-R RA.769-2 and ITU-R RA.1513-2, unless specifically agreed by the affected administration(s). (WRC-23)

5.511H *Additional allocation*: in Indonesia, the frequency band 15.41-15.7 GHz is also allocated to the aeronautical mobile (OR) service on a secondary basis. Stations in the aeronautical mobile (OR) service operating in the frequency band 15.41-15.7 GHz shall not cause harmful interference to the radio astronomy service operating in the frequency band 15.35-15.4 GHz. The aggregate power flux-density (pfd) received from stations in the aeronautical mobile (OR) service operating in the frequency band 15.41-15.7 GHz at any radio astronomy station operating in the frequency band 15.35-15.4 GHz shall be in compliance with the protection criteria provided in Recommendations ITU-R RA.769-2 and ITU-R RA.1513-2, unless specifically agreed by the affected administration(s). (WRC-23)

5.512 *Additional allocation:* in Algeria, Saudi Arabia, Austria, Bahrain, Bangladesh, Brunei Darussalam, Cameroon, Congo (Rep. of the), Egypt, El Salvador, the United Arab Emirates, Eritrea, Finland, Guatemala, India, Indonesia, Iran (Islamic Republic of), Jordan, Kenya, Kuwait, Lebanon, Libya, Malaysia, Mali, Morocco, Mauritania, Montenegro, Nepal, Nicaragua, Niger, Oman, Pakistan, Qatar, Syrian Arab Republic, the Dem. Rep. of the Congo, Singapore, Somalia, Sudan, South Sudan, Chad, Togo and Yemen, the frequency band 15.7-17.3 GHz is also allocated to the fixed and mobile services on a primary basis. (WRC-15)

5.513 *Additional allocation:* in Israel, the band 15.7-17.3 GHz is also allocated to the fixed and mobile services on a primary basis. These services shall not claim protection from or cause harmful interference to services operating in accordance with the Table in countries other than those included in No. **5.512**.

5.513A Spaceborne active sensors operating in the band 17.2-17.3 GHz shall not cause harmful interference to, or constrain the development of, the radiolocation and other services allocated on a primary basis. (WRC-97)

17.3-18.4 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
17.3-17.7 FIXED-SATELLITE (Earth-to-space) 5.516 (space-to-Earth) 5.516A 5.516B Radiolocation 5.514	**17.3-17.7** FIXED-SATELLITE (Earth-to-space) 5.516 (space-to-Earth) 5.484A 5.515A 5.515B 5.517 BROADCASTING-SATELLITE Radiolocation 5.514 5.515	**17.3-17.7** FIXED-SATELLITE (Earth-to-space) 5.516 Radiolocation 5.514
17.7-18.1 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.517A 5.517B (Earth-to-space) 5.516 MOBILE	**17.7-17.8** FIXED FIXED-SATELLITE (space-to-Earth) 5.517 5.517A 5.517B (Earth-to-space) 5.516 BROADCASTING-SATELLITE Mobile 5.515 **17.8-18.1** FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.517A 5.517B (Earth-to-space) 5.516 MOBILE 5.519	**17.7-18.1** FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.517A 5.517B (Earth-to-space) 5.516 MOBILE
18.1-18.4	FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B 5.517A 5.517B (Earth-to-space) 5.520 INTER-SATELLITE 5.521A MOBILE 5.519 5.521	

5.514 *Additional allocation:* in Algeria, Saudi Arabia, Bahrain, Bangladesh, Cameroon, Djibouti, El Salvador, the United Arab Emirates, Guatemala, India, Iran (Islamic Republic of), Iraq, Israel, Italy, Japan, Jordan, Kuwait, Libya, Lithuania, Nepal, Nicaragua, Nigeria, Oman, Uzbekistan, Pakistan, Qatar, Kyrgyzstan, Somalia, Sudan and South Sudan, the frequency band 17.3-17.7 GHz is also allocated to the fixed and mobile services on a secondary basis. The power limits given in Nos. **21.3** and **21.5** shall apply. (WRC-23)

5.515 In the band 17.3-17.8 GHz, sharing between the fixed-satellite service (Earth-to-space) and the broadcasting-satellite service shall also be in accordance with the provisions of § 1 of Annex 4 of Appendix **30A**.

5.515A In addition to the need to comply with the coordination criteria in Annex 4 to Appendix **30A**, under assumed free-space propagation conditions, the power flux-density of an assignment in the fixed-satellite service (space to-Earth) of a geostationary-satellite network in the frequency band 17.3-17.7 GHz in Region 2 shall not exceed the value of −98 dB(W/(m^2 · 27 MHz)) at points in the geostationary-satellite orbit with geocentric orbital separation angles between 152.6° and 162.6°. (WRC-23)

5.515B In the frequency band 17.3-17.7 GHz, the use of the fixed-satellite service (space-to-Earth) by geostationary-satellite space stations in Region 2 shall not cause harmful interference to space station receivers nor claim protection from the broadcasting-satellite service feeder-link earth stations operating under Appendix **30A** in all three Regions, nor put any limitations or restrictions on the locations of the broadcasting-satellite service feeder-link earth stations anywhere within the service area of the feeder link. The notifying administration for the fixed-satellite service (space-to-Earth), when submitting Appendix **4** information elements, shall provide a firm, objective, actionable, measurable and enforceable commitment that, in the event of harmful interference being reported to space station receivers in Appendix **30A**, it shall take immediate action to eliminate the interference or reduce it to an acceptable level. (WRC-23)

5.516 The use of the band 17.3-18.1 GHz by geostationary-satellite systems in the fixed-satellite service (Earth-to-space) is limited to feeder links for the broadcasting-satellite service. The use of the band 17.3-17.8 GHz in Region 2 by systems in the fixed-satellite service (Earth-to-space) is limited to geostationary satellites. For the use of the band 17.3-17.8 GHz in Region 2 by feeder links for the broadcasting-satellite service in the band 12.2-12.7 GHz, see Article **11**. The use of the bands 17.3-18.1 GHz (Earth-to-space) in Regions 1 and 3 and 17.8-18.1 GHz (Earth-to-space) in Region 2 by non-geostationary-satellite systems in the fixed-satellite service is subject to application of the provisions of No. **9.12** for coordination with other non-geostationary-satellite systems in the fixed-satellite service. Non-geostationary-satellite systems in the fixed-satellite service shall not claim protection from geostationary-satellite networks in the fixed-satellite service operating in accordance with the Radio Regulations, irrespective of the dates of receipt by the Bureau of the complete coordination or notification information, as appropriate, for the non-geostationary-satellite systems in the fixed-satellite service and of the complete coordination or notification information, as appropriate, for the geostationary-satellite networks, and No. **5.43A** does not apply. Non-geostationary-satellite systems in the fixed-satellite service in the above bands shall be operated in such a way that any unacceptable interference that may occur during their operation shall be rapidly eliminated. (WRC-2000)

5.516A In the band 17.3-17.7 GHz, earth stations of the fixed-satellite service (space-to-Earth) in Region 1 shall not claim protection from the broadcasting-satellite service feeder-link earth stations operating under Appendix **30A**, nor put any limitations or restrictions on the locations of the broadcasting-satellite service feeder-link earth stations anywhere within the service area of the feeder link. (WRC-03)

5.516B The following bands are identified for use by high-density applications in the fixed-satellite service:

17.3-17.7 GHz	(space-to-Earth) in Region 1,
18.3-19.3 GHz	(space-to-Earth) in Region 2,
19.7-20.2 GHz	(space-to-Earth) in all Regions,
39.5-40 GHz	(space-to-Earth) in Region 1,
40-40.5 GHz	(space-to-Earth) in all Regions,
40.5-42 GHz	(space-to-Earth) in Region 2,
47.5-47.9 GHz	(space-to-Earth) in Region 1,
48.2-48.54 GHz	(space-to-Earth) in Region 1,
49.44-50.2 GHz	(space-to-Earth) in Region 1,
and	
27.5-27.82 GHz	(Earth-to-space) in Region 1,
28.35-28.45 GHz	(Earth-to-space) in Region 2,
28.45-28.94 GHz	(Earth-to-space) in all Regions,
28.94-29.1 GHz	(Earth-to-space) in Region 2 and 3,
29.25-29.46 GHz	(Earth-to-space) in Region 2,
29.46-30 GHz	(Earth-to-space) in all Regions,
48.2-50.2 GHz	(Earth-to-space) in Region 2.

This identification does not preclude the use of these frequency bands by other fixed-satellite service applications or by other services to which these frequency bands are allocated on a co-primary basis and does not establish priority in these Radio Regulations among users of the frequency bands. Administrations should take this into account when considering regulatory provisions in relation to these frequency bands. See Resolution **143 (Rev.WRC-19)**. (WRC-19)

5.517 In Region 2, use of the fixed-satellite (space-to-Earth) service in the frequency band 17.3-17.8 GHz shall not cause harmful interference to nor claim protection from assignments in the broadcasting-satellite service operating in conformity with the Radio Regulations. (WRC-23)

5.517A The operation of earth stations in motion communicating with geostationary fixed-satellite service space stations within the frequency bands 17.7-19.7 GHz (space-to-Earth) and 27.5-29.5 GHz (Earth-to-space) shall be subject to the application of Resolution **169 (Rev.WRC-23)**. (WRC-23)

5.517B The operation of aeronautical and maritime earth stations in motion communicating with non-geostationary space stations in the fixed-satellite service in the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz and 19.7-20.2 GHz (space-to-Earth) and 27.5-29.1 GHz and 29.5-30 GHz (Earth-to-space) shall be subject to the application of Resolution **123 (WRC-23)**. (WRC-23)

5.518 (SUP - WRC-07)

5.519 *Additional allocation:* the bands 18-18.3 GHz in Region 2 and 18.1-18.4 GHz in Regions 1 and 3 are also allocated to the meteorological-satellite service (space-to-Earth) on a primary basis. Their use is limited to geostationary satellites. (WRC-07)

5.520 The use of the band 18.1-18.4 GHz by the fixed-satellite service (Earth-to-space) is limited to feeder links of geostationary-satellite systems in the broadcasting-satellite service. (WRC-2000)

5.521 *Alternative allocation:* in the United Arab Emirates, the frequency band 18.1-18.4 GHz is allocated to the fixed, fixed-satellite (space-to-Earth) and mobile services on a primary basis (see No. **5.33**). The provisions of No. **5.519** also apply. (WRC-23)

5.521A For use of the frequency bands 18.1-18.6 GHz, 18.8-20.2 GHz and 27.5-30 GHz, or parts thereof, by space stations in the inter-satellite service, Resolution **679 (WRC-23)** shall apply. Such use is limited to space research, space operation and/or Earth exploration-satellite applications, and also transmissions of data originating from industrial and medical activities in space. When using these frequencies, administrations shall ensure that this inter-satellite service is used only for the aforementioned purposes and is not subject to coordination under No. **9.11A**. For use of the frequency bands 18.1-18.6 GHz, 18.8-20.2 GHz, 27.5-29.1 GHz and 29.5-30 GHz by space stations, the allocation is limited to inter-satellite links between non-geostationary satellites or between non-geostationary satellites and geostationary satellites. For use of the frequency band 29.1-29.5 GHz by space stations, the allocation is limited to inter-satellite links between non-geostationary satellites and geostationary satellites. No. **4.10** does not apply. (WRC-23)

18.4-22 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
18.4-18.6	FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B 5.517A 5.517B INTER-SATELLITE 5.521A MOBILE	
18.6-18.8 EARTH EXPLORATION-SATELLITE (passive) FIXED FIXED-SATELLITE (space-to-Earth) 5.517A 5.522B MOBILE except aeronautical mobile Space research (passive) 5.522A 5.522C	**18.6-18.8** EARTH EXPLORATION-SATELLITE (passive) FIXED FIXED-SATELLITE (space-to-Earth) 5.516B 5.517A 5.522B MOBILE except aeronautical mobile SPACE RESEARCH (passive) 5.522A	**18.6-18.8** EARTH EXPLORATION-SATELLITE (passive) FIXED FIXED-SATELLITE (space-to-Earth) 5.517A 5.522B MOBILE except aeronautical mobile Space research (passive) 5.522A
18.8-19.3	FIXED FIXED-SATELLITE (space-to-Earth) 5.516B 5.517A 5.517B 5.523A INTER-SATELLITE 5.521A MOBILE	
19.3-19.7	FIXED FIXED-SATELLITE (space-to-Earth) (Earth-to-space) 5.517A 5.523B 5.523C 5.523D 5.523E INTER-SATELLITE 5.521A 5.523DA MOBILE	
19.7-20.1 FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B 5.516B 5.517B 5.527A INTER-SATELLITE 5.521A Mobile-satellite (space-to-Earth) 5.524	**19.7-20.1** FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B 5.516B 5.517B 5.527A INTER-SATELLITE 5.521A MOBILE-SATELLITE (space-to-Earth) 5.524 5.525 5.526 5.527 5.528 5.529	**19.7-20.1** FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B 5.516B 5.517B 5.527A INTER-SATELLITE 5.521A Mobile-satellite (space-to-Earth) 5.524
20.1-20.2	FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B 5.516B 5.517B 5.527A INTER-SATELLITE 5.521A MOBILE-SATELLITE (space-to-Earth) 5.524 5.525 5.526 5.527 5.528	
20.2-21.2	FIXED-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) Standard frequency and time signal-satellite (space-to-Earth) 5.524 5.529A	
21.2-21.4	EARTH EXPLORATION-SATELLITE (passive) FIXED MOBILE SPACE RESEARCH (passive)	
21.4-22 FIXED MOBILE BROADCASTING-SATELLITE 5.208B 5.530A 5.530B	**21.4-22** FIXED 5.530E MOBILE 5.530A	**21.4-22** FIXED MOBILE BROADCASTING-SATELLITE 5.208B 5.530A 5.530B 5.531

5.522 (SUP - WRC-2000)

5.522A The emissions of the fixed service and the fixed-satellite service in the band 18.6-18.8 GHz are limited to the values given in Nos. **21.5A** and **21.16.2**, respectively. (WRC-2000)

5.522B The use of the band 18.6-18.8 GHz by the fixed-satellite service is limited to geostationary systems and systems with an orbit of apogee greater than 20 000 km. (WRC-2000)

5.522C In the band 18.6-18.8 GHz, in Algeria, Saudi Arabia, Bahrain, Egypt, the United Arab Emirates, Jordan, Lebanon, Libya, Morocco, Oman, Qatar, the Syrian Arab Republic, Tunisia and Yemen, fixed-service systems in operation at the date of entry into force of the Final Acts of WRC-2000 are not subject to the limits of No. **21.5A**. (WRC-2000)

5.523 (SUP - WRC-2000)

5.523A The use of the bands 18.8-19.3 GHz (space-to-Earth) and 28.6-29.1 GHz (Earth-to-space) by geostationary and non-geostationary fixed-satellite service networks is subject to the application of the provisions of No. **9.11A** and No. **22.2** does not apply. Non-geostationary-satellite networks shall not cause unacceptable interference to geostationary fixed-satellite service networks for which complete Appendix **4** notification information is considered as having been received by the Bureau prior to 18 November 1995. (WRC-23)

5.523B The use of the band 19.3-19.6 GHz (Earth-to-space) by the fixed-satellite service is limited to feeder links for non-geostationary-satellite systems in the mobile-satellite service. Such use is subject to the application of the provisions of No. **9.11A**, and No. **22.2** does not apply.

5.523C No. **22.2** shall continue to apply in the bands 19.3-19.6 GHz and 29.1-29.4 GHz, between feeder links of non-geostationary mobile-satellite service networks and those fixed-satellite service networks for which complete Appendix **4** coordination information, or notification information, is considered as having been received by the Bureau prior to 18 November 1995. (WRC-97)

5.523D The use of the band 19.3-19.7 GHz (space-to-Earth) by geostationary fixed-satellite service systems and by feeder links for non-geostationary-satellite systems in the mobile-satellite service is subject to the application of the provisions of No. **9.11A**, but not subject to the provisions of No. **22.2**. The use of this band for other non-geostationary fixed-satellite service systems, or for the cases indicated in Nos. **5.523C** and **5.523E**, is not subject to the provisions of No. **9.11A** and shall continue to be subject to Articles **9** (except No. **9.11A**) and **11** procedures, and to the provisions of No. **22.2**. (WRC-97)

5.523DA In order to protect feeder links of non-geostationary networks in the mobile-satellite service in the frequency band 19.3-19.7 GHz, the power flux-density values produced at the surface of the Earth for all angles of arrival by a space station in the inter-satellite service operating in this band in accordance with Resolution **679 (WRC-23)** shall not exceed −140 dB(W/m^2) in any 1 MHz within 150 km of any of the above feeder-link earth stations recorded in the Master International Frequency Register. (WRC-23)

5.523E No. **22.2** shall continue to apply in the bands 19.6-19.7 GHz and 29.4-29.5 GHz, between feeder links of non-geostationary mobile-satellite service networks and those fixed-satellite service networks for which complete Appendix **4** coordination information, or notification information, is considered as having been received by the Bureau by 21 November 1997. (WRC-97)

5.524 *Additional allocation:* in Afghanistan, Algeria, Saudi Arabia, Bahrain, Brunei Darussalam, Cameroon, China, Congo (Rep. of the), Costa Rica, Djibouti, Egypt, the United Arab Emirates, Gabon, Guatemala, Guinea, India, Iran (Islamic Republic of), Iraq, Israel, Japan, Jordan, Kuwait, Lebanon, Malaysia, Mali, Morocco, Mauritania, Nepal, Nigeria, Oman, Pakistan, Palestine*, the Philippines, Qatar, the Syrian Arab Republic, the Dem. Rep. of the Congo, the Dem. People's Rep. of Korea, Singapore, Somalia, Sudan, South Sudan, Chad, Togo and Tunisia, the frequency band 19.7-21.2 GHz is also allocated to the fixed and mobile services on a primary basis. This additional use shall not impose any limitation on the power flux-density of space stations in the fixed-satellite service in the frequency band 19.7-21.2 GHz and of space stations in the mobile-satellite service in the frequency band 19.7-20.2 GHz where the allocation to the mobile-satellite service is on a primary basis in the latter frequency band. (WRC-23)

5.525 In order to facilitate interregional coordination between networks in the mobile-satellite and fixed-satellite services, carriers in the mobile-satellite service that are most susceptible to interference shall, to the extent practicable, be located in the higher parts of the bands 19.7-20.2 GHz and 29.5-30 GHz.

5.526 In the bands 19.7-20.2 GHz and 29.5-30 GHz in Region 2, and in the bands 20.1-20.2 GHz and 29.9-30 GHz in Regions 1 and 3, networks which are both in the fixed-satellite service and in the mobile-satellite service may include links between earth stations at specified or unspecified points or while in motion, through one or more satellites for point-to-point and point-to-multipoint communications.

5.527 In the bands 19.7-20.2 GHz and 29.5-30 GHz, the provisions of No. **4.10** do not apply with respect to the mobile-satellite service.

5.527A The operation of earth stations in motion communicating with the FSS is subject to Resolution **156 (Rev.WRC-23)**. (WRC-23)

5.528 The allocation to the mobile-satellite service is intended for use by networks which use narrow spot-beam antennas and other advanced technology at the space stations. Administrations operating systems in the mobile-satellite service in the band 19.7-20.1 GHz in Region 2 and in the band 20.1-20.2 GHz shall take all practicable steps to ensure the continued availability of these bands for administrations operating fixed and mobile systems in accordance with the provisions of No. **5.524**.

5.529 The use of the bands 19.7-20.1 GHz and 29.5-29.9 GHz by the mobile-satellite service in Region 2 is limited to satellite networks which are both in the fixed-satellite service and in the mobile-satellite service as described in No. **5.526**.

5.529A In the frequency bands 20.2-21.2 GHz and 30-31 GHz, non-geostationary-satellite systems for which complete coordination or notification information, according to the case, is received by the Bureau as of 1 January 2025 shall not cause unacceptable interference to and shall not claim protection from geostationary-satellite networks in the mobile-satellite service operating in accordance with these Regulations. No. **5.43A** does not apply. (WRC-23)

5.530 (SUP - WRC-12)

5.530A Unless otherwise agreed between the administrations concerned, any station in the fixed or mobile services of an administration shall not produce a power flux-density in excess of −120.4 dB(W/(m^2 · MHz)) at 3 m above the ground of any point of the territory of any other administration in Regions 1 and 3 for more than 20% of the time. In conducting the calculations, administrations should use the most recent version of Recommendation ITU-R P.452 (see also the most recent version of Recommendation ITU-R BO.1898). (WRC-15)

5.530B In the band 21.4-22 GHz, in order to facilitate the development of the broadcasting-satellite service, administrations in Regions 1 and 3 are encouraged not to deploy stations in the mobile service and are encouraged to limit the deployment of stations in the fixed service to point-to-point links. (WRC-12)

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* Pursuant to Resolution 99 (Rev. Dubai, 2018) of the Plenipotentiary Conference and taking into account the Israeli-Palestinian Interim Agreement of 28 September 1995.

5.530C (SUP - WRC-15)

5.530D (SUP - WRC-19)

5.530E The allocation to the fixed service in the frequency band 21.4-22 GHz is identified for use in Region 2 by high-altitude platform stations (HAPS). This identification does not preclude the use of this frequency band by other fixed-service applications or by other services to which it is allocated on a co-primary basis, and does not establish priority in the Radio Regulations. Such use of the fixed-service allocation by HAPS is limited to the HAPS-to-ground direction, and shall be in accordance with the provisions of Resolution **165 (Rev.WRC-23)**. (WRC-23)

5.531 *Additional allocation:* in Japan, the band 21.4-22 GHz is also allocated to the broadcasting service on a primary basis.

22-24.45 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
22-22.2 FIXED MOBILE except aeronautical mobile (R) 5.531A 5.531B 5.531C 5.531D 5.531F 5.149	**22-22.2** FIXED MOBILE except aeronautical mobile 5.149	**22-22.2** FIXED MOBILE except aeronautical mobile 5.531E 5.149
22.2-22.21	FIXED MOBILE except aeronautical mobile 5.149	
22.21-22.5	EARTH EXPLORATION-SATELLITE (passive) FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY SPACE RESEARCH (passive) 5.149 5.532	
22.5-22.55	FIXED MOBILE	
22.55-23.15	FIXED INTER-SATELLITE 5.338A MOBILE SPACE RESEARCH (Earth-to-space) 5.532A 5.149	
23.15-23.55	FIXED INTER-SATELLITE 5.338A MOBILE	
23.55-23.6	FIXED MOBILE	
23.6-24	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340	
24-24.05	AMATEUR AMATEUR-SATELLITE 5.150	
24.05-24.25	RADIOLOCATION Amateur Earth exploration-satellite (active) 5.150	
24.25-24.45 FIXED MOBILE except aeronautical mobile 5.338A 5.532AB	**24.25-24.45** FIXED 5.532AA MOBILE except aeronautical mobile 5.338A 5.532AB RADIONAVIGATION	**24.25-24.45** FIXED MOBILE 5.338A 5.532AB RADIONAVIGATION

5.531A The use of the aeronautical mobile (OR) service in the frequency band 22-22.2 GHz is limited to non-safety applications. (WRC-23)

5.531B Aircraft stations in the aeronautical mobile (OR) service operating in the frequency band 22-22.2 GHz are subject to agreement obtained under No. **9.21** with respect to the fixed service and shall not cause harmful interference to, nor claim protection from, the fixed service. The following power flux-density values shall be used as a threshold for coordination under No. **9.21**:

-110 dB(W/(m^2 · MHz))	for	$0° \leq \theta \leq 12.6°$
$2.86\ \theta - 146$ dB(W/(m^2 · MHz))	for	$12.6° < \theta \leq 15°$
$0.87\ \theta - 116$ dB(W/(m^2 · MHz))	for	$15° < \theta \leq 30°$
$0.067\ \theta - 92$ dB(W/(m^2 · MHz))	for	$30° < \theta \leq 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees.

This criterion should be applied at the border of the territory of another administration for any aircraft station located at an altitude of up to 15 km above the ground. In conducting the calculations, the most recent version of Recommendation ITU-R P.525 should be used. (WRC-23)

5.531C Stations in the aeronautical mobile (OR) service operating in the frequency band 22-22.2 GHz shall not cause harmful interference to the radio astronomy service operating in the frequency band 22.21-22.5 GHz. The aggregate power flux-density (pfd) received from these stations at any radio astronomy station operating in the frequency band 22.21-22.5 GHz shall be in compliance with the protection criteria provided in Recommendations ITU-R RA.769-2 and ITU-R RA.1513-2, unless specifically agreed by the affected administration(s). (WRC-23)

5.531D The use of the aeronautical mobile (OR) service in the frequency band 22-22.2 GHz outside national boundaries shall not cause harmful interference to, or claim protection from, services in other countries operating in accordance with the Table of Frequency Allocations. (WRC-23)

5.531E *Alternative allocation*: in Brunei Darussalam, Iran (Islamic Republic of), Malaysia, Singapore and Thailand, the frequency band 22-22.2 GHz is allocated to the mobile, except aeronautical mobile (R), service on a primary basis. The use of the service is limited to non-safety applications within national boundaries. The use of the aeronautical mobile (OR) service in the frequency band 22-22.2 GHz shall not cause harmful interference to, or claim protection from, services in other countries operating in accordance with the Table of Frequency Allocations. Furthermore, stations in the aeronautical mobile (OR) service operating in the frequency band 22-22.2 GHz shall not cause harmful interference to the radio astronomy service operating in the frequency band 22.21-22.5 GHz in other countries in accordance with the Table of Frequency Allocations. The aggregate power flux-density (pfd) received from these stations at any radio astronomy station operating in the frequency band 22.21-22.5 GHz shall be in compliance with the protection criteria provided in Recommendations ITU-R RA.769-2 and ITU-R RA.1513-2, unless specifically agreed by the affected administration(s). In order to protect stations of the Earth exploration-satellite service (passive) operating in the frequency band 22.21-22.5 GHz, the unwanted equivalent isotropically radiated power (e.i.r.p.) of stations operating in the aeronautical mobile (OR) service shall not exceed −23 dBW in any 100 MHz band in the frequency band 22.21-22.5 GHz.

Aircraft stations in the aeronautical mobile (OR) service operating in the frequency band 22-22.2 GHz are subject to agreement obtained under No. **9.21** with respect to the fixed service and shall not cause harmful interference to, nor claim protection from, the fixed service. The following pfd values shall be used as a threshold for coordination under No. **9.21**:

-110 dB(W/(m^2 · MHz))	for	$0° \leq \theta \leq 12.6°$
$2.86\ \theta - 146$ dB(W/(m^2 · MHz))	for	$12.6° < \theta \leq 15°$
$0.87\ \theta - 116$ dB(W/(m^2 · MHz))	for	$15° < \theta \leq 30°$
$0.067\ \theta - 92$ dB(W/(m^2 · MHz))	for	$30° < \theta \leq 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees.

This criterion should be applied at the border of the territory of another administration for any aircraft station located at an altitude of up to 15 km above the ground. In conducting the calculations, the most recent version of Recommendation ITU-R P.525 should be used. (WRC-23)

5.531F In order to protect stations of the Earth exploration-satellite service (passive) operating in the frequency band 22.21-22.5 GHz, the unwanted equivalent isotropically radiated power (e.i.r.p.) of stations operating in the aeronautical mobile (OR) service shall not exceed −23 dBW in any 100 MHz band in the frequency band 22.21-22.5 GHz. (WRC-23)

5.532 The use of the band 22.21-22.5 GHz by the Earth exploration-satellite (passive) and space research (passive) services shall not impose constraints upon the fixed and mobile, except aeronautical mobile, services.

5.532A The location of earth stations in the space research service shall maintain a separation distance of at least 54 km from the respective border(s) of neighbouring countries to protect the existing and future deployment of fixed and mobile services unless a shorter distance is otherwise agreed between the corresponding administrations. Nos. **9.17** and **9.18** do not apply. (WRC-12)

5.532AA The allocation to the fixed service in the frequency band 24.25-25.25 GHz is identified for use in Region 2 by high-altitude platform stations (HAPS). This identification does not preclude the use of this frequency band by other fixed-service applications or by other services to which this frequency band is allocated on a co-primary basis, and does not establish priority in the Radio Regulations. Such use of the fixed-service allocation by HAPS is limited to the HAPS-to-ground direction and shall be in accordance with the provisions of Resolution **166 (Rev.WRC-23)**. (WRC-23)

5.532AB The frequency band 24.25-27.5 GHz is identified for use by administrations wishing to implement the terrestrial component of International Mobile Telecommunications (IMT). This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. Resolution **242 (Rev.WRC-23)** applies. (WRC-23)

24.45-24.75 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
24.45-24.65 FIXED INTER-SATELLITE MOBILE except aeronautical mobile 5.338A 5.532AB	**24.45-24.65** FIXED 5.532AA INTER-SATELLITE MOBILE except aeronautical mobile 5.338A 5.532AB RADIONAVIGATION 5.533	**24.45-24.65** FIXED INTER-SATELLITE MOBILE 5.338A 5.532AB RADIONAVIGATION 5.533
24.65-24.75 FIXED FIXED-SATELLITE (Earth-to-space) 5.532B INTER-SATELLITE MOBILE except aeronautical mobile 5.338A 5.532AB	**24.65-24.75** FIXED 5.532AA INTER-SATELLITE MOBILE except aeronautical mobile 5.338A 5.532AB RADIOLOCATION-SATELLITE (Earth-to-space)	**24.65-24.75** FIXED FIXED-SATELLITE (Earth-to-space) 5.532B INTER-SATELLITE MOBILE 5.338A 5.532AB

5.532B Use of the band 24.65-25.25 GHz in Region 1 and the band 24.65-24.75 GHz in Region 3 by the fixed-satellite service (Earth-to-space) is limited to earth stations using a minimum antenna diameter of 4.5 m. (WRC-12)

5.533 The inter-satellite service shall not claim protection from harmful interference from airport surface detection equipment stations of the radionavigation service.

5.534 (SUP - WRC-03)

24.75-29.9 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
24.75-25.25 FIXED FIXED-SATELLITE (Earth-to-space) 5.532B MOBILE except aeronautical mobile 5.338A 5.532AB	**24.75-25.25** FIXED 5.532AA FIXED-SATELLITE (Earth-to-space) 5.535 MOBILE except aeronautical mobile 5.338A 5.532AB	**24.75-25.25** FIXED FIXED-SATELLITE (Earth-to-space) 5.535 MOBILE 5.338A 5.532AB
25.25-25.5	FIXED 5.534A INTER-SATELLITE 5.536 MOBILE 5.338A 5.532AB Standard frequency and time signal-satellite (Earth-to-space)	
25.5-27	EARTH EXPLORATION-SATELLITE (space-to-Earth) 5.536B FIXED 5.534A INTER-SATELLITE 5.536 MOBILE 5.338A 5.532AB SPACE RESEARCH (space-to-Earth) 5.536C Standard frequency and time signal-satellite (Earth-to-space) 5.536A	
27-27.5 FIXED INTER-SATELLITE 5.536 MOBILE 5.338A 5.532AB	**27-27.5** FIXED 5.534A FIXED-SATELLITE (Earth-to-space) INTER-SATELLITE 5.536 5.537 MOBILE 5.338A 5.532AB	
27.5-28.5	FIXED 5.537A FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.517A 5.517B 5.539 INTER-SATELLITE 5.521A MOBILE 5.538 5.540	
28.5-29.1	FIXED FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.517A 5.517B 5.523A 5.539 INTER-SATELLITE 5.521A MOBILE Earth exploration-satellite (Earth-to-space) 5.541 5.540	
29.1-29.5	FIXED FIXED-SATELLITE (Earth-to-space) 5.516B 5.517A 5.523C 5.523E 5.535A 5.539 5.541A INTER-SATELLITE 5.521A MOBILE Earth exploration-satellite (Earth-to-space) 5.541 5.540	
29.5-29.9 FIXED-SATELLITE (Earth-to-space) 5.484A 5.484B 5.516B 5.517B 5.527A 5.539 INTER-SATELLITE 5.521A Earth exploration-satellite (Earth-to-space) 5.541 Mobile-satellite (Earth-to-space) 5.540 5.542	**29.5-29.9** FIXED-SATELLITE (Earth-to-space) 5.484A 5.484B 5.516B 5.517B 5.527A 5.539 INTER-SATELLITE 5.521A MOBILE-SATELLITE (Earth-to-space) Earth exploration-satellite (Earth-to-space) 5.541 5.525 5.526 5.527 5.529 5.540	**29.5-29.9** FIXED-SATELLITE (Earth-to-space) 5.484A 5.484B 5.516B 5.517B 5.527A 5.539 INTER-SATELLITE 5.521A Earth exploration-satellite (Earth-to-space) 5.541 Mobile-satellite (Earth-to-space) 5.540 5.542

5.534A The allocation to the fixed service in the frequency band 25.25-27.5 GHz is identified in Region 2 for use by high-altitude platform stations (HAPS) in accordance with the provisions of Resolution **166 (Rev.WRC-23)**. Such use of the fixed-service allocation by HAPS shall be limited to the ground-to-HAPS direction in the frequency band 25.25-27.0 GHz and to the HAPS-to-ground direction in the frequency band 27.0-27.5 GHz. Furthermore, the use of the frequency band 25.5-27.0 GHz by HAPS shall be limited to gateway links. This identification does not preclude the use of this frequency band by other fixed-service applications or by other services to which this band is allocated on a co-primary basis, and does not establish priority in the Radio Regulations. (WRC-23)

5.535 In the band 24.75-25.25 GHz, feeder links to stations of the broadcasting-satellite service shall have priority over other uses in the fixed-satellite service (Earth-to-space). Such other uses shall protect and shall not claim protection from existing and future operating feeder-link networks to such broadcasting satellite stations.

5.535A The use of the band 29.1-29.5 GHz (Earth-to-space) by the fixed-satellite service is limited to geostationary-satellite systems and feeder links to non-geostationary-satellite systems in the mobile-satellite service. Such use is subject to the application of the provisions of No. **9.11A**, but not subject to the provisions of No. **22.2**, except as indicated in Nos. **5.523C** and **5.523E** where such use is not subject to the provisions of No. **9.11A** and shall continue to be subject to Articles **9** (except No. **9.11A**) and **11** procedures, and to the provisions of No. **22.2**. (WRC-97)

5.536 Use of the 25.25-27.5 GHz band by the inter-satellite service is limited to space research and Earth exploration-satellite applications, and also transmissions of data originating from industrial and medical activities in space.

5.536A Administrations operating earth stations in the Earth exploration-satellite service or the space research service shall not claim protection from stations in the fixed and mobile services operated by other administrations. In addition, earth stations in the Earth exploration-satellite service or in the space research service should be operated taking into account the most recent version of Recommendation ITU-R SA.1862. Resolution **242 (Rev.WRC-23)** applies. (WRC-23)

5.536B In Algeria, Saudi Arabia, Austria, Bahrain, Belgium, Brazil, China, Korea (Rep. of), Denmark, Egypt, United Arab Emirates, Estonia, Finland, Hungary, India, Iran (Islamic Republic of), Iraq, Ireland, Israel, Italy, Jordan, Kenya, Kuwait, Lebanon, Libya, Lithuania, Moldova, Norway, Oman, Uganda, Pakistan, the Philippines, Poland, Portugal, Qatar, the Syrian Arab Republic, Türkiye, Dem. People's Rep. of Korea, Slovakia, the Czech Rep., Romania, the United Kingdom, Singapore, Slovenia, Somalia, Sudan, Sweden, Tanzania, Viet Nam and Zimbabwe, earth stations operating in the Earth exploration-satellite service in the frequency band 25.5-27 GHz shall not claim protection from, or constrain the use and deployment of, stations of the fixed and mobile services. Resolution **242 (Rev.WRC-23)** applies. (WRC-23)

5.536C In Algeria, Saudi Arabia, Bahrain, Botswana, Brazil, Cameroon, Comoros, Cuba, Djibouti, Egypt, United Arab Emirates, Estonia, Finland, Iran (Islamic Republic of), Israel, Jordan, Kenya, Kuwait, Lithuania, Malaysia, Morocco, Nigeria, Oman, Qatar, Syrian Arab Republic, Somalia, Sudan, South Sudan, Tanzania, Tunisia, Uruguay, Zambia and Zimbabwe, earth stations operating in the space research service in the band 25.5-27 GHz shall not claim protection from, or constrain the use and deployment of, stations of the fixed and mobile services. (WRC-12)

5.537 Space services using non-geostationary satellites operating in the inter-satellite service in the band 27-27.5 GHz are exempt from the provisions of No. **22.2**.

5.537A In Bhutan, Cameroon, China, Korea (Rep. of), the Russian Federation, India, Indonesia, Iran (Islamic Republic of), Iraq, Japan, Kazakhstan, Malaysia, Maldives, Mongolia, Myanmar, Uzbekistan, Pakistan, the Philippines, Kyrgyzstan, the Dem. People's Rep. of Korea, Sudan, Sri Lanka, Thailand and Viet Nam, the allocation to the fixed service in the frequency band 27.9-28.2 GHz may also be used by high altitude platform stations (HAPS) within the territory of these countries. Such use of 300 MHz of the fixed-service allocation by HAPS in the above countries is further limited to operation in the HAPS-to-ground direction and shall not cause harmful interference to, nor claim protection from, other types of fixed-service systems or other co-primary services. Furthermore, the development of these other services shall not be constrained by HAPS. See Resolution **145 (Rev.WRC-19)**. (WRC-19)

5.538 *Additional allocation:* the bands 27.500-27.501 GHz and 29.999-30.000 GHz are also allocated to the fixed-satellite service (space-to-Earth) on a primary basis for the beacon transmissions intended for up-link power control. Such space-to-Earth transmissions shall not exceed an equivalent isotropically radiated power (e.i.r.p.) of +10 dBW in the direction of adjacent satellites on the geostationary-satellite orbit. (WRC-07)

5.539 The band 27.5-30 GHz may be used by the fixed-satellite service (Earth-to-space) for the provision of feeder links for the broadcasting-satellite service.

5.540 *Additional allocation:* the band 27.501-29.999 GHz is also allocated to the fixed-satellite service (space-to-Earth) on a secondary basis for beacon transmissions intended for up-link power control.

5.541 In the band 28.5-30 GHz, the earth exploration-satellite service is limited to the transfer of data between stations and not to the primary collection of information by means of active or passive sensors.

5.541A Feeder links of non-geostationary networks in the mobile-satellite service and geostationary networks in the fixed-satellite service operating in the band 29.1-29.5 GHz (Earth-to-space) shall employ uplink adaptive power control or other methods of fade compensation, such that the earth station transmissions shall be conducted at the power level required to meet the desired link performance while reducing the level of mutual interference between both networks. These methods shall apply to networks for which Appendix **4** coordination information is considered as having been received by the Bureau after 17 May 1996 and until they are changed by a future competent world radiocommunication conference. Administrations submitting Appendix **4** information for coordination before this date are encouraged to utilize these techniques to the extent practicable. (WRC-2000)

5.542 *Additional allocation:* in Algeria, Saudi Arabia, Bahrain, Brunei Darussalam, Cameroon, China, Congo (Rep. of the), Djibouti, Egypt, the United Arab Emirates, Eritrea, Ethiopia, Guinea, India, Iran (Islamic Republic of), Iraq, Japan, Jordan, Kuwait, Lebanon, Malaysia, Mali, Morocco, Mauritania, Nepal, Oman, Pakistan, Palestine[*], Philippines, Qatar, the Syrian Arab Republic, the Dem. People's Rep. of Korea, Somalia, Sudan, South Sudan, Sri Lanka and Chad, the frequency band 29.5-31 GHz is also allocated to the fixed and mobile services on a secondary basis. The power limits specified in Nos. **21.3** and **21.5** shall apply. (WRC-23)

[*] Pursuant to Resolution 99 (Rev. Dubai, 2018) of the Plenipotentiary Conference and taking into account the Israeli-Palestinian Interim Agreement of 28 September 1995.

29.9-34.2 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
29.9-30	FIXED-SATELLITE (Earth-to-space) 5.484A 5.484B 5.516B 5.517B 5.527A 5.539 INTER-SATELLITE 5.521A MOBILE-SATELLITE (Earth-to-space) Earth exploration-satellite (Earth-to-space) 5.541 5.543 5.525 5.526 5.527 5.538 5.540 5.542	
30-31	FIXED-SATELLITE (Earth-to-space) 5.338A MOBILE-SATELLITE (Earth-to-space) Standard frequency and time signal-satellite (space-to-Earth) 5.529A 5.542	
31-31.3	FIXED 5.338A 5.543B MOBILE Standard frequency and time signal-satellite (space-to-Earth) Space research 5.544 5.545 5.149	
31.3-31.5	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340	
31.5-31.8 EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) Fixed Mobile except aeronautical mobile 5.149 5.546	**31.5-31.8** EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340	**31.5-31.8** EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) Fixed Mobile except aeronautical mobile 5.149 5.546
31.8-32	FIXED 5.547A RADIONAVIGATION SPACE RESEARCH (deep space) (space-to-Earth) 5.547 5.547B 5.548	
32-32.3	FIXED 5.547A RADIONAVIGATION SPACE RESEARCH (deep space) (space-to-Earth) 5.547 5.547C 5.548	
32.3-33	FIXED 5.547A INTER-SATELLITE RADIONAVIGATION 5.547 5.547D 5.548	
33-33.4	FIXED 5.547A RADIONAVIGATION 5.547 5.547E	
33.4-34.2	RADIOLOCATION 5.549	

5.543 The band 29.95-30 GHz may be used for space-to-space links in the Earth exploration-satellite service for telemetry, tracking, and control purposes, on a secondary basis.

5.543A (SUP - WRC-19)

5.543B The allocation to the fixed service in the frequency band 31-31.3 GHz is identified for worldwide use by high-altitude platform stations (HAPS). This identification does not preclude the use of this frequency band by other fixed-service applications or by other services to which this frequency band is allocated on a co-primary basis, and does not establish priority in the Radio Regulations. Such use of the fixed-service allocation by HAPS shall be in accordance with the provisions of Resolution **167 (Rev.WRC-23)**. (WRC-23)

5.544 In the band 31-31.3 GHz the power flux-density limits specified in Article **21**, Table **21-4** shall apply to the space research service.

5.545 *Different category of service:* in Armenia, Georgia, Kyrgyzstan, Tajikistan and Turkmenistan, the allocation of the band 31-31.3 GHz to the space research service is on a primary basis (see No. **5.33**). (WRC-12)

5.546 *Different category of service:* in Saudi Arabia, Armenia, Azerbaijan, Bahrain, Belarus, Djibouti, Egypt, the United Arab Emirates, Spain, Estonia, the Russian Federation, Georgia, Hungary, Iran (Islamic Republic of), Israel, Jordan, Lebanon, Moldova, Mongolia, Oman, Uzbekistan, Poland, the Syrian Arab Republic, Türkiye, Kyrgyzstan, Romania, the United Kingdom, Somalia, South Africa, Tajikistan and Turkmenistan, the allocation of the frequency band 31.5-31.8 GHz to the fixed and mobile, except aeronautical mobile, services is on a primary basis (see No. **5.33**). (WRC-23)

5.547 The frequency bands 31.8-33.4 GHz, 37-40 GHz, 40.5-43.5 GHz, 51.4-52.6 GHz, 55.78-59 GHz and 64-66 GHz are available for high-density applications in the fixed service. Administrations should take this into account when considering regulatory provisions in relation to these bands. Because of the potential deployment of high-density applications in the fixed-satellite service in the frequency bands 39.5-40 GHz and 40.5-42 GHz (see No. **5.516B**), administrations should further take into account potential constraints to high-density applications in the fixed service, as appropriate. (WRC-23)

5.547A Administrations should take practical measures to minimize the potential interference between stations in the fixed service and airborne stations in the radionavigation service in the 31.8-33.4 GHz band, taking into account the operational needs of the airborne radar systems. (WRC-2000)

5.547B *Alternative allocation*: in the United States, the band 31.8-32 GHz is allocated to the radionavigation and space research (deep space) (space-to-Earth) services on a primary basis. (WRC-97)

5.547C *Alternative allocation*: in the United States, the band 32-32.3 GHz is allocated to the radionavigation and space research (deep space) (space-to-Earth) services on a primary basis. (WRC-03)

5.547D *Alternative allocation*: in the United States, the band 32.3-33 GHz is allocated to the inter-satellite and radionavigation services on a primary basis. (WRC-97)

5.547E *Alternative allocation*: in the United States, the band 33-33.4 GHz is allocated to the radionavigation service on a primary basis. (WRC-97)

5.548 In designing systems for the inter-satellite service in the frequency band 32.3-33 GHz, for the radionavigation service in the frequency band 32-33 GHz, and for the space research service (deep space) in the frequency band 31.8-32.3 GHz, administrations shall take all necessary measures to prevent harmful interference between these services, bearing in mind the safety aspects of the radionavigation service (see Recommendation **707 (Rev.WRC-23)**). (WRC-23)

5.549 *Additional allocation:* in Saudi Arabia, Bahrain, Bangladesh, Egypt, the United Arab Emirates, Gabon, Indonesia, Iran (Islamic Republic of), Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Malaysia, Mali, Morocco, Mauritania, Nepal, Nigeria, Oman, Pakistan, the Philippines, Qatar, the Syrian Arab Republic, the Dem. Rep. of the Congo, Singapore, Somalia, Sudan, South Sudan, Sri Lanka, Togo, Tunisia and Yemen, the band 33.4-36 GHz is also allocated to the fixed and mobile services on a primary basis. (WRC-12)

34.2-40 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
34.2-34.7	RADIOLOCATION SPACE RESEARCH (deep space) (Earth-to-space) 5.549	
34.7-35.2	RADIOLOCATION Space research 5.550 5.549	
35.2-35.5	METEOROLOGICAL AIDS RADIOLOCATION 5.549	
35.5-36	METEOROLOGICAL AIDS EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH (active) 5.549 5.549A	
36-37	EARTH EXPLORATION-SATELLITE (passive) FIXED MOBILE SPACE RESEARCH (passive) 5.149 5.550A	
37-37.5	FIXED MOBILE except aeronautical mobile 5.550B SPACE RESEARCH (space-to-Earth) 5.547	
37.5-38	FIXED FIXED-SATELLITE (space-to-Earth) 5.550C 5.550CA MOBILE except aeronautical mobile 5.550B SPACE RESEARCH (space-to-Earth) Earth exploration-satellite (space-to-Earth) 5.547	
38-39.5	FIXED 5.550D FIXED-SATELLITE (space-to-Earth) 5.550C MOBILE 5.550B Earth exploration-satellite (space-to-Earth) 5.547	
39.5-40	FIXED FIXED-SATELLITE (space-to-Earth) 5.516B 5.550C MOBILE 5.550B MOBILE-SATELLITE (space-to-Earth) Earth exploration-satellite (space-to-Earth) 5.547 5.550E	

5.549A In the band 35.5-36.0 GHz, the mean power flux-density at the Earth's surface, generated by any spaceborne sensor in the Earth exploration-satellite service (active) or space research service (active), for any angle greater than 0.8° from the beam centre shall not exceed –73.3 dB(W/m^2) in this band. (WRC-03)

5.550 *Different category of service:* in Armenia, Azerbaijan, Belarus, the Russian Federation, Georgia, Kyrgyzstan, Tajikistan and Turkmenistan, the allocation of the band 34.7-35.2 GHz to the space research service is on a primary basis (see No. **5.33**). (WRC-12)

5.550A For sharing of the band 36-37 GHz between the Earth exploration-satellite (passive) service and the fixed and mobile services, Resolution **752 (WRC-07)** shall apply. (WRC-07)

5.550B The frequency band 37-43.5 GHz, or portions thereof, is identified for use by administrations wishing to implement the terrestrial component of International Mobile Telecommunications (IMT). This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. Because of the potential deployment of FSS earth stations within the frequency range 37.5-42.5 GHz and high-density applications in the fixed-satellite service in the frequency bands 39.5-40 GHz in Region 1, 40-40.5 GHz in all Regions and 40.5-42 GHz in Region 2 (see No. **5.516B**), administrations should further take into account potential constraints to IMT in these frequency bands, as appropriate. Resolution **243 (Rev.WRC-23)** applies. (WRC-23)

5.550C The use of the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space) by a non-geostationary-satellite system in the fixed-satellite service is subject to the application of the provisions of No. **9.12** for coordination with other non-geostationary-satellite systems in the fixed-satellite service but not with non-geostationary-satellite systems in other services. Resolution **770 (WRC-19)*** shall also apply, and No. **22.2** shall continue to apply. (WRC-19)

5.550CA Non-geostationary-satellite systems in the fixed-satellite service operating with an apogee altitude above 407 km and below 2 000 km in the frequency band 37.5-38 GHz shall not exceed an unwanted emission e.i.r.p. density of −21 dB(W/100 MHz) per space station for angles greater than 65.0° from nadir relative to the space station in the fixed-satellite service in the frequency band 36-37 GHz in order to protect the Earth exploration-satellite service (passive) operating in the latter frequency band. (WRC-23)

5.550D The allocation to the fixed service in the frequency band 38-39.5 GHz is identified for worldwide use by administrations wishing to implement high-altitude platform stations (HAPS). In the HAPS-to-ground direction, the HAPS ground station shall not claim protection from stations in the fixed, mobile and fixed-satellite services; and No. **5.43A** does not apply. This identification does not preclude the use of this frequency band by other fixed-service applications or by other services to which this frequency band is allocated on a co-primary basis and does not establish priority in the Radio Regulations. Furthermore, the development of the fixed-satellite, fixed and mobile services shall not be unduly constrained by HAPS. Such use of the fixed-service allocation by HAPS shall be in accordance with the provisions of Resolution **168 (Rev.WRC-23)**. (WRC-23)

5.550E The use of the frequency bands 39.5-40 GHz and 40-40.5 GHz by non-geostationary-satellite systems in the mobile-satellite service (space-to-Earth) and by non-geostationary-satellite systems in the fixed-satellite service (space-to-Earth) is subject to the application of the provisions of No. **9.12** for coordination with other non-geostationary-satellite systems in the fixed-satellite and mobile-satellite services but not with non-geostationary-satellite systems in other services. No. **22.2** shall continue to apply for non-geostationary-satellite-systems. (WRC-19)

5.551 (SUP - WRC-97)

5.551A (SUP - WRC-03)

5.551AA (SUP - WRC-03)

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* *Note by the Secretariat:* This Resolution was revised by WRC-23.

40-47.5 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
40-40.5	EARTH EXPLORATION-SATELLITE (Earth-to-space) FIXED FIXED-SATELLITE (space-to-Earth) 5.516B 5.550C MOBILE 5.550B MOBILE-SATELLITE (space-to-Earth) SPACE RESEARCH (Earth-to-space) Earth exploration-satellite (space-to-Earth) 5.550E	
40.5-41 FIXED FIXED-SATELLITE (space-to-Earth) 5.550C LAND MOBILE 5.550B BROADCASTING BROADCASTING-SATELLITE Aeronautical mobile Maritime mobile 5.547	**40.5-41** FIXED FIXED-SATELLITE (space-to-Earth) 5.516B 5.550C LAND MOBILE 5.550B BROADCASTING BROADCASTING-SATELLITE Aeronautical mobile Maritime mobile Mobile-satellite (space-to-Earth) 5.547	**40.5-41** FIXED FIXED-SATELLITE (space-to-Earth) 5.550C LAND MOBILE 5.550B BROADCASTING BROADCASTING-SATELLITE Aeronautical mobile Maritime mobile 5.547
41-42.5	FIXED FIXED-SATELLITE (space-to-Earth) 5.516B 5.550C LAND MOBILE 5.550B BROADCASTING BROADCASTING-SATELLITE Aeronautical mobile Maritime mobile 5.547 5.551F 5.551H 5.551I	
42.5-43.5	FIXED FIXED-SATELLITE (Earth-to-space) 5.552 MOBILE except aeronautical mobile 5.550B RADIO ASTRONOMY 5.149 5.547	
43.5-47	MOBILE 5.553 5.553A MOBILE-SATELLITE RADIONAVIGATION RADIONAVIGATION-SATELLITE 5.554	
47-47.2	AMATEUR AMATEUR-SATELLITE	
47.2-47.5	FIXED FIXED-SATELLITE (Earth-to-space) 5.550C 5.552 MOBILE 5.553B 5.552A	

5.551B (SUP - WRC-2000)

5.551C (SUP - WRC-2000)

5.551D (SUP - WRC-2000)

5.551E (SUP - WRC-2000)

5.551F *Different category of service*: in Japan, the allocation of the band 41.5-42.5 GHz to the mobile service is on a primary basis (see No. **5.33**). (WRC-97)

5.551G (SUP - WRC-03)

5.551H The equivalent power flux-density (epfd) produced in the frequency band 42.5-43.5 GHz by all space stations in any non-geostationary-satellite system in the fixed-satellite service (space-to-Earth) or in the broadcasting-satellite service, operating in the frequency band 42-42.5 GHz, shall not exceed the following values at the site of any radio astronomy station for more than 2% of the time:

−230 dB(W/m^2) in 1 GHz and −246 dB(W/m^2) in any 500 kHz of the frequency band 42.5-43.5 GHz at the site of any radio astronomy station registered as a single-dish telescope; and

−209 dB(W/m^2) in any 500 kHz of the frequency band 42.5-43.5 GHz at the site of any radio astronomy station registered as a very long baseline interferometry station.

These epfd values shall be evaluated using the methodology given in Recommendation ITU-R S.1586-1 and the reference antenna pattern and the maximum gain of an antenna in the radio astronomy service given in Recommendation ITU-R RA.1631-0 and shall apply over the whole sky and for elevation angles higher than the minimum operating angle θ_{min} of the radiotelescope (for which a default value of 5° should be adopted in the absence of notified information).

These values shall apply at any radio astronomy station that either:

– was in operation prior to 5 July 2003 and has been notified to the Bureau before 4 January 2004; or

– was notified before the date of receipt of the complete Appendix **4** information for coordination or notification, as appropriate, for the space station to which the limits apply.

Other radio astronomy stations notified after these dates may seek an agreement with administrations that have authorized the space stations. In Region 2, Resolution **743 (WRC-03)** shall apply. The limits in this footnote may be exceeded at the site of a radio astronomy station of any country whose administration so agreed. (WRC-23)

5.551I The power flux-density in the band 42.5-43.5 GHz produced by any geostationary space station in the fixed-satellite service (space-to-Earth), or the broadcasting-satellite service operating in the 42-42.5 GHz band, shall not exceed the following values at the site of any radio astronomy station:

–137 dB(W/m^2) in 1 GHz and –153 dB(W/m^2) in any 500 kHz of the 42.5-43.5 GHz band at the site of any radio astronomy station registered as a single-dish telescope; and

–116 dB(W/m^2) in any 500 kHz of the 42.5-43.5 GHz band at the site of any radio astronomy station registered as a very long baseline interferometry station.

These values shall apply at the site of any radio astronomy station that either:

– was in operation prior to 5 July 2003 and has been notified to the Bureau before 4 January 2004; or

– was notified before the date of receipt of the complete Appendix **4** information for coordination or notification, as appropriate, for the space station to which the limits apply.

Other radio astronomy stations notified after these dates may seek an agreement with administrations that have authorized the space stations. In Region 2, Resolution **743 (WRC-03)** shall apply. The limits in this footnote may be exceeded at the site of a radio astronomy station of any country whose administration so agreed. (WRC-03)

5.552 The allocation of the spectrum for the fixed-satellite service in the bands 42.5-43.5 GHz and 47.2-50.2 GHz for Earth-to-space transmission is greater than that in the band 37.5-39.5 GHz for space-to-Earth transmission in order to accommodate feeder links to broadcasting satellites. Administrations are urged to take all practicable steps to reserve the band 47.2-49.2 GHz for feeder links for the broadcasting-satellite service operating in the band 40.5-42.5 GHz.

5.552A The allocation to the fixed service in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz is identified for use by high-altitude platform stations (HAPS). This identification does not preclude the use of this frequency band by any application of the services to which it is allocated on a co-primary basis, and does not establish priority in the Radio Regulations. Such use of the fixed-service allocation in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz by HAPS shall be in accordance with the provisions of Resolution **122 (Rev.WRC-19)**. (WRC-19)

5.553 In the bands 43.5-47 GHz and 66-71 GHz, stations in the land mobile service may be operated subject to not causing harmful interference to the space radiocommunication services to which these bands are allocated (see No. **5.43**). (WRC-2000)

5.553A In Algeria, Angola, Bahrain, Belarus, Benin, Botswana, Brazil, Burkina Faso, Cabo Verde, Korea (Rep. of), Côte d'Ivoire, Croatia, Djibouti, Egypt, United Arab Emirates, Estonia, Eswatini, Gabon, Gambia, Ghana, Greece, Guinea, Guinea-Bissau, Hungary, Iran (Islamic Republic of), Iraq, Jordan, Kuwait, Lesotho, Latvia, Liberia, Lithuania, Madagascar, Malawi, Mali, Morocco, Mauritius, Mauritania, Mozambique, Namibia, Niger, Nigeria, Oman, Qatar, Senegal, Seychelles, Sierra Leone, Slovenia, Somalia, Sudan, South Africa, Sweden, Tanzania, Togo, Tunisia, Zambia and Zimbabwe, the frequency band 45.5-47 GHz is identified for use by administrations wishing to implement the terrestrial component of International Mobile Telecommunications (IMT), taking into account No. **5.553**. With respect to the aeronautical mobile service and radionavigation service, the use of this frequency band for the implementation of IMT is subject to agreement obtained under No. **9.21** with concerned administrations and shall not cause harmful interference to, or claim protection from these services. This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. Resolution **244 (Rev.WRC-23**) applies. (WRC-23)

5.553B In Region 2 and Algeria, Angola, Saudi Arabia, Australia, Bahrain, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Rep., Comoros, Congo (Rep. of the), Korea (Rep. of), Côte d'Ivoire, Djibouti, Egypt, United Arab Emirates, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Equatorial Guinea, India, Iran (Islamic Republic of), Iraq, Japan, Jordan, Kenya, Kuwait, Lesotho, Liberia, Libya, Lithuania, Madagascar, Malaysia, Malawi, Mali, Morocco, Mauritius, Mauritania, Mozambique, Namibia, Niger, Nigeria, Oman, Uganda, Qatar, the Syrian Arab Republic, the Dem. Rep. of the Congo, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Singapore, Slovenia, Somalia, Sudan, South Sudan, South Africa, Sweden, Tanzania, Chad, Togo, Tunisia, Zambia and Zimbabwe, the frequency band 47.2-48.2 GHz is identified for use by administrations wishing to implement International Mobile Telecommunications (IMT). This identification does not preclude the use of this frequency band by any application of the services to which it is allocated, and does not establish any priority in the Radio Regulations. Resolution **243 (Rev.WRC-23)** applies. (WRC-23)

5.554 In the bands 43.5-47 GHz, 66-71 GHz, 95-100 GHz, 123-130 GHz, 191.8-200 GHz and 252-265 GHz, satellite links connecting land stations at specified fixed points are also authorized when used in conjunction with the mobile-satellite service or the radionavigation-satellite service. (WRC-2000)

47.5-51.4 GHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>47.5-47.9
FIXED
FIXED-SATELLITE
(Earth-to-space) 5.550C 5.552
(space-to-Earth) 5.516B 5.554A
MOBILE 5.553B</td><td colspan="2">47.5-47.9
FIXED
FIXED-SATELLITE (Earth-to-space) 5.550C 5.552
MOBILE 5.553B</td></tr>
<tr><td>47.9-48.2</td><td colspan="2">FIXED
FIXED-SATELLITE (Earth-to-space) 5.550C 5.552
MOBILE 5.553B
5.552A</td></tr>
<tr><td>48.2-48.54
FIXED
FIXED-SATELLITE
(Earth-to-space) 5.550C 5.552
(space-to-Earth) 5.516B 5.554A 5.555B
MOBILE</td><td colspan="2" rowspan="3">48.2-50.2
FIXED
FIXED-SATELLITE (Earth-to-space) 5.338A 5.516B 5.550C 5.552
MOBILE
5.149 5.340 5.555</td></tr>
<tr><td>48.54-49.44
FIXED
FIXED-SATELLITE
(Earth-to-space) 5.550C 5.552
MOBILE
5.149 5.340 5.555</td></tr>
<tr><td>49.44-50.2
FIXED
FIXED-SATELLITE
(Earth-to-space) 5.338A 5.550C 5.552
(space-to-Earth) 5.516B 5.554A 5.555B
MOBILE</td></tr>
<tr><td>50.2-50.4</td><td colspan="2">EARTH EXPLORATION-SATELLITE (passive)
SPACE RESEARCH (passive)
5.340</td></tr>
<tr><td>50.4-51.4</td><td colspan="2">FIXED
FIXED-SATELLITE (Earth-to-space) 5.338A 5.550C
MOBILE
Mobile-satellite (Earth-to-space)</td></tr>
</table>

5.554A The use of the bands 47.5-47.9 GHz, 48.2-48.54 GHz and 49.44-50.2 GHz by the fixed-satellite service (space-to-Earth) is limited to geostationary satellites. (WRC-03)

5.555 *Additional allocation:* the band 48.94-49.04 GHz is also allocated to the radio astronomy service on a primary basis. (WRC-2000)

5.555A (SUP - WRC-03)

5.555B The power flux-density in the band 48.94-49.04 GHz produced by any geostationary space station in the fixed-satellite service (space-to-Earth) operating in the bands 48.2-48.54 GHz and 49.44-50.2 GHz shall not exceed –151.8 dB(W/m^2) in any 500 kHz band at the site of any radio astronomy station. (WRC-03)

51.4-55.78 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
51.4-52.4	FIXED FIXED-SATELLITE (Earth-to-space) 5.555C MOBILE 5.338A 5.547 5.556	
52.4-52.6	FIXED 5.338A MOBILE 5.547 5.556	
52.6-54.25	EARTH EXPLORATION-SATELLITE (passive) SPACE RESEARCH (passive) 5.340 5.556	
54.25-55.78	EARTH EXPLORATION-SATELLITE (passive) INTER-SATELLITE 5.556A SPACE RESEARCH (passive) 5.556B	

5.555C The use of the frequency band 51.4-52.4 GHz by the fixed-satellite service (Earth-to-space) is limited to geostationary-satellite networks. The earth stations shall be limited to gateway earth stations with a minimum antenna diameter of 2.4 metres. (WRC-19)

5.556 In the bands 51.4-54.25 GHz, 58.2-59 GHz and 64-65 GHz, radio astronomy observations may be carried out under national arrangements. (WRC-2000)

5.556A Use of the bands 54.25-56.9 GHz, 57-58.2 GHz and 59-59.3 GHz by the inter-satellite service is limited to satellites in the geostationary-satellite orbit. The single-entry power flux-density at all altitudes from 0 km to 1 000 km above the Earth's surface produced by a station in the inter-satellite service, for all conditions and for all methods of modulation, shall not exceed –147 dB(W/(m^2 · 100 MHz)) for all angles of arrival. (WRC-97)

5.556B *Additional allocation:* in Japan, the band 54.25-55.78 GHz is also allocated to the mobile service on a primary basis for low-density use. (WRC-97)

55.78-66 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
55.78-56.9	EARTH EXPLORATION-SATELLITE (passive) FIXED 5.557A INTER-SATELLITE 5.556A MOBILE 5.558 SPACE RESEARCH (passive) 5.547 5.557	
56.9-57	EARTH EXPLORATION-SATELLITE (passive) FIXED INTER-SATELLITE 5.558A MOBILE 5.558 SPACE RESEARCH (passive) 5.547 5.557	
57-58.2	EARTH EXPLORATION-SATELLITE (passive) FIXED INTER-SATELLITE 5.556A MOBILE 5.558 SPACE RESEARCH (passive) 5.547 5.557	
58.2-59	EARTH EXPLORATION-SATELLITE (passive) FIXED MOBILE SPACE RESEARCH (passive) 5.547 5.556	
59-59.3	EARTH EXPLORATION-SATELLITE (passive) FIXED INTER-SATELLITE 5.556A MOBILE 5.558 RADIOLOCATION 5.559 SPACE RESEARCH (passive)	
59.3-64	FIXED INTER-SATELLITE MOBILE 5.558 RADIOLOCATION 5.559 5.138	
64-65	FIXED INTER-SATELLITE MOBILE except aeronautical mobile 5.547 5.556	
65-66	EARTH EXPLORATION-SATELLITE FIXED INTER-SATELLITE MOBILE except aeronautical mobile SPACE RESEARCH 5.547	

5.557 *Additional allocation:* in Japan, the band 55.78-58.2 GHz is also allocated to the radiolocation service on a primary basis. (WRC-97)

5.557A In the band 55.78-56.26 GHz, in order to protect stations in the Earth exploration-satellite service (passive), the maximum power density delivered by a transmitter to the antenna of a fixed service station is limited to –26 dB(W/MHz). (WRC-2000)

5.558 In the bands 55.78-58.2 GHz, 59-64 GHz, 66-71 GHz, 122.25-123 GHz, 130-134 GHz, 167-174.8 GHz and 191.8-200 GHz, stations in the aeronautical mobile service may be operated subject to not causing harmful interference to the inter-satellite service (see No. **5.43**). (WRC-2000)

5.558A Use of the band 56.9-57 GHz by inter-satellite systems is limited to links between satellites in geostationary-satellite orbit and to transmissions from non-geostationary satellites in high-Earth orbit to those in low-Earth orbit. For links between satellites in the geostationary-satellite orbit, the single entry power flux-density at all altitudes from 0 km to 1 000 km above the Earth's surface, for all conditions and for all methods of modulation, shall not exceed –147 dB(W/(m^2 · 100 MHz)) for all angles of arrival. (WRC-97)

5.559 In the band 59-64 GHz, airborne radars in the radiolocation service may be operated subject to not causing harmful interference to the inter-satellite service (see No. **5.43**). (WRC-2000)

66-81 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
66-71	INTER-SATELLITE MOBILE 5.553 5.558 5.559AA MOBILE-SATELLITE RADIONAVIGATION RADIONAVIGATION-SATELLITE 5.554	
71-74	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE MOBILE-SATELLITE (space-to-Earth)	
74-76	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE BROADCASTING BROADCASTING-SATELLITE Space research (space-to-Earth) 5.561	
76-77.5	RADIO ASTRONOMY RADIOLOCATION Amateur Amateur-satellite Space research (space-to-Earth) 5.149	
77.5-78	AMATEUR AMATEUR-SATELLITE RADIOLOCATION 5.559B Radio astronomy Space research (space-to-Earth) 5.149	
78-79	RADIOLOCATION Amateur Amateur-satellite Radio astronomy Space research (space-to-Earth) 5.149 5.560	
79-81	RADIO ASTRONOMY RADIOLOCATION Amateur Amateur-satellite Space research (space-to-Earth) 5.149	

5.559A (SUP - WRC-07)

5.559AA The frequency band 66-71 GHz is identified for use by administrations wishing to implement the terrestrial component of International Mobile Telecommunications (IMT). This identification does not preclude the use of this frequency band by any application of the services to which this frequency band is allocated and does not establish priority in the Radio Regulations. Resolution **241 (Rev.WRC-23)** applies. (WRC-23)

5.559B The use of the frequency band 77.5-78 GHz by the radiolocation service shall be limited to short-range radar for ground-based applications, including automotive radars. The technical characteristics of these radars are provided in the most recent version of Recommendation ITU-R M.2057. The provisions of No. **4.10** do not apply. (WRC-15)

5.560 In the band 78-79 GHz radars located on space stations may be operated on a primary basis in the Earth exploration-satellite service and in the space research service.

5.561 In the band 74-76 GHz, stations in the fixed, mobile and broadcasting services shall not cause harmful interference to stations of the fixed-satellite service or stations of the broadcasting-satellite service operating in accordance with the decisions of the appropriate frequency assignment planning conference for the broadcasting-satellite service. (WRC-2000)

81-86 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
81-84	FIXED 5.338A FIXED-SATELLITE (Earth-to-space) MOBILE MOBILE-SATELLITE (Earth-to-space) RADIO ASTRONOMY Space research (space-to-Earth) 5.149 5.561A	
84-86	FIXED 5.338A FIXED-SATELLITE (Earth-to-space) 5.561B MOBILE RADIO ASTRONOMY 5.149	

5.561A The 81-81.5 GHz band is also allocated to the amateur and amateur-satellite services on a secondary basis. (WRC-2000)

5.561B In Japan, use of the band 84-86 GHz, by the fixed-satellite service (Earth-to-space) is limited to feeder links in the broadcasting-satellite service using the geostationary-satellite orbit. (WRC-2000)

86-111.8 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
86-92	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340	
92-94	FIXED 5.338A MOBILE RADIO ASTRONOMY RADIOLOCATION 5.149	
94-94.1	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH (active) Radio astronomy 5.562 5.562A	
94.1-95	FIXED MOBILE RADIO ASTRONOMY RADIOLOCATION 5.149	
95-100	FIXED MOBILE RADIO ASTRONOMY RADIOLOCATION RADIONAVIGATION RADIONAVIGATION-SATELLITE 5.149 5.554	
100-102	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.341	
102-105	FIXED MOBILE RADIO ASTRONOMY 5.149 5.341	
105-109.5	FIXED MOBILE RADIO ASTRONOMY SPACE RESEARCH (passive) 5.562B 5.149 5.341	
109.5-111.8	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.341	

5.562 The use of the band 94-94.1 GHz by the Earth exploration-satellite (active) and space research (active) services is limited to spaceborne cloud radars. (WRC-97)

5.562A In the bands 94-94.1 GHz and 130-134 GHz, transmissions from space stations of the Earth exploration-satellite service (active) that are directed into the main beam of a radio astronomy antenna have the potential to damage some radio astronomy receivers. Space agencies operating the transmitters and the radio astronomy stations concerned should mutually plan their operations so as to avoid such occurrences to the maximum extent possible. (WRC-2000)

5.562B In the frequency bands 105-109.5 GHz, 111.8-114.25 GHz and 217-226 GHz, the use of this allocation is limited to space-based radio astronomy only. (WRC-19)

111.8-119.98 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
111.8-114.25	FIXED MOBILE RADIO ASTRONOMY SPACE RESEARCH (passive) 5.562B 5.149 5.341	
114.25-116	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.341	
116-119.98	EARTH EXPLORATION-SATELLITE (passive) INTER-SATELLITE 5.562C SPACE RESEARCH (passive) 5.341	

5.562C Use of the band 116-122.25 GHz by the inter-satellite service is limited to satellites in the geostationary-satellite orbit. The single-entry power flux-density produced by a station in the inter-satellite service, for all conditions and for all methods of modulation, at all altitudes from 0 km to 1 000 km above the Earth's surface and in the vicinity of all geostationary orbital positions occupied by passive sensors, shall not exceed –148 dB(W/(m^2 · MHz)) for all angles of arrival. (WRC-2000)

119.98-151.5 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
119.98-122.25	EARTH EXPLORATION-SATELLITE (passive) INTER-SATELLITE 5.562C SPACE RESEARCH (passive) 5.138 5.341	
122.25-123	FIXED INTER-SATELLITE MOBILE 5.558 Amateur 5.138	
123-130	FIXED-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) RADIONAVIGATION RADIONAVIGATION-SATELLITE Radio astronomy 5.562D 5.149 5.554	
130-134	EARTH EXPLORATION-SATELLITE (active) 5.562E FIXED INTER-SATELLITE MOBILE 5.558 RADIO ASTRONOMY 5.149 5.562A	
134-136	AMATEUR AMATEUR-SATELLITE Radio astronomy	
136-141	RADIO ASTRONOMY RADIOLOCATION Amateur Amateur-satellite 5.149	
141-148.5	FIXED MOBILE RADIO ASTRONOMY RADIOLOCATION 5.149	
148.5-151.5	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340	

5.562D *Additional allocation*: In Korea (Rep. of), the frequency bands 128-130 GHz, 171-171.6 GHz, 172.2-172.8 GHz and 173.3-174 GHz are also allocated to the radio astronomy service on a primary basis. Radio astronomy stations in Korea (Rep. of) operating in the frequency bands referred to in this footnote shall not claim protection from, or constrain the use and development of, services in other countries operating in accordance with the Radio Regulations. (WRC-15)

5.562E The allocation to the Earth exploration-satellite service (active) is limited to the band 133.5-134 GHz. (WRC-2000)

151.5-158.5 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
151.5-155.5	FIXED MOBILE RADIO ASTRONOMY RADIOLOCATION 5.149	
155.5-158.5	FIXED MOBILE RADIO ASTRONOMY 5.149	

5.562F (SUP - WRC-19)

5.562G (SUP - WRC-19)

158.5-200 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
158.5-164	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE MOBILE-SATELLITE (space-to-Earth)	
164-167	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340	
167-174.5	FIXED FIXED-SATELLITE (space-to-Earth) INTER-SATELLITE MOBILE 5.558 5.149 5.562D	
174.5-174.8	FIXED INTER-SATELLITE MOBILE 5.558	
174.8-182	EARTH EXPLORATION-SATELLITE (passive) INTER-SATELLITE 5.562H SPACE RESEARCH (passive)	
182-185	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340	
185-190	EARTH EXPLORATION-SATELLITE (passive) INTER-SATELLITE 5.562H SPACE RESEARCH (passive)	
190-191.8	EARTH EXPLORATION-SATELLITE (passive) SPACE RESEARCH (passive) 5.340	
191.8-200	FIXED INTER-SATELLITE MOBILE 5.558 MOBILE-SATELLITE RADIONAVIGATION RADIONAVIGATION-SATELLITE 5.149 5.341 5.554	

5.562H Use of the bands 174.8-182 GHz and 185-190 GHz by the inter-satellite service is limited to satellites in the geostationary-satellite orbit. The single-entry power flux-density produced by a station in the inter-satellite service, for all conditions and for all methods of modulation, at all altitudes from 0 to 1 000 km above the Earth's surface and in the vicinity of all geostationary orbital positions occupied by passive sensors, shall not exceed –144 dB(W/(m^2 · MHz)) for all angles of arrival. (WRC-2000)

5.563 (SUP - WRC-03)

200-241 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
200-209	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.341 5.563A	
209-217	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE RADIO ASTRONOMY 5.149 5.341	
217-226	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE RADIO ASTRONOMY SPACE RESEARCH (passive) 5.562B 5.149 5.341	
226-231.5	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340	
231.5-232	FIXED MOBILE Radiolocation	
232-235	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE Radiolocation	
235-238	EARTH EXPLORATION-SATELLITE (passive) 5.563AA FIXED FIXED-SATELLITE (space-to-Earth) MOBILE SPACE RESEARCH (passive) 5.563A 5.563B	
238-239.2	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE RADIOLOCATION RADIONAVIGATION RADIONAVIGATION-SATELLITE	
239.2-240	EARTH EXPLORATION-SATELLITE (passive) FIXED-SATELLITE (space-to-Earth) RADIOLOCATION RADIONAVIGATION RADIONAVIGATION-SATELLITE	
240-241	EARTH EXPLORATION-SATELLITE (passive) RADIOLOCATION	

5.563A In the bands 200-209 GHz, 235-238 GHz, 250-252 GHz and 265-275 GHz, ground-based passive atmospheric sensing is carried out to monitor atmospheric constituents. (WRC-2000)

5.563AA In the frequency band 235-238 GHz, stations in the Earth exploration-satellite service (passive) shall not claim protection from stations in the fixed and mobile services. (WRC-23)

5.563B The band 237.9-238 GHz is also allocated to the Earth exploration-satellite service (active) and the space research service (active) for spaceborne cloud radars only. (WRC-2000)

241-3 000 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
241-242.2	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY RADIOLOCATION Amateur Amateur-satellite 5.149	
242.2-244.2	RADIO ASTRONOMY RADIOLOCATION Amateur Amateur-satellite 5.138 5.149	
244.2-247.2	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY RADIOLOCATION Amateur Amateur-satellite 5.138 5.149	
247.2-248	RADIO ASTRONOMY RADIOLOCATION Amateur Amateur-satellite 5.149	
248-250	AMATEUR AMATEUR-SATELLITE Radio astronomy 5.149	
250-252	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.563A	
252-265	FIXED MOBILE MOBILE-SATELLITE (Earth-to-space) RADIO ASTRONOMY RADIONAVIGATION RADIONAVIGATION-SATELLITE 5.149 5.554	
265-275	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE RADIO ASTRONOMY 5.149 5.563A	
275-3 000	(Not allocated) 5.564A 5.565	

5.564 (SUP - WRC-2000)

5.564A For the operation of fixed and land mobile service applications in frequency bands in the range 275-450 GHz:

The frequency bands 275-296 GHz, 306-313 GHz, 318-333 GHz and 356-450 GHz are identified for use by administrations for the implementation of land mobile and fixed service applications where no specific conditions are necessary to protect Earth exploration-satellite service (passive) applications.

The frequency bands 296-306 GHz, 313-318 GHz and 333-356 GHz may only be used by fixed and land mobile service applications when specific conditions to ensure the protection of Earth exploration-satellite service (passive) applications are determined in accordance with Resolution **731 (Rev.WRC-23)**.

In those portions of the frequency range 275-450 GHz where radio astronomy applications are used, specific conditions (e.g. minimum separation distances and/or avoidance angles) may be necessary to ensure protection of radio astronomy sites from land mobile and/or fixed service applications, on a case-by-case basis, in accordance with Resolution **731 (Rev.WRC-23)**.

The use of the above-mentioned frequency bands by land mobile and fixed service applications does not preclude use by, and does not establish priority over, any other applications of radio services in the range of 275-450 GHz. (WRC-23)

5.565 The following frequency bands in the range 275-1 000 GHz are identified for use by administrations for passive service applications:

– radio astronomy service: 275-323 GHz, 327-371 GHz, 388-424 GHz, 426-442 GHz, 453-510 GHz, 623-711 GHz, 795-909 GHz and 926-945 GHz;

– Earth exploration-satellite service (passive) and space research service (passive): 275-286 GHz, 296-306 GHz, 313-356 GHz, 361-365 GHz, 369-392 GHz, 397-399 GHz, 409-411 GHz, 416-434 GHz, 439-467 GHz, 477-502 GHz, 523-527 GHz, 538-581 GHz, 611-630 GHz, 634-654 GHz, 657-692 GHz, 713-718 GHz, 729-733 GHz, 750-754 GHz, 771-776 GHz, 823-846 GHz, 850-854 GHz, 857-862 GHz, 866-882 GHz, 905-928 GHz, 951-956 GHz, 968-973 GHz and 985-990 GHz.

The use of the range 275-1 000 GHz by the passive services does not preclude use of this range by active services. Administrations wishing to make frequencies in the 275-1 000 GHz range available for active service applications are urged to take all practicable steps to protect these passive services from harmful interference until the date when the Table of Frequency Allocations is established in the above-mentioned 275-1 000 GHz frequency range.

All frequencies in the range 1 000-3 000 GHz may be used by both active and passive services. (WRC-12)

ARTICLE 6

Special agreements

6.1 § 1 Two or more Member States may, under the provisions for special arrangements in the Constitution, conclude special agreements regarding the sub-allocation of bands of frequencies to the appropriate services of the participating countries.

6.2 § 2 Two or more Member States may, under the provisions for special arrangements in the Constitution, conclude special agreements, as a result of a conference to which all those Member States concerned have been invited, regarding the assignment of frequencies to those of their stations which participate in one or more specific services within the frequency bands allocated to these services by Article **5**, either below 5 060 kHz or above 27 500 kHz, but not between those limits.

6.3 § 3 Member States may, under the provisions for special arrangements in the Constitution, conclude, on a worldwide basis, and as a result of a conference to which all Member States have been invited, special agreements concerning the assignment of frequencies to those of their stations participating in a specific service, on condition that such assignments are within the frequency bands allocated exclusively to that service in Article **5**.

6.4 § 4 Special agreements concluded in accordance with the provisions of Nos. **6.1** to **6.3** shall not be in conflict with any of the provisions of these Regulations.

6.5 § 5 The Secretary-General shall be informed, in advance, of any conference to be convened to conclude such an agreement; he shall also be informed of the terms of the agreement when concluded; and he shall inform the Member States of the existence of such agreements.

6.6 § 6 The Director of the Radiocommunication Bureau and the Chairman of the Radio Regulations Board may be invited to send representatives to participate in an advisory capacity in the preparation of these agreements and in the proceedings of the conferences, it being recognized that in the majority of cases such participation is desirable.

6.7 § 7 If, besides the action they may take in accordance with No. **6.2**, two or more Member States coordinate the use of individual frequencies in any of the frequency bands covered by Article **5** before notifying the frequency assignments concerned, they shall in all appropriate cases inform the Bureau of such coordination.

CHAPTER III

Coordination, notification and recording of frequency assignments and Plan modifications

ARTICLE 7

Application of the procedures

7.1 The procedures of this Chapter shall be applied by administrations, the Radio Regulations Board (the Board) and the Radiocommunication Bureau (the Bureau) for the purposes of:

7.2 *a)* obtaining coordination with, or the agreement of, other administrations whenever such a requirement is specified in one or more provisions of these Regulations (see Article **9**);

7.3 Not used.

7.4 *b)* notifying to the Bureau frequency assignments for the purposes of examination and recording in the Master Register (see Article **11**).

7.4A Unless otherwise stated in an applicable regulatory provision of these Regulations or in a Resolution relating to the application of the provisions of Articles **9** or **11**, the following shall be applied by the Bureau:

– when applying the provisions of No. **9.35** or **9.36**, as appropriate, the Bureau shall apply the provisions in force at the date of receipt of the information submitted under No. **9.34**;

– when applying the provisions of No. **11.31**, the Bureau shall apply the provisions in force at the date of receipt of the complete notice submitted under No. **11.15**;

– when applying the provisions of No. **11.32**, the Bureau shall apply the provisions in force at the date of receipt of complete information submitted under No. **9.34**. In the case where a new form of coordination exists on the date of receipt of notification under Article **11**, where no such form existed at the coordination stage, the Bureau shall apply the forms of coordination in force on the date of receipt of complete Appendix **4** data under Article **11**;

– in the case where a form of coordination or coordination requirements existed on the date of receipt of complete coordination data under Article **9** where no such form or coordination requirements exist on the date of receipt of complete notification data under Article **11**, the Bureau shall not take into account these forms of coordination or coordination requirements. (WRC-03)

7.5 Any administration may request the assistance of the Board or the Bureau in the application of any part of the procedures of this Chapter (see Articles **13** and **14**).

7.5A If a frequency assignment is brought into use before commencement of the coordination procedure under Article **9** when coordination is required, or before notification when coordination is not required, the operation in advance of the application of the procedure shall, in no way, afford any priority.

7.6 If requested by any administration, particularly by the administration of a country in need of special assistance, the Bureau and, when necessary, the Board shall, using such means at their disposal as are appropriate in the circumstances, render the assistance requested in the application of the procedures of this Chapter.

7.7 The Board shall, in accordance with the relevant provisions of the Constitution, the Convention and these Regulations, approve the Rules of Procedure which are to be applied by the Bureau (see Article **13**, Section III).

7.8 In a case of harmful interference involving the application of the provisions of Article **15**, Section VI, except when there is an obligation to eliminate harmful interference under the provisions of this Chapter, administrations are urged to exercise the utmost goodwill and mutual cooperation taking into account all the relevant technical and operational factors of the case.

ARTICLE 8

Status of frequency assignments recorded in the Master International Frequency Register

8.1 The international rights and obligations of administrations in respect of their own and other administrations' frequency assignments[1] shall be derived from the recording of those assignments in the Master International Frequency Register (the Master Register) or from their conformity, where appropriate, with a plan. Such rights shall be conditioned by the provisions of these Regulations and those of any relevant frequency allotment or assignment plan.

8.2 Not used.

8.3 Any frequency assignment recorded in the Master Register with a favourable finding under No. **11.31** shall have the right to international recognition. For such an assignment, this right means that other administrations shall take it into account when making their own assignments, in order to avoid harmful interference. In addition, frequency assignments in frequency bands subject to coordination or to a plan shall have a status derived from the application of the procedures relating to the coordination or associated with the plan.

8.4 A frequency assignment shall be known as a non-conforming assignment when it is not in accordance with the Table of Frequency Allocations or the other[2] provisions of these Regulations. Such an assignment shall be recorded for information purposes, only when the notifying administration states that it will be operated in accordance with No. **4.4** (see also No. **8.5**).

8.5 If harmful interference to the reception of any station whose assignment is in accordance with No. **11.31** is actually caused by the use of a frequency assignment which is not in conformity with No. **11.31**, the station using the latter frequency assignment must, upon receipt of advice thereof, immediately eliminate this harmful interference.

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[1] **8.1.1** The expression "frequency assignment", wherever it appears in this Chapter, shall be understood to refer either to a new frequency assignment or to a change in an assignment already recorded in the Master Register. Additionally, wherever the expression relates to a geostationary or non-geostationary space station, it shall be associated with § A.4 of Annex 2 to Appendix **4**, as relevant, and wherever the expression relates to an earth station associated with a geostationary or non-geostationary space station, it shall be associated with § A.4.c of Annex 2 to Appendix **4**, as relevant. (WRC-12)

[2] **8.4.1** The "other provisions" shall be identified and included in the Rules of Procedure.

ARTICLE 9

Procedure for effecting coordination with or obtaining agreement of other administrations[1, 2, 3, 4, 5, 6, 7, 8] (WRC-19)

Section I – Advance publication of information on satellite networks or satellite systems

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[1] **A.9.1** For the application of the provisions of this Article with respect to stations in a space radiocommunication service using frequency bands covered by the fixed-satellite service allotment Plan, see also Appendix **30B**.

[2] **A.9.2** These procedures may be applicable to stations on board satellite launching vehicles.

[3] **A.9.3** See Appendices **30** and **30A**, as appropriate, for the coordination of:

a) proposed modifications to the Appendix **30** Plans for the broadcasting-satellite service in the frequency bands 11.7-12.2 GHz (in Region 3), 11.7-12.5 GHz (in Region 1) and 12.2-12.7 GHz (in Region 2), or new or modified assignments proposed for inclusion in the Regions 1 and 3 List of additional uses, with respect to frequency assignments in the same service or in other services to which these bands are allocated;

b) frequency assignments in other services to which the frequency bands referred to in § *a)* above are allocated in the same Region or in another Region, with respect to assignments in the broadcasting-satellite service in the frequency bands 11.7-12.2 GHz (in Region 3), 11.7-12.5 GHz (in Region 1) and 12.2-12.7 GHz (in Region 2);

c) proposed modifications to the Appendix **30A** Plans for feeder links to the broadcasting-satellite service in the frequency bands 17.3-17.8 GHz (in Region 2) and 14.5-14.8 GHz and 17.3-18.1 GHz (in Regions 1 and 3), or new or modified assignments proposed for inclusion in the Regions 1 and 3 Lists of additional uses, with respect to frequency assignments in the same service or in other services to which these bands are allocated;

d) frequency assignments in other services to which the frequency bands referred to in § *c)* above are allocated in the same Region or in another Region, with respect to assignments in the fixed-satellite service (Earth-to-space) in the frequency bands 17.3-17.8 GHz (in Region 2) and 14.5-14.8 GHz and 17.3-18.1 GHz (in Regions 1 and 3).

For the broadcasting-satellite service and for feeder links for the broadcasting-satellite service in the fixed-satellite service in Region 2, Resolution **42 (Rev.Orb-88)*** is also applicable. (WRC-2000)

* *Note by the Secretariat:* This Resolution was revised by WRC-03, WRC-12, WRC-15 and WRC-19.

[4] **A.9.4** Resolution **49 (Rev.WRC-23)**, Resolution **552 (Rev.WRC-23)** or Resolution **32 (Rev.WRC-23)**, as appropriate, shall also be applied with respect to those satellite networks and satellite systems that are subject to it. (WRC-23)

[5] **A.9.5** See also Resolution **51 (Rev.WRC-2000)****. (WRC-2000)

** *Note by the Secretariat:* This Resolution was abrogated by WRC-15.

[6] **A.9.6** The provisions of Appendices **30**, **30A** and **30B** do not apply to non-geostationary satellite systems in the fixed-satellite service. (WRC-23)

[7] **A.9.6A** For the purpose of this Article, a geostationary satellite is a geosynchronous satellite with an orbit the inclination of which is less than or equal to 15°. (WRC-03)

A.9.7 (SUP – WRC-19)

[8] **A.9.8** In respect of submission for Regions 1 and 3 satellite networks in the broadcasting-satellite service in the frequency band 21.4-22 GHz meeting special requirements, Resolution **553 (WRC-12)***** applies. (WRC-12)

*** *Note by the Secretariat:* This Resolution was revised by WRC-15 and WRC-23.

General

9.1 Before initiating any action under Article **11** in respect of frequency assignments for a satellite network or system not subject to the coordination procedure described in Section II of Article **9** below, an administration, or one[9] acting on behalf of a group of named administrations, shall send to the Bureau a general description of the network or system for advance publication in the International Frequency Information Circular (BR IFIC) not earlier than seven years and preferably not later than two years before the planned date of bringing into use of the network or system (see also No. **11.44**). The characteristics to be provided for this purpose are listed in Appendix **4**. The notification information may also be communicated to the Bureau at the same time, but shall be considered as having been received by the Bureau not earlier than four months after the date of publication of the advance publication information. (WRC-19)

9.1A (SUP - WRC-23)

9.2 Amendments to the information sent in accordance with the provisions of No. **9.1** shall also be sent to the Bureau as soon as they become available. The use of an additional frequency band, or modification of the orbital location for a space station using the geostationary-satellite orbit, the modification of the reference body or the modification of the direction of transmission for a space station using a non-geostationary-satellite orbit, as well as the use of inter-satellite links of a geostationary space station communicating with a non-geostationary space station which are not subject to the coordination procedure under Section II of Article **9**, will require the application of the advance publication procedure[10]. (WRC-19)

9.2A If the information is found to be incomplete, the Bureau shall immediately seek from the administration concerned any clarification required and information not provided.

9.2B On receipt of the complete information sent under Nos. **9.1** and **9.2**, the Bureau shall publish[11] it in a Special Section of its BR IFIC within two months. When the Bureau is not in a position to comply with the time-limit referred to above, it shall periodically so inform the administrations, giving the reasons therefor. (WRC-19)

9.2C (SUP - WRC-23)

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[9] **9.1.1** Whenever, under this provision, an administration acts on behalf of a group of named administrations, all members of that group retain the right to respond in respect of their own networks or systems.

[10] **9.2.1** For geostationary-satellite networks using inter-satellite links of a geostationary space station communicating with a non-geostationary space station which are not subject to the coordination procedure under Section II of Article **9**, the Appendix **4** characteristics to be provided for advance publication in the BR IFIC shall be the same as those listed for the coordination of a geostationary-satellite network. (WRC-19)

[11] **9.2B.1** If the payments are not received in accordance with the provisions of Council Decision 482, as amended, on the implementation of cost recovery for satellite network filings, the Bureau shall cancel the publication, after informing the administration concerned. The Bureau shall inform all administrations of such action, and that the network specified in the publication in question no longer has to be taken into consideration by the Bureau and other administrations. The Bureau shall send a reminder to the notifying administration not later than two months prior to the deadline for the payment in accordance with the above-mentioned Council Decision 482 unless the payment has already been received. (WRC-07)

Sub-Section IA – Advance publication of information on satellite networks or satellite systems that are not subject to coordination procedure under Section II

9.3 If, upon receipt of the BR IFIC containing information published under No. **9.2B**, any administration believes that interference which may be unacceptable may be caused to its existing or planned satellite networks or systems, it shall within four months of the date of publication of the BR IFIC communicate to the publishing administration its comments[12] on the particulars of the anticipated interference to its existing or planned systems. A copy of these comments shall also be sent to the Bureau. Thereafter, both administrations shall endeavour to cooperate in joint efforts to resolve any difficulties, with the assistance of the Bureau, if so requested by either of the parties, and shall exchange any additional relevant information that may be available. If no such comments are received from an administration within the aforementioned period, it may be assumed that the administration concerned has no objections to the planned satellite network(s) of the system on which details have been published. (WRC-19)

9.4 In the case of difficulties, the administration responsible for the planned satellite network shall explore all possible means to resolve the difficulties without considering the possibility of adjustment to networks of other administrations. If no such means can be found, it may request the other administrations to explore all possible means to meet its requirements. The administrations concerned shall make every possible effort to resolve the difficulties by means of mutually acceptable adjustments to their networks. An administration on behalf of which details of planned satellite networks have been published in accordance with the provisions of No. **9.2B** may, after the period of four months, inform the Bureau of the progress made in resolving any difficulties. (WRC-19)

9.5 The Bureau shall inform all administrations of the list of administrations which have sent comments under No. **9.3** and provide a summary of the comments received.

9.5A The procedure of Sub-Section IA shall be considered mainly for the purposes of informing all administrations of developments in the use of space radiocommunications.

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[12] **9.3.1** Upon receipt of the International Frequency Information Circular (BR IFIC) containing information published under No. **9.2B** for frequency assignments to non-geostationary-satellite systems subject to Resolution **32 (WRC-19)***, any administration which believes that unacceptable interference may be caused to its existing or planned satellite networks or systems shall, as soon as possible and within a period of four months, communicate to the notifying administration, with a copy to the Bureau, these comments on the particulars of the potential interference to its existing or planned systems. The Bureau shall promptly make these comments available "as received" on the ITU website. (WRC-19)

* *Note by the Secretariat:* This Resolution was revised by WRC-23.

Sub-Section IB (SUP - WRC-15)

9.5B (SUP - WRC-15)

9.5C (SUP - WRC-15)

9.5D (SUP - WRC-15)

Section II – Procedure for effecting coordination[13, 14]

Sub-Section IIA – Requirement and request for coordination

9.6 Before an administration[15, 16, 17] notifies to the Bureau or brings into use a frequency assignment in any of the cases listed below, it shall effect coordination, as required, with other administrations identified under No. **9.27**: (WRC-03)

9.7 *a)* for a station in a satellite network using the geostationary-satellite orbit, in any space radiocommunication service, in a frequency band and in a Region where this service is not subject to a plan, in respect of any other satellite network using that orbit, in any space radiocommunication service in a frequency band and in a Region where this service is not subject to a plan, with the exception of coordination between earth stations operating in the opposite direction of transmission.

9.5B.1 (SUP - WRC-15)

[13] **A.9.II.1** These procedures are also applicable for earth stations of the Earth exploration-satellite, space research, space operation and radiodetermination-satellite services intended to be used while in motion or during halts at unspecified points.

[14] **A.9.II.2** The word "coordination" as used throughout this Article refers also to the process of seeking an agreement of other administrations when required under No. **9.21**.

[15] **9.6.1** In the case of coordination of an assignment in a satellite network, an administration may act on behalf of a group of named administrations. Whenever, under this provision, an administration acts on behalf of a group of named administrations, all members of the group retain the right to respond in respect of their own services which could affect or be affected by the proposed assignment.

[16] **9.6.2** In all cases, the coordination of an earth station with terrestrial stations or other earth stations operating in the opposite direction of transmission shall remain within the authority of the administration on the territory of which this station is located.

[17] **9.6.3** Unless otherwise specified, coordination under any of the particular sharing situations defined in Nos. **9.7** to **9.21** is not applicable when limits for that sharing situation are specified elsewhere in these Regulations. (WRC-03)

9.7A *b)*[18, 19] for a specific earth station in a geostationary-satellite network in the fixed-satellite service in certain frequency bands, in respect of a non-geostationary-satellite system in the fixed-satellite service; (WRC-2000)

9.7B *c)*[18, 19] for a non-geostationary-satellite system in the fixed-satellite service in certain frequency bands, in respect of a specific earth station in a geostationary-satellite network in the fixed-satellite service. (WRC-2000)

9.8 (SUP - WRC-2000)

9.9 (SUP - WRC-2000)

9.10 Not used;

9.11 *d)* for a space station in the broadcasting-satellite service in any band shared on an equal primary basis with terrestrial services and where the broadcasting-satellite service is not subject to a plan, in respect of terrestrial services;

9.11A *e)* for a station for which the requirement to coordinate is included in a footnote to the Table of Frequency Allocations referring to this provision, the provisions of Nos. **9.12** to **9.16** are applicable; (WRC-2000)

9.12 *f)* for a station in a satellite network using a non-geostationary-satellite orbit, for which the requirement to coordinate is included in a footnote to the Table of Frequency Allocations referring to this provision or to No. **9.11A**, in respect of any other satellite network using a non-geostationary-satellite orbit, with the exception of coordination between earth stations operating in the opposite direction of transmission; (WRC-2000)

9.12A *g)* for a station in a satellite network using a non-geostationary-satellite orbit, for which the requirement to coordinate is included in a footnote to the Table of Frequency Allocations referring to this provision or to No. **9.11A**, in respect of any other satellite network using the geostationary-satellite orbit, with the exception of coordination between earth stations operating in the opposite direction of transmission; (WRC-2000)

9.13 *h)* for a station in a satellite network using the geostationary-satellite orbit, for which the requirement to coordinate is included in a footnote to the Table of Frequency Allocations referring to this provision or to No. **9.11A**, in respect of any other satellite network using a non-geostationary-satellite orbit, with the exception of coordination between earth stations operating in the opposite direction of transmission; (WRC-2000)

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[18] **9.7A.1** and **9.7B.1** The coordination of a specific earth station under Nos. **9.7A** or **9.7B** shall remain within the authority of the administration on whose territory the station is located. (WRC-2000)

[19] **9.7A.2** and **9.7B.2** Coordination information relating to a specific earth station received by the Bureau prior to 30 June 2000 is considered as complete information under Nos. **9.7A** or **9.7B** from the date of receipt of complete information for the associated satellite network under No. **9.7**, provided that the maximum isotropic antenna gain, the lowest total receiving system noise temperature of the earth station and the necessary bandwidth of the emission received by the earth station are equal to those of any typical earth station included in the coordination request for the geostationary-satellite network in the fixed-satellite service. (WRC-2000)

9.14 *i)* for a transmitting space station of a satellite network for which the requirement to coordinate is included in a footnote to the Table of Frequency Allocations referring to this provision or to No. **9.11A** in respect of receiving stations of terrestrial services where the threshold value is exceeded; (WRC-07)

9.15 *j)* for either a specific earth station or typical earth station of a non-geostationary satellite network for which the requirement to coordinate is included in a footnote to the Table of Frequency Allocations referring to No. **9.11A**, in respect of terrestrial stations in frequency bands allocated with equal rights to space and terrestrial services and where the coordination area of the earth station includes the territory of another country; (WRC-2000)

9.16 *k)* for a transmitting station of a terrestrial service for which the requirement to coordinate is included in a footnote to the Table of Frequency Allocations referring to No. **9.11A** and which is located within the coordination area of an earth station in a non-geostationary-satellite network; (WRC-2000)

9.17 *l)* for any specific earth station or typical mobile earth station in frequency bands above 100 MHz allocated with equal rights to space and terrestrial services, in respect of terrestrial stations, where the coordination area of the earth station includes the territory of another country, with the exception of the coordination under No. **9.15**; (WRC-2000)

9.17A *m)* for any specific earth station, in respect of other earth stations operating in the opposite direction of transmission or for any typical mobile earth station in respect of specific earth stations operating in the opposite direction of transmission, in frequency bands allocated with equal rights to space radiocommunication services in both directions of transmission and where the coordination area of the earth station includes the territory of another country or the earth station is located within the coordination area of another earth station, with the exception of the coordination under No. **9.19**; (WRC-03)

9.18 *n)* for any transmitting station of a terrestrial service in the bands referred to in No. **9.17** within the coordination area of an earth station, in respect of this earth station, with the exception of the coordination under Nos. **9.16** and **9.19**; (WRC-2000)

9.19 *o)* for any transmitting station of a terrestrial service or any transmitting earth station in the fixed-satellite service (Earth-to-space) in a frequency band shared on an equal primary basis with the broadcasting-satellite service, with respect to typical earth stations included in the service area of a space station in the broadcasting-satellite service. (WRC-2000)

9.20 Not used;

9.21 *p)* for any station of a service for which the requirement to seek the agreement of other administrations is included in a footnote to the Table of Frequency Allocations referring to this provision. (WRC-2000)

9.22 Not used.

9.23 Whenever there is a requirement to effect more than one form of coordination in accordance with No. **9.30**, the requests shall be appropriately identified by reference to Nos. **9.7** to **9.14** and **9.21**, and they shall as far as possible be sent to the Bureau and, where appropriate, shall be published simultaneously.

9.24 and **9.25** Not used.

9.26 Coordination may be effected for a satellite network using the information relating to the space station, including its service area, and the parameters of one or more typical earth stations located in all or part of the service area of the space station. Coordination may also be effected for terrestrial stations using the information relating to typical terrestrial stations, except for those mentioned in Nos. **11.18** to **11.23**.

9.27 Frequency assignments to be taken into account in effecting coordination are identified using Appendix **5**.

9.28 In the case of requests for coordination under No. **9.29**, the requesting administration shall, by applying the calculation method and criteria contained in Appendix **5** to those frequency assignments, identify, to the extent possible, the administrations with which coordination is to be effected.

9.29 Requests for coordination made under Nos. **9.15** to **9.19** shall be sent by the requesting administration to the identified administrations, together with the appropriate information listed in Appendix **4** to these Regulations.

9.30 Requests for coordination made under Nos. **9.7** to **9.14** and **9.21** shall be sent by the requesting administration to the Bureau, together with the appropriate information listed in Appendix **4** to these Regulations. Any additional frequency bands subsequently added to the request for coordination, or any modification to the request for coordination involving a change of the orbital location for a space station using the geostationary-satellite orbit, shall be given a new date of receipt with respect to the application of Nos. **11.44**, **11.44.1** and **11.48**. (WRC-23)

9.31 The information sent under No. **9.29** shall also, in the cases covered by Nos. **9.15**, **9.17** or **9.17A**, include a copy of diagrams drawn to appropriate scale indicating, for both transmission and reception, the location of the earth station and its associated coordination area, or the coordination area related to the service area in which it is intended to operate the mobile earth station, and the data on which the diagrams are based. In respect of terrestrial stations, in the cases covered by Nos. **9.16**, **9.18** and **9.19** the information shall include the locations of terrestrial stations within the coordination area of the relevant earth station.

9.32 If the responsible administration concludes that coordination is not required under Nos. **9.7** to **9.7B**, it shall send the relevant information pursuant to Appendix **4** to the Bureau for action under No. **9.34**. (WRC-2000)

9.32A If the responsible administration, following the application of Nos. **9.15** to **9.19**, concludes that coordination is not required, it may send the relevant information pursuant to Appendix **4** to the Bureau for action under Section I of Article **11**.

9.33 If for any reason an administration cannot act in accordance with No. **9.29**, it shall seek the assistance of the Bureau. The Bureau shall then send the request for coordination to the administration concerned and take any necessary further action as appropriate under Nos. **9.45** and **9.46**.

9.34 On receipt of the complete information sent under No. **9.30** or No. **9.32** the Bureau shall promptly:

9.35 *a)* examine that information with respect to its conformity with No. **11.31**[20]; (WRC-19)

9.36 *b)* identify in accordance with No. **9.27** any administration with which coordination may need to be effected[21, 22]; (WRC-19)

9.37 *c)* include their names in the publication under No. **9.38**;

9.38 *d)* publish[23], as appropriate, the complete information in the BR IFIC within four months. Where the Bureau is not in a position to comply with the time-limit referred to above, it shall periodically so inform the administrations, giving the reasons therefor. (WRC-2000)

9.39 Not used;

9.40 *e)* inform the administrations concerned of its actions and communicate the results of its calculations, drawing attention to the relevant BR IFIC.

9.40A If the information is found to be incomplete, the Bureau shall immediately seek from the administration concerned any clarification required and information not provided.

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[20] **9.35.1** The Bureau shall include the detailed results of its examination under No. **11.31** of compliance with the limits in Tables **22-1** to **22-3** or the single-entry limits in No. **22.5L** of Article **22**, as applicable, in the publication under No. **9.38**. (WRC-19)

[21] **9.36.1** In the case of coordination under Nos. **9.12**, **9.12A** and **9.13**, the Bureau shall also identify the satellite networks or systems with which coordination may need to be effected. The list of administrations identified by the Bureau under Nos. **9.11** to **9.14** and **9.21** and the list of satellite networks or systems identified by the Bureau under Nos. **9.12**, **9.12A** and **9.13** are only for information purposes, to help administrations comply with this procedure. (WRC-19)

[22] **9.36.2** In the case of coordination under Nos. **9.7**, **9.7A** and **9.7B**, the Bureau shall also identify the specific satellite networks or earth stations with which coordination needs to be effected (see also No. **9.42**). (WRC-12)

[23] **9.38.1** If the payments are not received in accordance with the provisions of Council Decision 482, as amended, on the implementation of cost recovery for satellite network filings, the Bureau shall cancel the publication, after informing the administration concerned. The Bureau shall inform all administrations of such action and that the network specified in the publication in question no longer has to be taken into consideration by the Bureau and other administrations. The Bureau shall send a reminder to the notifying administration not later than two months prior to the deadline for the payment in accordance with the above-mentioned Council Decision 482 unless the payment has already been received. (WRC-07)

9.41 Following receipt of the BR IFIC referring to requests for coordination under Nos. **9.7** to **9.7B**, an administration believing that it, or any of its satellite networks not identified under No. **9.36.2**, should have been included in the request, or the initiating administration believing that an administration, or any of the satellite networks identified under No. **9.36.2,** in accordance with the provisions of No. **9.7** (GSO/GSO) (items 1) to 8) of the frequency band column), No. **9.7A** (GSO earth station/non-GSO system) or No. **9.7B** (non-GSO system/GSO earth station) of Table 5-1 of Appendix **5** should not have been included in the request, shall, within four months of the date of publication of the relevant BR IFIC, inform the initiating administration or the identified administration, as appropriate, and the Bureau, giving its technical reasons for doing so, and shall request that its name, or the name of any of its satellite networks not identified under No. **9.36.2**, be included, or that the name of the identified administration, or any of its satellite networks identified under No. **9.36.2**, be excluded, as appropriate. (WRC-12)

9.42 The Bureau shall study this information on the basis of Appendix **5** and shall inform both administrations of its conclusions. Should the Bureau agree to include or exclude, as appropriate, an administration and/or a satellite network in the request, it shall publish a Special Section, indicating the list of administrations and associated satellite networks with which coordination needs to be effected[24]. (WRC-12)

9.43 Those administrations not responding under No. **9.41** within the time limit specified therein shall be regarded as unaffected and the provisions of Nos. **9.48** and **9.49** shall apply.

9.44 The administration requesting coordination and those with which it is requested, or the Bureau when acting pursuant to No. **7.6**, may request any additional information they consider necessary.

Sub-Section IIB – Acknowledgement of receipt of a request for coordination

9.45 An administration receiving a request for coordination under No. **9.29** shall, within 30 days from the date of the request, acknowledge receipt by telegram to the requesting administration. In the absence of an acknowledgement of receipt of its request within the 30 days, the requesting administration shall send a telegram requesting an acknowledgement.

9.46 If there is no acknowledgement of receipt within 15 days of its second request sent under No. **9.45**, the requesting administration may seek the assistance of the Bureau. In this event, the Bureau shall forthwith send a telegram to the administration which has failed to reply requesting an immediate acknowledgement.

9.47 If there is no acknowledgement of receipt within 30 days after the Bureau's action under No. **9.46**, the Bureau shall immediately send a reminder providing an additional 15-day period for the response. In the absence of such an acknowledgement within 15 days, it shall be deemed that the administration which has failed to acknowledge receipt has undertaken: (WRC-15)

9.48 *a)* that no complaint will be made in respect of any harmful interference affecting its own assignments which may be caused by the assignment for which coordination was requested; and

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[24] **9.42.1** During coordination discussions between administrations, additional networks can be included in the coordination process on the basis of the agreement of the administrations concerned. (WRC-12)

9.49 *b)* that the use of its own assignments will not cause harmful interference to the assignment for which coordination was requested.

Sub-Section IIC – Action upon a request for coordination

9.50 An administration having received a request for coordination under Nos. **9.7** to **9.21**, or having been included in the procedure following action under No. **9.41**, shall promptly examine the matter with regard to interference which may be caused to or, in certain cases, by its own assignments[25], identified in accordance with Appendix **5**[26, 27]. (WRC-15)

9.51 Following its action under No. **9.50**, the administration with which coordination was sought under Nos. **9.7** to **9.7B** shall, within four months of the date of publication of the BR IFIC under No. **9.38**, either inform the requesting administration and the Bureau of its agreement or act under No. **9.52**. (WRC-2000)

9.51A Following its action under No. **9.50**, the administration with which coordination was sought under Nos. **9.15** to **9.19** shall, within four months of the date of dispatch of the coordination data under No. **9.29**, either inform the requesting administration of its agreement or act under No. **9.52**.

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[25] **9.50.1** In the absence of specific provisions in these Regulations relating to the evaluation of interference, the calculation methods and the criteria should be based on relevant ITU-R Recommendations agreed by the administrations concerned. In the event of disagreement on a Recommendation or in the absence of such a Recommendation, the methods and criteria shall be agreed between the administrations concerned. Such agreements shall be concluded without prejudice to other administrations.

[26] **9.50.2** Where Appendix **5** specifies a period for which planned assignments may be taken into account, that period may be extended by agreement between the administrations concerned.

[27] **9.50.3** See also No. **9.52.1**. (WRC-15)

9.52 If an administration, following its action under No. **9.50**, does not agree to the request for coordination, it shall, within four months of the date of publication of the BR IFIC under No. **9.38**, or of the date of dispatch of the coordination data under No. **9.29**, inform the requesting administration of its disagreement[28] and shall provide information concerning its own assignments upon which that disagreement is based. It shall also make such suggestions as it is able to offer with a view to satisfactory resolution of the matter. A copy of that information shall be sent to the Bureau. Where the information relates to terrestrial stations or earth stations operating in the opposite direction of transmission within the coordination area of an earth station, only that information relating to existing radiocommunication stations or to those to be brought into use within the next three months for terrestrial stations, or three years for earth stations, shall be treated as notifications under Nos. **11.2** or **11.9**. (WRC-15)

9.52A In the case of coordination requested under No. **9.14**, on receipt of the Special Section of the BR IFIC referred to in No. **9.38**, and within the same four-month period from the publication of that Special Section, an administration in need of assistance may inform the Bureau that it has existing or planned terrestrial stations which might be affected by the planned satellite network, and may request the Bureau to determine the need for coordination by applying the Appendix **5** criteria. The Bureau shall inform the administration seeking coordination of this request, indicating the date by which it may be able to provide the results of its analysis. When these results are available, the Bureau shall inform both administrations. This request shall be considered as a disagreement, pending the results of the analysis by the Bureau of the need for coordination.

9.52B When an agreement on coordination is reached, the administration responsible for the terrestrial stations or the earth station operating in the opposite direction of transmission may send to the Bureau the information concerning those stations covered by the agreement which are intended to be notified under Nos. **11.2** or **11.9**. The Bureau shall consider as notifications only that information relating to existing terrestrial or earth stations operating in the opposite direction of transmission or to those to be brought into use within the next three years.

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[28] **9.52.1** An administration believing that:

i) unacceptable interference may be caused to its existing or planned satellite networks or systems not subject to the coordination procedure under Section II of Article **9,** or

ii) unacceptable interference may be caused to its existing or planned satellite networks or systems subject to Section II of Article **9** by an incoming frequency assignment to a space station subject to this Section only with respect to terrestrial services, or

iii) unacceptable interference may be caused to its existing or planned satellite networks or systems subject to Section II of Article **9** by an incoming frequency assignment to a space station subject to this Section only with respect to a list of administrations provided in the relevant footnote to Article **5**, and that list does not include the potentially affected administration,

may send its comments to the requesting administration. A copy of these comments may also be sent to the Bureau. Such comments shall however not by themselves constitute a disagreement under No. **9.52**. Thereafter, both administrations shall endeavour to cooperate in joint efforts to resolve any difficulties, with the assistance of the Bureau, if so requested by either of the parties, and shall exchange any additional relevant information that may be available. (WRC-23)

9.52C For coordination requests under Nos. **9.11** to **9.14** and **9.21**, an administration not responding under No. **9.52** within the same four-month period shall be regarded as unaffected and, in the cases of Nos. **9.11** to **9.14**, the provisions of Nos. **9.48** and **9.49** shall apply. Furthermore, for coordination under Nos. **9.12**, **9.12A** and **9.13**, any satellite networks or systems identified under No. **9.36.1** but not confirmed in the response provided by the administration under No. **9.52** within the same four-month period shall be regarded as unaffected and the provisions of Nos. **9.48** and **9.49** shall also apply. (WRC-19)

9.52D For coordination requests under Nos. **9.12** to **9.14**, forty-five days prior to the expiry of the same four-month period the Bureau shall dispatch a circular-telegram to all administrations, bringing the matter to their attention. Upon receipt of the aforementioned circular-telegram, an administration shall acknowledge receipt immediately by telegram. If no acknowledgement is received within thirty days, the Bureau shall dispatch a telegram requesting acknowledgement, to which the receiving administration shall reply within a further period of fifteen days.

9.53 Thereafter, the requesting and responding administrations shall make every possible mutual effort to overcome the difficulties, in a manner acceptable to the parties concerned.

9.53A Upon expiry of the deadline for comments in respect of a coordination request under Nos. **9.11** to **9.14** and **9.21**, the Bureau shall, according to its records, publish a Special Section, indicating the list of administrations having submitted their disagreement and the list of satellite networks or systems upon which this disagreement is based, as appropriate, or other comments within the regulatory deadline. (WRC-19)

9.54 Either the administration seeking coordination or one whose assignments may be affected thereby may request additional information which it may require in order to assess the interference to its own assignments or to assist in resolving the matter.

9.55 All administrations may use correspondence, any appropriate means of telecommunication or meetings, as necessary, to assist in resolving the matter. The results thereof shall be communicated to the Bureau, which shall publish them in the BR IFIC, as appropriate.

9.56 and **9.57** Not used.

9.58 An administration which has initiated coordination, as well as any administration with which coordination is sought, shall communicate to the Bureau any modifications to the published characteristics of their respective networks that were required to reach agreement on the coordination. The Bureau shall publish this information in accordance with No. **9.38**, indicating that these modifications resulted from the joint effort of the administrations concerned to reach agreement on coordination and that, for this reason, they should be given special consideration. These modifications may involve the application of Sub-Section IIA of Article **9** with respect to other administrations.

9.59 If there is disagreement between the administration seeking coordination and an administration with which coordination is sought concerning the level of acceptable interference, either may seek the assistance of the Bureau; in such a case, it shall provide the necessary information to enable the Bureau to endeavour to effect such coordination.

Sub-Section IID – Action in the event of no reply, no decision or disagreement on a request for coordination

9.60 If, within the same four-month period specified in Nos. **9.51** or **9.51A**, an administration with which coordination is sought under Nos. **9.7** to **9.7B** and **9.15** to **9.19** fails to reply or to give a decision under Nos. **9.51** or **9.51A** or, following its disagreement under No. **9.52**, fails to provide information concerning its own assignments on which its disagreement is based, the requesting administration may seek the assistance of the Bureau. (WRC-2000)

9.61 The Bureau, acting on a request for assistance under No. **9.60**, shall forthwith request the administration concerned to give an early decision in the matter or provide the relevant information.

9.62 If the administration concerned fails to respond within 30 days of the Bureau's action under No. **9.61**, the Bureau shall immediately send a reminder providing an additional 15-day period for the response. If the administration still fails to respond after the Bureau's reminder within the 15 days, the provisions of Nos. **9.48** and **9.49** shall apply. (WRC-15)

9.63 If there is continuing disagreement, or if any administration involved in the matter has requested the assistance of the Bureau, the Bureau shall seek any necessary information to enable it to assess the interference. It shall communicate its conclusions to the administrations involved.

9.64 If the disagreement remains unresolved after the Bureau has communicated its conclusions to the administrations involved, the administration which requested coordination shall, having regard to the other provisions of this Section, defer the submission of its notice of frequency assignments under Article **11** to the Bureau for six months from the date of the request or the BR IFIC containing the request for coordination, as appropriate.

9.65 If, at the date of receipt of a notice under No. **9.64** above, the Bureau has been informed of a continuing disagreement, the Bureau shall examine the notice under Nos. **11.32A** or **11.33**[29] and shall act in accordance with No. **11.38**.

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[29] **9.65.1** A notice of a frequency assignment for which coordination was requested under No. **9.21** and in respect of which there is continuing disagreement shall not be examined under Nos. **11.32A** or **11.33**; it shall, however, be examined under No. **11.31**.

ARTICLE 10 (*Number not used*)

ARTICLE 11

Notification and recording of frequency assignments[1, 2, 3, 4, 5, 6, 7] (WRC-19)

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[1] **A.11.1** See also Appendices **30** and **30A** as appropriate, for the notification and recording of:

a) frequency assignments to stations in the broadcasting-satellite service in the frequency bands 11.7-12.2 GHz (in Region 3), 11.7-12.5 GHz (in Region 1) and 12.2-12.7 GHz (in Region 2);

b) frequency assignments to stations in other services to which the frequency bands referred to in § *a)* above are allocated in the same Region or in another Region, so far as their relationship to the broadcasting-satellite service is concerned, in the frequency bands 11.7-12.2 GHz (in Region 3), 11.7-12.5 GHz (in Region 1) and 12.2-12.7 GHz (in Region 2);

c) frequency assignments to feeder-link stations in the fixed-satellite service (Earth-to-space) in the frequency bands 14.5-14.8 GHz in Region 1 (see No. **5.510**) and in Region 3, 17.3-18.1 GHz in Regions 1 and 3 and 17.3-17.8 GHz in Region 2, and to stations in other services in these bands;

d) frequency assignments to stations in the same service or other services to which the frequency bands referred to in § *c)* above are allocated in the same Region or in another Region, so far as their relationship to the fixed-satellite service (Earth-to-space) in these bands is concerned.

For the broadcasting-satellite service in Region 2 and for feeder links in the fixed-satellite service for the broadcasting-satellite service in Region 2, Resolution **42 (Rev.Orb-88)*** is also applicable.

See also Appendix **30B** for the notification and recording of assignments in the following frequency bands:

All Regions, fixed-satellite service only

4 500-4 800 MHz	(space-to-Earth)
6 725-7 025 MHz	(Earth-to-space)
10.7-10.95 GHz	(space-to-Earth)
11.2-11.45 GHz	(space-to-Earth)
12.75-13.25 GHz	(Earth-to-space) (WRC-2000)

* *Note by the Secretariat:* This Resolution was revised by WRC-03, WRC-12, WRC-15 and WRC-19.

[2] **A.11.2** Resolution **49 (Rev.WRC-23)**, Resolution **552 (Rev.WRC-23)** or Resolution **32 (Rev.WRC-23)**, as appropriate, shall also be applied with respect to those satellite networks and satellite systems that are subject to it. (WRC-23)

[3] **A.11.3** See also Resolution **51 (Rev.WRC-2000)****. (WRC-2000)

** *Note by the Secretariat:* This Resolution was abrogated by WRC-15.

[4] **A.11.4** The provisions of Appendices **30**, **30A** and **30B** do not apply to non-geostationary-satellite systems in the fixed-satellite service. (WRC-2000)

[5] **A.11.4A** For the purpose of this Article, a geostationary satellite is a geosynchronous satellite with an orbit the inclination of which is less than or equal to 15°. (WRC-03)

A.11.5 (SUP - WRC-19)

[6] **A.11.6** If the payments are not received in accordance with the provisions of Council Decision 482, as amended, on the implementation of cost recovery for satellite network filings, the Bureau shall cancel the publication specified in Nos. **11.28** and **11.43** and the corresponding entries in the Master Register under Nos. **11.36**, **11.37**, **11.38**, **11.39**, **11.41**, **11.43B** or **11.43C**, as appropriate, after informing the administration concerned. The Bureau shall inform all administrations of such action and that the entries specified in the publication in question no longer have to be taken into consideration by the Bureau and other administrations and that any resubmitted notice shall be considered to be a new notice. The Bureau shall send a reminder to the notifying administration not later than two months prior to the deadline for the payment in accordance with the above-mentioned Council Decision 482 unless the payment has already been received. (WRC-23)

[7] **A.11.7** In respect of submissions for Regions 1 and 3 satellite networks in the broadcasting-satellite service in the frequency band 21.4-22 GHz meeting special requirements, Resolution **554 (WRC-12)** applies. (WRC-12)

Section I – Notification

11.1 The expression "frequency assignment", wherever it appears in this Article, shall be understood to refer either to a new frequency assignment or to a change in an assignment already recorded in the Master International Frequency Register (hereinafter called the *Master Register*).

11.2 Any frequency assignment to a transmitting station and to its associated receiving stations except for those mentioned in Nos. **11.13** and **11.14** shall be notified to the Bureau:

11.3 *a)* if the use of that assignment is capable of causing harmful interference to any service of another administration; or

11.3A (SUP - WRC-07)

11.4 *b)* if that assignment is to be used for international radiocommunication; or

11.5 *c)* if that assignment is subject to a world or regional frequency allotment or assignment plan which does not have its own notification procedure; or

11.6 *d)* if that assignment is subject to the coordination procedure of Article **9** or is involved in such a case; or

11.7 *e)* if it is desired to obtain international recognition for that assignment; or

11.8 *f)* if it is a non-conforming assignment under No. **8.4** and if the administration wishes to have it recorded for information.

11.9 Similar notification shall be made for a frequency assignment to a receiving earth station or space station, or to a receiving high-altitude platform station in the fixed service using the frequency bands mentioned in Nos. **5.457**, **5.534A**, **5.543B**, **5.550D** and **5.552A** or to a land station for reception from mobile stations, when: (WRC-19)

11.10 *a)* any of the conditions in Nos. **11.4**, **11.5** or **11.7** apply to the receiving station; or

11.11 *b)* any of the conditions in No. **11.2** apply to the associated transmitting station.

11.12 Any frequency to be used for reception by a particular radio astronomy station may be notified if it is desired that such data be included in the Master Register.

11.13 Assignments involving specific frequencies which are prescribed by these Regulations for common use by terrestrial stations of a given service shall not be notified. They shall be entered in the Master Register and a consolidated table shall also be published in the Preface to the International Frequency Information Circular (BR IFIC). (WRC-19)

11.14 Frequency assignments to ship stations and to mobile stations of other services, to stations in the amateur service, to earth stations in the amateur-satellite service, and those to broadcasting stations in the high-frequency bands allocated to the broadcasting service between 5 900 kHz and 26 100 kHz which are subject to Article **12** shall not be notified under this Article.

11.15 When notifying a frequency assignment, the administration[8] shall provide the relevant characteristics listed in Appendix **4**. (WRC-07)

11.16 Not used.

11.17 Frequency assignments relating to a number of stations or earth stations may be notified in the form of the characteristics of a typical station or a typical earth station and the intended geographical area of operation. Except for mobile earth stations, individual notices of frequency assignments are however necessary in the following cases (see also No. **11.14**):

11.18 *a)* stations covered by the Allotment Plans in Appendices **25**, **26** and **27**;

11.19 *b)* broadcasting stations;

11.20 *c)* terrestrial stations within the coordination area of an earth station;[9]

11.21 *d)* any terrestrial stations in bands shared with space services which exceed the limits specified in Tables 8a, 8b, 8c and 8d of Appendix **7** and in No. **21.3**;[9]

11.21A *e)* any terrestrial stations in bands listed in Table **21-2**;[9]

11.21B *f)* any terrestrial station in bands referred to in a footnote which includes a reference to No. **9.21**, if it pertains to a service which is subject to the application of the procedure for seeking agreement under No. **9.21**; (WRC-03)

11.22 *g)* earth stations whose coordination area includes the territory of another administration, or where the earth station is located within the coordination area of an earth station operating in the opposite direction of transmission;[9, 10] (WRC-03)

11.23 *h)* earth stations whose interference potential is greater than that of a coordinated typical earth station.[9] (WRC-03)

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[8] **11.15.1** A frequency assignment to a space station or typical earth station as part of the satellite network may be notified by one administration acting on behalf of a group of named administrations. Any further notice (modification or deletion) relating to such an assignment shall, in the absence of information to the contrary, be regarded as having been submitted on behalf of the entire group.

[9] **11.20.1**, **11.21.1**, **11.21A.1**, **11.22.1** and **11.23.1** In such cases, individual notices of frequency assignments are required for frequency bands allocated with equal rights to terrestrial and space services where coordination is required under Appendix **5**, Table 5-1.

[10] **11.22.2** In such cases, individual notices of frequency assignments are required for frequency bands allocated with equal rights to space services, in the opposite direction of transmission, where coordination is required under Appendix **5**, Table 5-1.

11.24 Notices relating to assignments to stations of terrestrial services, except for those referred to in Nos. **11.25**, **11.26** or **11.26A**, shall reach the Bureau not earlier than three months before the assignments are brought into use. (WRC-03)

11.25 Notices relating to assignments to stations in space services, and to terrestrial stations involved in coordination with a satellite network, shall reach the Bureau not earlier than three years before the assignments are brought into use.

11.26 Notices relating to assignments for high-altitude platform stations in the fixed service in the frequency bands identified in Nos. **5.457**, **5.537A**, **5.530E**, **5.532AA**, **5.534A, 5.543B**, **5.550D** and **5.552A** shall reach the Bureau not earlier than five years before the assignments are brought into use. (WRC-19)

11.26A Notices relating to assignments of high-altitude platform station as International Mobile Telecommunications base station in the frequency bands identified in Nos. **5.312B**, **5.314A**, **5.388A** and **5.409A** shall reach the Bureau not earlier than three years before the assignments are brought into use. (WRC-23)

Section II – Examination of notices and recording of frequency assignments in the Master Register

11.27 Notices not containing those characteristics specified in Appendix **4** as mandatory or required shall be returned with comments to help the notifying administration to complete and resubmit them, unless the information not provided is immediately forthcoming in response to an inquiry by the Bureau.

11.28 Complete notices shall be marked by the Bureau with their date of receipt and shall be examined in the date order of their receipt. On receipt of a complete notice the Bureau shall, within no more than two months, publish its contents, with any diagrams and maps and the date of receipt, in the BR IFIC which shall constitute the acknowledgement to the notifying administration of receipt of its notice[11]. When the Bureau is not in a position to comply with the time limit referred to above, it shall periodically so inform the administrations, giving the reasons therefor. (WRC-12)

11.29 The Bureau shall not postpone the formulation of a finding on a complete notice unless it lacks sufficient data to reach a conclusion thereon. Moreover, the Bureau shall not act upon any notice having a technical bearing on an earlier notice which is still under consideration by the Bureau until it has reached a finding with respect to the earlier notice.

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[11] **11.28.1** In case of satellite networks or systems not subject to the coordination procedure under Section II of Article **9**, an administration believing that unacceptable interference may be caused to its existing or planned satellite networks or systems by submitted modifications to the characteristics initially published under No. **9.2B** may provide its comments to the notifying administration with copy to the Bureau. The Bureau shall publish any such comments received on its website. Both administrations shall thereafter cooperate to resolve any difficulties. (WRC-23)

11.30 Each notice shall be examined:

11.31 *a)* with respect to its conformity with the Table of Frequency Allocations[12] and the other provisions[13] of these Regulations, except those relating to conformity with the procedures for obtaining coordination or the probability of harmful interference, or those relating to conformity with a plan, as appropriate, which are the subject of the following sub-paragraphs;[14]

11.32 *b)* with respect to its conformity with the procedures relating to coordination with other administrations applicable to the radiocommunication service and the frequency band concerned; or

11.32A *c)* with respect to the probability of harmful interference that may be caused to or by assignments recorded with a favourable finding under Nos. **11.36** and **11.37** or **11.38**, or recorded in application of No. **11.41**, or published under Nos. **9.38** or **9.58** but not yet notified, as appropriate, for those cases for which the notifying administration states that the procedure for coordination under Nos. **9.7**, **9.7A**, **9.7B**, **9.11**, **9.12**, **9.12A**, **9.13** or **9.14**, could not be successfully completed (see also No. **9.65**);[15, 16] or (WRC-15)

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[12] **11.31.1** Conformity with the Table of Frequency Allocations implies the successful application of No. **9.21**, when necessary. However, the recording of the assignment with respect to those objecting administration(s) whose agreement(s) have not been obtained will be with a favourable finding, subject to the condition that the assignment in question shall not cause harmful interference to nor claim protection from the service(s) of the objecting administration(s) from which the agreement was sought. With respect to the administration(s) which have not objected under No. **9.21**, the recording of the assignment shall also be made with a favourable finding. (WRC-03)

[13] **11.31.2** The "other provisions" shall be identified and included in the Rules of Procedure.

[14] **11.31.3** Notices relating to radio astronomy stations are examined with respect to No. **11.31** only.

[15] **11.32A.1** The examination of such notices with respect to any other frequency assignment for which a request for coordination under Nos. **9.7**, **9.7A**, **9.7B**, **9.12**, **9.12A** or **9.13**, as appropriate, has been published under No. **9.38** but not yet notified shall be effected by the Bureau in the order of their publication under the same number using the most recent information available. (WRC-2000)

[16] **11.32A.2** For the application of No. **11.32A** with respect to the procedure for coordination under No. **9.7** in the frequency bands 5 725-5 850 MHz (Region 1), 5 850-6 725 MHz and 7 025-7 075 MHz (Earth-to-space) for satellite networks having a nominal orbital separation in the geostationary-satellite orbit of more than 7°, and in the frequency bands 10.95-11.2 GHz, 11.45-11.7 GHz, 11.7-12.2 GHz (Region 2), 12.2-12.5 GHz (Region 3), 12.5-12.7 GHz (Regions 1 and 3) and 12.7-12.75 GHz (space-to-Earth) and 13.75-14.5 GHz (Earth-to-space) for satellite networks having a nominal orbital separation in the geostationary-satellite orbit of more than 6°, Resolution **762 (WRC-15)** shall apply. For other cases, the methodology shall be identified and included in the Rules of Procedure, if so required. (WRC-15)

11.33 *d)* with respect to the probability of harmful interference that may be caused to or by other assignments recorded with a favourable finding in application of Nos. **11.36** and **11.37** or **11.38** or in application of No. **11.41**, as appropriate, for those cases for which the notifying administration states that the procedure for coordination or prior agreement under Nos. **9.15**[17], **9.16**[17] **9.17**[17] **9.17A** or **9.18**[17] could not be successfully completed (see also No. **9.65**);[18] or (WRC-2000)

11.34 *e)* where appropriate, with respect to its conformity with a world or regional allotment or assignment plan and the associated provisions.

11.35 In cases where the Bureau is not in a position to conduct the examination under No. **11.32A** or **11.33**, the Bureau shall immediately inform the notifying administration, which may then resubmit its notice under No. **11.41**, under the assumption that the finding under No. **11.32A** or **11.33** is unfavourable. (WRC-2000)

11.36 When the examination with respect to No. **11.31** leads to a favourable finding, the assignment shall be recorded in the Master Register or examined further with respect to Nos. **11.32** to **11.34**, as appropriate. When the finding with respect to No. **11.31** is unfavourable, the assignment shall be recorded in the Master Register for information purposes and subject to application of No. **8.5**, only if the administration undertakes that it will be operated in accordance with No. **4.4**; otherwise the notice shall be returned with an indication of the appropriate action.

11.37 When the examination with respect to No. **11.32** leads to a favourable finding, the assignment shall be recorded in the Master Register indicating the administrations with which the coordination procedure has been completed[19, 20]. When the finding is unfavourable, the notice shall be returned to the notifying administration, with an indication of the appropriate action, if Nos. **11.32A** or **11.33** do not apply. (WRC-12)

11.38 When the examination with respect to Nos. **11.32A** or **11.33** leads to a favourable finding, the assignment shall be recorded in the Master Register indicating the names of the administrations with which coordination was completed and those with which it was not completed but in respect of which the finding was favourable. When the finding is unfavourable, the notice shall be returned with an indication of the appropriate action.

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[17] **11.33.1** When typical earth stations are involved, administrations are required to furnish the necessary information to enable the Bureau to effect the examination.

[18] **11.33.2** The examination under No. **11.33** shall also take into account assignments for terrestrial services which are in use or which are to be brought into use within the next three years and have been communicated to the Bureau as a result of continuing disagreement in coordination.

[19] **11.37.1** When the agreement of the administrations affected has been obtained only for a specified period, the Bureau shall be notified accordingly and the frequency assignment shall be recorded in the Master Register with a note indicating that the frequency assignment is valid only for the period specified. The notifying administration using the frequency assignment over a specified period shall not subsequently use this circumstance to justify continued use of the frequency beyond the period specified if it does not obtain the agreement of the administration(s) concerned.

[20] **11.37.2** When a frequency assignment to a space station in the broadcasting-satellite service in a non-planned band other than the frequency band 21.4-22 GHz is recorded in the Master Register, a note shall be entered in the remarks column indicating that such recording does not prejudge in any way the decisions to be included in the agreements and associated plans referred to in Resolution **507 (Rev.WRC-19)**. (WRC-19)

11.39 When the examination with respect to No. **11.34** leads to a favourable finding, the assignment shall be recorded in the Master Register. When the finding is unfavourable, the notice shall be returned to the notifying administration, with an indication of the appropriate action. However, notices under Appendices **25**, **26** or **27** which are in accordance with the technical principles of the relevant appendix but not with the associated allotment plan shall be treated as follows: (WRC-03)

11.39A In the case of a notice in conformity with the technical principles of Appendix **27**, but not in conformity with the Allotment Plan, the Bureau shall examine whether the protection specified in Appendix **27** is afforded to the allotments in the Plan and to assignments already recorded in the Master Register with a favourable finding.

11.39B When the examination under No. **11.39A** leads to a favourable finding, the assignment shall be recorded in the Master Register. When the finding is unfavourable, the assignment shall be recorded in the Master Register with a symbol indicating that it shall cause no harmful interference to any frequency assignment which is either in conformity with the Allotment Plan or recorded in the Master Register with a favourable finding with respect to No. **11.39A**.

11.39C A notice in conformity with the technical principles of Appendix **26**, but not in conformity with the Allotment Plan, shall be examined with respect to the allotments in Part III of Appendix **26**.

11.39D When the examination under No. **11.39C** leads to a favourable finding, the assignment shall be recorded in the Master Register. When the finding is unfavourable, the assignment shall be recorded in the Master Register with a symbol indicating that it shall cause no harmful interference to any frequency assignment which is either in conformity with the Allotment Plan or recorded in the Master Register with a favourable finding with respect to No. **11.39C**.

11.39E In the case of a notice not in conformity with the Allotment Plan of Appendix **25**, the assignment may be recorded provisionally in the Master Register on the condition that the administration has initiated the procedure of Appendix **25** in accordance with § **25**/1.23 of Section I of Appendix **25**.

11.39F A notice which is not in conformity with the technical principles of Appendices **25**, **26** or **27**, as applicable, shall be returned to the notifying administration, unless the administration undertakes that it will be operated in accordance with No. **4.4**; in such a case the assignment shall be recorded in the Master Register for information purposes and subject to application of No. **8.5**. (WRC-03)

11.40 Not used.

11.41 After a notice is returned under No. **11.38**, should the notifying administration resubmit the notice[21] and insist upon its reconsideration, the Bureau shall enter the assignment in the Master Register with an indication of those administrations whose assignments were the basis of the unfavourable finding (see also No. **11.42** below). (WRC-12)

11.41.1 (SUP - WRC-12)

[21] **11.41.2** When submitting notices in application of No. **11.41**, the notifying administration shall indicate to the Bureau that efforts have been made to effect coordination with those administrations whose assignments were the basis of the unfavourable findings under No. **11.38**, without success. (WRC-12)

11.41A Should the assignments that were the basis of the unfavourable finding under Nos. **11.32A** or **11.33** not be brought into use within the period specified in Nos. **11.24**, **11.25** or **11.44**, as appropriate, then the finding of the assignments resubmitted under No. **11.41** shall be reviewed accordingly.

11.41B Should the coordination procedure specified in No. **11.32** be completed with an administration whose assignments were the basis for the recording made under No. **11.41**, then, based on the updated information sent by the notifying administration, the relevant remarks or indications relating to assignments for which an unfavourable finding led to their recording under No. **11.41** shall be removed. (WRC-12)

11.42 Should harmful interference actually be caused by an assignment recorded under No. **11.41** to any recorded assignment which was the basis of the unfavourable finding, the administration responsible for the station using the frequency assignment recorded under No. **11.41** shall, upon receipt of a report providing the particulars relating to the harmful interference[22], immediately eliminate this harmful interference. (WRC-12)

11.42A In applying No. **11.42** with respect to satellite networks, administrations involved shall cooperate in the elimination of harmful interference and may request the assistance of the Bureau, and shall exchange relevant technical and operational information required to resolve the issue. Should any administration involved in the matter inform the Bureau that all efforts to resolve the harmful interference have failed, the Bureau shall immediately inform other involved administrations and prepare a report, together with all necessary supporting documents (including comments from the administrations involved), for the next meeting of the Board for its consideration and any required action (including the possible cancellation of the assignment recorded under No. **11.41**), as appropriate. The Bureau shall thereafter implement the decision of the Board and inform the administrations concerned. (WRC-12)

11.43 In every case when a new assignment is recorded in the Master Register it shall, in accordance with the provisions of Article **8** of this Chapter, include an indication of the finding reflecting the status of the assignment. This information shall also be published in the BR IFIC.

11.43A A notice of a change in the characteristics of an assignment already recorded, as specified in Appendix **4**, shall be examined by the Bureau under Nos. **11.31** to **11.34**, as appropriate. Any change to the characteristics of an assignment that has been recorded and confirmed as having been brought into use shall be brought into use within five years from the date of the notification of the modification. Any change to the characteristics of an assignment that has been recorded but not yet brought into use shall be brought into use within the period provided for in No. **11.44**. (WRC-07)

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[22] **11.42.1** When providing the particulars relating to the harmful interference under No. **11.42**, administrations involved shall use, to the maximum extent possible, the format prescribed in Appendix **10** of the Radio Regulations. (WRC-12)

11.43B In the case of a change in the characteristics of an assignment which is in conformity with No. **11.31**, should the Bureau reach a favourable finding with respect to Nos. **11.32** to **11.34**, as appropriate, or find that the changes do not increase the probability of harmful interference to assignments already recorded, the amended assignment shall retain the original date of entry in the Master Register. The date of receipt by the Bureau of the notice relating to the change shall be entered in the Master Register.

11.43C Where the notifying administration resubmits the notice and the Bureau finds that the coordination procedures specified in No. **11.32** have been successfully completed with all administrations whose space or terrestrial radiocommunication stations may be affected, the assignment shall be recorded in the Master Register. The date of receipt by the Bureau of the original notice shall be entered in the appropriate column of the Master Register. The date of receipt by the Bureau of the resubmitted notice shall be entered in the "Remarks" column.

11.43D Where the notifying administration resubmits the notice with a request that the Bureau effect the required coordination under Nos. **9.7** to **9.19**, the Bureau shall take the necessary action in accordance with the relevant provisions of Articles **9** and **11**, as appropriate. However, in any subsequent recording of the assignment, the date of receipt by the Bureau of the resubmitted notice shall be entered in the "Remarks" column.

11.44 The notified date[23, 24, 25] of bringing into use of any frequency assignment to a space station of a satellite network or system shall be not later than seven years following the date of receipt by the Bureau of the relevant complete information under No. **9.1** or **9.2** in the case of satellite networks or systems not subject to Section II of Article **9** or under No. **9.30** in the case of satellite networks or systems subject to Section II of Article **9**. Any frequency assignment not brought into use within the required period shall be cancelled by the Bureau after having informed the administration at least three months before the expiry of this period. (WRC-23)

11.44A A notice not conforming to No. **11.44** shall be returned to the notifying administration with a recommendation to restart the advance publication procedure or the coordination procedure, as appropriate. (WRC-23)

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[23] **11.44.1** In the case of space station frequency assignments that are brought into use prior to the completion of the coordination process, and for which the Resolution **49 (Rev.WRC-23)** or Resolution **552 (Rev.WRC-23)** data, as appropriate, have been submitted to the Bureau, the assignment shall continue to be taken into consideration for a maximum period of seven years from the date of receipt of the relevant information under No. **9.30**. If the first notice for recording of the assignments in question under No. **11.15** related to No. **9.1** or No. **9.30** has not been received by the Bureau by the end of this seven-year period, the assignments shall be cancelled by the Bureau after having informed the notifying administration of its pending actions six months in advance. (WRC-23)

[24] **11.44.2** The notified date of bringing into use of a frequency assignment to a space station of a satellite network or system shall be the date of the commencement of the continuous period defined in No. **11.44B** or No. **11.44C**, or the date of deployment as defined in No. **11.44D** or No. **11.44E**, as applicable. (WRC-19)

[25] **11.44.3**, **11.44B.1**, **11.44C.2**, **11.44D.2** and **11.44E.1** Upon receipt of this information and whenever it appears from reliable information available that a notified frequency assignment has not been brought into use in accordance with No. **11.44**, No. **11.44B**, No. **11.44C**, No. **11.44D** or No. **11.44E**, as the case may be, the consultation procedures and subsequent applicable course of action prescribed in No. **13.6** shall apply, as appropriate. (WRC-19)

11.44B A frequency assignment to a space station in the geostationary-satellite orbit shall be considered as having been brought into use when a space station in the geostationary-satellite orbit with the capability of transmitting or receiving that frequency assignment has been deployed and maintained at the notified orbital position for a continuous period of 90 days. The notifying administration shall so inform the Bureau within 30 days from the end of the 90-day period[25, 26, 26*bis*]. On receipt of the information sent under this provision, the Bureau shall make that information available on the ITU website as soon as possible and shall publish it in the BR IFIC. Resolution **40 (Rev.WRC-19)** shall apply. (WRC-23)

11.44C A frequency assignment to a space station in a non-geostationary-satellite orbit network or system in the fixed-satellite service, the mobile-satellite service or the broadcasting-satellite service shall be considered as having been brought into use when a space station with the capability of transmitting or receiving that frequency assignment has been deployed and maintained on one of the notified orbital plane(s)[27] of the non-geostationary satellite network or system for a continuous period of 90 days, irrespective of the notified number of orbital planes and satellites per orbital plane in the network or system. The notifying administration shall so inform the Bureau within 30 days from the end of the 90-day period[25, 26*bis*, 28, 29]. On receipt of the information sent under this provision, the Bureau shall make that information available on the ITU website as soon as possible and shall publish it in the BR IFIC subsequently. (WRC-23)

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[26] **11.44B.2** A frequency assignment to a space station in the geostationary-satellite orbit with a notified date of bringing into use more than 120 days prior to the date of receipt of the notification information shall also be considered as having been brought into use if the notifying administration confirms, when submitting the notification information for this assignment, that a space station in the geostationary-satellite orbit with the capability of transmitting or receiving that frequency assignment has been deployed and maintained for a continuous period of time from the notified date of bringing into use until the date of receipt of the notification information for this frequency assignment. (WRC-15)

[26*bis*] **11.44B.3** and **11.44C.5** If the notifying administration has informed the Bureau of the date of commencement of the 90-day bringing-into-use period, but, as of 15 days after the end of the 90-day bringing-into-use period, has not yet informed the Bureau of the completion of the bringing-into-use period in accordance with Nos. **11.44B** or **11.44C**, the Bureau shall promptly send the notifying administration a reminder of its obligation to inform the Bureau of the completion of the bringing-into-use period under Nos. **11.44B** or **11.44C**. (WRC-23)

[27] **11.44C.1** and **11.44D.1** For the purposes of No. **11.44C** or No. **11.44D**, the term "notified orbital plane" means an orbital plane of the non-geostationary-satellite system, as provided to the Bureau in the most recent notification information for the system's frequency assignments, that corresponds to Items A.4.b.4.a, A.4.b.4.d, A.4.b.4.e and A.4.b.4.i (only for orbits whose altitudes of the apogee and perigee are different) in Table A of Annex 2 to Appendix **4**. For the purposes of No. **11.44C**, Resolution **8 (WRC-23)** shall apply. (WRC-23)

[28] **11.44C.3** A frequency assignment to a space station in a non-geostationary-satellite orbit with a notified date of bringing into use more than 120 days prior to the date of receipt of the notification information shall also be considered as having been brought into use if the notifying administration confirms, when submitting the notification information for this assignment, that a space station in a non-geostationary-satellite orbit with the capability of transmitting or receiving that frequency assignment has been deployed and maintained on one of the notified orbital planes as provided for in No. **11.44C** for a continuous period of time from the notified date of bringing into use until the date of receipt of the notification information for this frequency assignment. (WRC-19)

[29] **11.44C.4** and **11.44D.3** For the purposes of Nos. **11.44C** and **11.44D**, when the notifying administration informs the Bureau of the bringing into use, it shall identify the orbital plane number as in the latest notification information received by the Bureau that corresponds to the orbital plane in which the space station has been deployed to bring into use the frequency assignments. (WRC-19)

11.44D A frequency assignment to a space station in a non-geostationary satellite orbit network or system with "Earth" as the reference body, other than a frequency assignment to which No. **11.44C** applies, shall be considered as having been brought into use when a space station with the capability of transmitting or receiving that frequency assignment has been deployed on one of the notified orbital plane(s)[27] of the non-geostationary satellite network or system, irrespective of the notified number of orbital planes and satellites per orbital plane in the network or system. The notifying administration shall so inform the Bureau as soon as possible, but not later than 30 days after the end of the period referred to in No. **11.44**.[25, 29] On receipt of the information sent under this provision, the Bureau shall make that information available on the ITU website as soon as possible and shall publish it in the BR IFIC subsequently. (WRC-19)

11.44E A frequency assignment to a space station with a reference body that is not "Earth" shall be considered as having been brought into use when the notifying administration informs the Bureau that a space station with the capability of transmitting or receiving that frequency assignment has been deployed in accordance with the notification information. The notifying administration shall so inform the Bureau as soon as possible, but not later than 30 days after the end of the period referred to in No. **11.44**.[25] On receipt of the information sent under this provision, the Bureau shall make that information available on the ITU website as soon as possible and shall publish it in the BR IFIC subsequently. (WRC-19)

11.44F (SUP - WRC-03)

11.44G (SUP - WRC-03)

11.44H (SUP - WRC-03)

11.44I (SUP - WRC-03)

11.45 The notified date of bringing into use of an assignment to a terrestrial station will be extended at the request of the notifying administration by not more than six months.

11.46 In applying the provisions of this Article, any resubmitted notice which is received by the Bureau more than six months after the date on which the original notice was returned by the Bureau shall be considered to be a new notification with a new date of receipt[30]. For frequency assignments to a space station, should the new date of receipt of such a notice not comply with the period specified in No. **11.44.1** or No. **11.43A**, as appropriate, the notice shall be returned to the notifying administration in the case of No. **11.44.1**, and the notice shall be examined as a new notice of a change in the characteristics of an assignment already recorded with a new date of receipt in the case of No. **11.43A**. The Bureau shall appropriately reflect the resubmission on the ITU website within 30 days of receipt. (WRC-19)

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[30] **11.46.1** If the resubmitted notice is not received by the Bureau within four months from the date on which the original notice was returned by the Bureau, the Bureau shall promptly send a reminder to the notifying administration. (WRC-19)

11.47 All frequency assignments notified in advance of their being brought into use shall be entered provisionally in the Master Register. Any frequency assignment to a space station provisionally recorded under this provision shall be brought into use no later than the end of the period provided under No. **11.44**. Any other frequency assignment provisionally recorded under this provision shall be brought into use by the date specified in the notice, or by the end of the extension period granted under No. **11.45**, as the case may be. Unless the Bureau has been informed by the notifying administration of the bringing into use of the assignment, it shall, no later than fifteen days before either the notified date of bringing into use, in the case of an earth station, or the end of the regulatory period established under No. **11.44** or No. **11.45**, as appropriate, send a reminder requesting confirmation that the assignment has been brought into use within that regulatory period. If the Bureau does not receive that confirmation within thirty days following the notified date of bringing into use, in the case of an earth station, or the period provided under No. **11.44** or No. **11.45**, as the case may be, it shall cancel the entry in the Master Register. The Bureau shall, however, inform the administration concerned before taking such action. (WRC-07)

11.48 If, after the expiry of the period of seven years from the date of receipt of the relevant complete information referred to in No. **9.1** or **9.2** in the case of satellite networks or systems not subject to Section II of Article **9** or in No. **9.30** in the case of satellite networks or systems subject to Section II of Article **9**, the administration responsible for the satellite network has not brought the frequency assignments to stations of the network into use, or has not submitted the first notice for recording of the frequency assignments under No. **11.15**, or, where required, has not provided the due diligence information pursuant to Resolution **49 (Rev.WRC-23)**, as appropriate, the corresponding information published under Nos. **9.2B** and **9.38**, as appropriate, shall be cancelled, but only after the administration concerned has been informed at least six months before the expiry date referred to in Nos. **11.44** and **11.44.1** and, where required, § 10 of Annex 1 of Resolution **49 (Rev.WRC-23)**[31]. (WRC-23)

[31] **11.48.1** If the information pursuant to Resolution **552 (Rev.WRC-23)** has not been provided, the corresponding information published under No. **9.38** shall be cancelled 30 days after the end of the seven-year period following the date of receipt by the Bureau of the relevant complete information under No. **9.30**. (WRC-23)

11.49 Wherever the use of a recorded frequency assignment to a space station of a satellite network or to all space stations of a non-geostationary-satellite system is suspended for a period exceeding six months, the notifying administration shall inform the Bureau of the date on which such use was suspended. When the recorded assignment is brought back into use, the notifying administration shall, subject to the provisions of Nos. **11.49.1**, **11.49.2**, **11.49.3** or **11.49.4**, as applicable, so inform the Bureau, as soon as possible. On receipt of the information sent under this provision, the Bureau shall make that information available as soon as possible on the ITU website and shall publish it in the BR IFIC. The date on which the recorded assignment is brought back into use[32, 32*bis*, 33, 34, 35, 36] shall be not later than three years from the date on which the use of the frequency assignment was suspended, provided that the notifying administration informs the Bureau

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[32] **11.49.1** The date of bringing back into use of a frequency assignment to a space station in the geostationary-satellite orbit shall be the date of the commencement of the 90-day period defined below. A frequency assignment to a space station in the geostationary-satellite orbit shall be considered as having been brought back into use when a space station in the geostationary-satellite orbit with the capability of transmitting or receiving that frequency assignment has been deployed and maintained at the notified orbital position for a continuous period of 90 days. The notifying administration shall so inform the Bureau within 30 days from the end of the 90-day period. Resolution **40 (Rev.WRC-19)** shall apply. (WRC-19)

[32*bis*] **11.49.1A** and **11.49.2A** If the notifying administration has informed the Bureau of the date of commencement of the 90-day bringing-back-into-use period, but, as of 15 days after the end of the 90-day bringing-back-into-use period, has not yet informed the Bureau of the completion of the bringing-back-into-use period in accordance with Nos. **11.49.1** or **11.49.2**, the Bureau shall promptly send the notifying administration a reminder of its obligation to inform the Bureau of the completion of the bringing-back-into-use period under Nos. **11.49.1** or **11.49.2**, as applicable. (WRC-23)

[33] **11.49.2** The date of bringing back into use of a frequency assignment to a space station in a non-geostationary-satellite orbit network or system in the fixed-satellite service, the mobile-satellite service or the broadcasting-satellite service shall be the date of the commencement of the 90-day period defined below. A frequency assignment to such a space station shall be considered as having been brought back into use when a space station with the capability of transmitting or receiving that frequency assignment has been deployed and maintained on one of the notified orbital plane(s) (see No. **11.49.5**) of the non-geostationary-satellite network or system for a continuous period of 90 days, irrespective of the notified number of orbital planes and satellites per orbital plane in the network or system. The notifying administration shall so inform the Bureau within 30 days from the end of the 90-day period. When the notifying administration informs the Bureau of the bringing back into use, it shall identify the orbital plane number as in the latest notification information received by the Bureau that corresponds to the orbital plane in which the space station has been deployed to bring back into use the frequency assignments. (WRC-19)

[34] **11.49.3** A frequency assignment to a space station in a non-geostationary-satellite orbit network or system with "Earth" as the reference body, other than a frequency assignment to which No. **11.49.2** applies, shall be considered as having been brought back into use when a space station with the capability of transmitting or receiving that frequency assignment has been deployed on one of the notified orbital plane(s) (see No. **11.49.5**) of the non-geostationary-satellite network or system, irrespective of the notified number of orbital planes and satellites per orbital plane in the network or system. The notifying administration shall so inform the Bureau not later than 30 days after the end of the suspension period referred to in No. **11.49**. When the notifying administration informs the Bureau of the bringing back into use, it shall identify the orbital plane number as in the latest notification information received by the Bureau that corresponds to the orbital plane in which the space station has been deployed to bring back into use the frequency assignments. (WRC-19)

[35] **11.49.4** A frequency assignment to a space station with a reference body that is not "Earth" shall be considered as having been brought back into use when the notifying administration informs the Bureau that a space station with the capability of transmitting or receiving that frequency assignment has been deployed and operated in accordance with the notification information. The notifying administration shall so inform the Bureau not later than 30 days after the end of the suspension period referred to in No. **11.49**. (WRC-19)

[36] **11.49.5** For the purposes of Nos. **11.49.2** and **11.49.3**, the term "notified orbital plane" means an orbital plane of the non-geostationary-satellite system, as provided to the Bureau in the most recent notification information for the system's frequency assignments, that corresponds to Items A.4.b.4.a, A.4.b.4.d, A.4.b.4.e and A.4.b.4.i (only for orbits whose altitudes of the apogee and perigee are different) in Table A of Annex 2 to Appendix **4**. For the purposes of No. **11.49.2**, Resolution **8 (WRC-23)** shall apply. (WRC-23)

of the suspension within six months from the date on which the use was suspended. If the notifying administration informs the Bureau of the suspension more than six months after the date on which the use of the frequency assignment was suspended, this three-year time period shall be reduced. In this case, the amount by which the three-year period shall be reduced shall be equal to the amount of time that has elapsed between the end of the six-month period and the date that the Bureau is informed of the suspension. If the notifying administration informs the Bureau of the suspension more than 21 months after the date on which the use of the frequency assignment was suspended, the frequency assignment shall be cancelled. Ninety days before the end of the period of suspension, the Bureau shall send a reminder to the notifying administration. If the Bureau does not receive the declaration of the commencement of the bringing-back-into-use period within thirty days following the limit date of the period of suspension established in accordance with this provision, it shall cancel the entry in the Master Register. The Bureau shall, however, inform the administration concerned before taking such action. (WRC-23)

11.50 The Bureau shall review periodically the Master Register with the aim of maintaining or improving its accuracy, with particular emphasis on the review of the findings so as to adjust them to the changing allocation situation after each conference. (WRC-03)

Section III – Maintenance of the recording of frequency assignments to non-geostationary-satellite systems in the Master Register (WRC-19)

11.51 For frequency assignments to some non-geostationary-satellite systems in specific frequency bands and services, Resolution **35 (Rev.WRC-23)** and Resolution **8 (WRC-23)** shall apply. (WRC-23)

ARTICLE 12

Seasonal planning of the HF bands allocated to the broadcasting service between 5 900 kHz and 26 100 kHz

Section I – Introduction

12.1 The use of the frequency bands allocated to high frequency broadcasting (HFBC) between 5 900 kHz and 26 100 kHz shall be based on the principles given below and shall be in conformity with seasonal planning based on a coordination procedure between administrations (referred in this Article as the Procedure) described in **12.2** to **12.45**. An administration may authorize a broadcasting organization (referred to in this Article as a broadcaster), among others, to act on its behalf in this coordination.

Section II – Principles

12.2 § 1 The Procedure shall be based on the principle of equal rights of all countries, large or small, to equitable access to these bands. Attempts shall also be made to achieve efficient use of these frequency bands, account being taken of the technical and economic constraints that may exist in certain cases. On the basis of the foregoing, the following principles shall be applied.

12.3 § 2 All broadcasting requirements, formulated by administrations, shall be taken into account and treated on an equitable basis, so as to guarantee the equality of rights referred to in No. **12.2**, and to enable each administration to provide a satisfactory service.

12.4 § 3 The Procedure shall be based solely on the broadcasting requirements expected to become operational during the schedule period. It shall furthermore be flexible in order to take into account new broadcasting requirements and modifications to existing broadcasting requirements.

12.5 § 4 All broadcasting requirements, national[1] and international, shall be treated on an equal basis, with due consideration of the differences between these two kinds of broadcasting requirements.

12.6 § 5 In the Procedure, an attempt shall be made to ensure, as far as practicable, continuity of use of a frequency or of a frequency band.

12.7 § 6 The Procedure shall be based on double-sideband or single-sideband emissions. Other modulation techniques recommended by ITU-R shall be permitted in place of double-sideband or single-sideband emissions, provided that the level of interference caused to existing emissions is not increased.

12.8 § 7 To promote efficient spectrum use, the number of frequencies used shall be the minimum necessary to provide a satisfactory quality of reception. Whenever practicable, only one frequency should be used.

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[1] **12.5.1** An HF broadcasting requirement is considered as being for the purposes of national coverage when the transmitting station and its associated required service area are both located within the territory of the same country.

12.9 § 8 The Procedure shall include a technical analysis, as specified in the Radio Regulations Board Rules of Procedure.

12.10 § 9 The Procedure should encourage administrations or broadcasters empowered to make changes to pursue a continual coordination process to resolve incompatibilities, at meetings (regional[2] or worldwide, bilateral or multilateral) or by correspondence.

12.11 § 10 Regional coordination groups, which will facilitate bilateral and multilateral coordination among administrations and broadcasters in various regions of the world, shall identify themselves to the Bureau. Administrations and broadcasters shall be urged to participate in the relevant regional coordination groups. However, such participation would be on a voluntary basis.

12.12 § 11 When an administration, in particular the administration of a developing country, requests assistance in the application of the Procedure, the Bureau shall take appropriate action, including, if need be, coordination of the requirements submitted by the requesting administration.

12.13 § 12 The regional coordination groups should follow the coordination procedures prescribed in Section III. In the process of coordinating broadcasting requirements, an attempt shall be made to obtain agreement to the maximum number of submitted requirements with the quality level acceptable to administrations or broadcasters.

12.14 § 13 In order to ensure maximum success from the Procedure, administrations and broadcasters shall show the utmost goodwill and mutual cooperation, and give due consideration to all the relevant technical and operational factors involved.

Section III – The Procedure

12.15 The application of the Procedure shall be facilitated and coordinated by the Bureau as defined elsewhere in this Article.

12.16 Twice yearly, administrations shall submit their projected seasonal broadcasting schedules in the relevant frequency bands to the Bureau. These schedules shall cover the following seasonal periods:

12.17 Schedule A: Last Sunday in March to last Sunday in October.

12.18 Schedule B: Last Sunday in October to last Sunday in March.

12.19 Implementation of these schedules shall start at 0100 UTC.

12.20 If an administration considers it necessary to take account of propagation changes during the schedule period, it is recommended, for reasons of spectrum efficiency, that such requirements should be implemented on the following dates:

12.21 first Sunday in May;

12.22 first Sunday in September.

12.23 Implementation of these changes shall start at 0100 UTC on these dates.

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[2] **12.10.1** The word "regional" in this Article is not related to the ITU Regions.

12.24 Other start and stop dates within a schedule period may be used to accommodate requirements that have different schedule periods, e.g. special events, clock changes on different dates not coincident with the schedule period, etc.

12.25 Administrations may include assignments in their schedules up to one year in advance of their use.

12.26 In those cases where an administration does not indicate its requirements for a new seasonal schedule, the Bureau shall use the assignments from the previous corresponding seasonal schedule for this administration for the new schedule period. A note in the schedule shall be used to identify such requirements. The Bureau shall follow this practice for two consecutive schedule periods.

12.27 Following the action taken in No. **12.26**, the Bureau shall notify the administration concerned that the schedule will not include their broadcasting requirements unless the administration advises otherwise.

12.28 When an administration decides to cease its broadcasting service in the HF bands, it shall notify the Bureau of that decision.

12.29 The frequencies in the schedules should be those that will be used during the season concerned, and should be the minimum number required to provide satisfactory reception of the programmes in each of the areas and for each of the periods intended. In each schedule, to the maximum possible extent, the frequencies to be used in each reception area should remain unchanged from season to season.

12.30 Administrations are encouraged to coordinate their schedules with other administrations as far as possible prior to submission. An administration may, on behalf of a group of administrations, submit their coordinated schedules, the frequencies of which shall however have no priority for use over those submitted by other administrations.

12.31 The closing dates for receipt by the Bureau of the schedules relating to the two seasons referred to in No. **12.17** and **12.18** shall be established and published by the Bureau.

12.32 The schedules shall be submitted with the relevant data as specified in Appendix **4**.

12.33 Upon receipt of the schedules, the Bureau shall, in accordance with the Rules of Procedure, validate the data where necessary, perform a compatibility analysis and prepare the tentative high frequency broadcasting schedules (the Tentative Schedules). These Schedules shall include all assignments where administrations gave no alternatives, the selections made by the Bureau from any alternatives given, and the frequencies selected by the Bureau in cases where the need for its assistance was indicated by their intentional omission from the individual schedules. (WRC-03)

12.34 The Tentative Schedules shall be published two months and one month before the start of each of the two schedule periods in Nos. **12.17** and **12.18**. (WRC-03)

12.35 Administrations should examine the Tentative Schedule and should coordinate their frequency schedules to resolve or to minimize, as far as possible, any incompatibilities identified by the compatibility analysis, or by the monitoring results of similar assignments, or by a combination of both.

12.36 Coordination shall be achieved through bilateral or multilateral meetings of administrations or broadcasters or other means acceptable to the parties concerned.

12.37 Administrations, either jointly or separately, shall inform the Bureau, as quickly as possible, but no later than two weeks prior to the start of the schedule period, of any changes to their requirements resulting from the coordination process. The Bureau shall prepare a new consolidated high frequency broadcasting schedule (the Schedule), and shall perform a new compatibility analysis. The Bureau shall publish the Schedule and the results of the compatibility analysis at the start of the relevant broadcasting season.

12.38 Administrations shall notify the Bureau of changes to their schedules as quickly as possible and the Bureau shall update and make available the Schedule on a monthly basis. The Bureau shall perform new compatibility analyses and publish the updated Schedule and the results of these analyses at regular intervals during the season. (WRC-03)

12.39 To facilitate the coordination process, the Bureau shall also forward the schedules to the regional coordination groups.

12.40 Regional coordination groups should consider communicating with administrations and broadcasters through the use of any appropriate, mutually agreeable means, such as e-mail, news-groups, bulletin boards and other forms of electronic data transfer.

12.41 Each regional coordination group should consider appointing a steering committee to ensure smooth progress of the coordination process.

12.42 During and after the coordination process, the regional coordination groups shall exchange schedule data among themselves with a view to further enhancing the efficacy of the coordination process.

12.43 One month after the end of a season, the Bureau shall publish the final high frequency broadcasting schedule (the Final Schedule). If any changes have been notified to the Bureau since the previous consolidated Schedule, the Bureau shall also perform a compatibility analysis and publish it with the Final Schedule.

12.44 The Bureau should, as and when required, convene joint meetings of the representatives of all the regional coordination groups to develop strategies for further reduction of incompatibilities and to discuss related matters. The outcome of these meetings shall be circulated among the regional groups and administrations.

12.45 In a case of harmful interference involving the application of the provisions of Article **15**, administrations are urged to exercise the utmost goodwill and mutual cooperation, taking into account all the relevant technical and operational factors of the case.

ARTICLE 13

Instructions to the Bureau

Section 0 – Development of the Rules of Procedure and proposals to resolve inconsistencies encountered in the application of the Radio Regulations (WRC-03)

13.0.1 The Board shall develop a new Rule of Procedure only when there is a clear need with proper justification for such a Rule. For all such Rules, the Board shall submit to the coming world radiocommunication conference the necessary modifications to the Radio Regulations, to alleviate such difficulties or inconsistencies and include its suggestions in the Report of the Director to the next world radiocommunication conference. (WRC-03)

13.0.2 If such a need is not identified under No. **13.0.1**, the Board shall submit also to the coming world radiocommunication conference the necessary modifications to the Radio Regulations to alleviate such difficulties or inconsistencies. (WRC-03)

Section I – Assistance to administrations by the Bureau

13.1 When an administration has difficulty in applying the procedures of Articles **9** and **11** and Appendices **30**, **30A** and **30B**, the Bureau shall, upon request, endeavour to assist in such cases.

13.2 When an administration has difficulty in resolving a case of harmful interference and seeks the assistance of the Bureau, the latter shall, as appropriate, help in identifying the source of the interference and seek the cooperation of the responsible administration in order to resolve the matter, and prepare a report for consideration by the Board, including draft recommendations to the administrations concerned.

13.3 When an administration so requests, the Bureau shall, using such means at its disposal as are appropriate in the circumstances, conduct a study of reported cases of alleged contravention or non-observance of these Regulations and shall prepare a report for consideration by the Board, including draft recommendations to the administrations concerned.

Section II – Maintenance of the Master Register and of World Plans by the Bureau

13.4 The Bureau shall be solely responsible for maintenance of the Master Register in accordance with the Rules of Procedure, and shall:

13.5 *a)* following consultation with administrations, from time to time make any necessary adjustments to the format, structure and presentation of data in the Master Register;

13.6 *b)* whenever it appears from reliable information available that a recorded assignment has not been brought into use, or is no longer in use, or continues to be in use but not in accordance with the notified required characteristics[1] as specified in Appendix **4**, the Bureau shall consult the notifying administration and request clarification as to whether the assignment was brought into use in accordance with the notified characteristics or continues to be in use in accordance with the notified characteristics. Such a request shall include the reason for the query. In the event of a response and subject to the agreement of the notifying administration the Bureau shall cancel, suitably modify, or retain the basic characteristics of the entry. If the notifying administration does not respond within three months, the Bureau shall issue a reminder. In the event the notifying administration does not respond within one month of the first reminder, the Bureau shall issue a second reminder. In the event the notifying administration does not respond within one month of the second reminder, action taken by the Bureau to cancel the entry shall be subject to a decision of the Board. In the event of non-response or disagreement by the notifying administration, the entry will continue to be taken into account by the Bureau when conducting its examinations until the decision to cancel or modify the entry is made by the Board. In the event of a response, the Bureau shall inform the notifying administration of the conclusion reached by the Bureau within three months of the administration's response. When the Bureau is not in a position to comply with the three-month deadline referred to above, the Bureau shall so inform the notifying administration together with the reasons therefor. In case of disagreement between the notifying administration and the Bureau, the matter shall be carefully investigated by the Board, including taking into account submissions of additional supporting materials from administrations through the Bureau within the deadlines as established by the Board. The application of this provision shall not preclude the application of other provisions of the Radio Regulations. (WRC-19)

13.7 *c)* enter in the Master Register and publish in the Preface to the International Frequency Information Circular (BR IFIC) all frequencies prescribed by these Regulations for common use; (WRC-19)

13.8 *d)* make appropriate entries in the Master Register resulting from its examinations of frequency assignment notices in accordance with Article **11**;

13.9 *e)* maintain and periodically update the Preface to the BR IFIC. (WRC-19)

13.10 The Bureau shall also compile, for publication by the Secretary-General in the form of the BR IFIC, comprehensive listings of entries extracted from the Master Register and such other extracts as may periodically be required. (WRC-19)

13.11 The Bureau shall maintain master copies of all world frequency allotment or assignment plans contained in Appendices to these Regulations, or adopted by world conferences convened by the Union, including, where applicable, the carrier-to-interference ratios, or margins, as appropriate, associated with each assignment or allotment, and incorporating any modifications resulting from the successful application of the relevant modification procedure, and shall provide such copies in an appropriate form for publication by the Secretary-General when justified by circumstances.

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[1] **13.6.1** See also No. **11.51**, frequency assignments to non-geostationary-satellite systems recorded in the Master Register. (WRC-19)

Section III – Maintenance of the Rules of Procedure by the Bureau

13.12 The Board shall approve a set of Rules of Procedure to govern its own activities and those of the Bureau in the application of the Radio Regulations, to ensure the impartial, accurate and consistent processing of frequency assignment notices and to assist in the application of these Regulations.

13.12A In the preparation and development of the Rules of Procedure, the Board, the Bureau and administrations shall apply the following steps:

a) the Bureau shall also publish under No. **13.17**, on the ITU website, a list of future proposed Rules and the time-frame for their consideration by the Board and for comments by administrations on the list of future proposed Rules;

b) any practice used by the Bureau in the application of the provisions of the Radio Regulations shall be identified and proposed for inclusion in the Rules of Procedure in accordance with the procedures of this section;

c) all draft Rules prepared by the Bureau shall be available to administrations on the ITU website and by Circular Letter at least ten weeks prior to the start of the Board meeting;

d) any comments on these draft Rules of Procedure from administrations shall be submitted to the Bureau at least four weeks before the start of the Board meeting;

e) in submitting comments administrations should, if possible, suggest the actual text of their proposed Rules;

f) all comments from administrations shall be posted on the ITU website. However, those comments that do not meet the above time-limits shall not be considered by the Board;

g) any Rules of Procedure are to be in conformity with the spirit and principle of the Constitution, Convention and the Radio Regulations and shall avoid any relaxation to the application of the corresponding provisions of the Radio Regulation to which the Rules make reference. (WRC-03)

13.13 The Rules of Procedure shall include, *inter alia*, calculation methods and other data required for the application of these Regulations. These shall be based upon the decisions of world radiocommunication conferences and the Recommendations of the Radiocommunication Sector. Where requirements arise for new data for which there are no such decisions or Recommendations the Bureau shall develop such data in accordance with No. **13.14**, and shall revise them when appropriate decisions or Recommendations are available.

13.14 The Bureau shall submit to the Board the final drafts of all proposed changes to the Rules of Procedure. The Rules of Procedure approved by the Board shall be published and shall be open for comment by administrations. In case of continuing disagreement, the matter shall be submitted by the Director in his report, with the agreement of the concerned administration, to the next world radiocommunication conference. The Director of the Bureau shall also inform the appropriate study groups of this matter. Pending resolution of the matter, the Board and the Bureau shall continue to use the particular Rule of Procedure in dispute but, following resolution of the matter by a decision of a world radiocommunication conference, the Board shall promptly review and revise as necessary the Rules of Procedure and the Bureau shall review all relevant findings.

13.15 If an administration, or the Board or the Bureau identifies a need for a special study, in relation to the Rules of Procedure, of any provisions of these Regulations or of a regional agreement with an associated frequency allotment or assignment plan, the case shall be handled under No. **13.14**. The same shall apply if as a consequence of the review of a finding or other action by the Board it is necessary to re-examine the Rules of Procedure.

13.16 The Rules of Procedure shall be maintained and published in a form that will facilitate easy modification and maximize their value to administrations and other users.

Section IV – Board documents

13.17 The Bureau shall, where appropriate, prepare draft modifications or additions to the Rules of Procedure which shall be made available for comment before being submitted to the Board. One week beforehand, the draft agenda of each Board meeting shall be sent by facsimile, or mailed, to all administrations and shall also be made available in electronic form. At the same time, all documents which are both referred to in that draft agenda and available at that time shall be sent by facsimile, or mailed, to those administrations requesting them as well as simultaneously being made accessible in electronic form.

13.18 Within one week after a meeting of the Board, a summary of all decisions, including the reasons for each decision, taken in that meeting shall be made available on the ITU website. After each Board meeting the approved minutes of that meeting shall normally be circulated at least one month before the start of the following meeting to administrations by means of a circular letter and these approved minutes shall also be made available on the ITU website. (WRC-03)

13.19 A copy of all documents considered at the Board's meetings, including the minutes, shall be available for public inspection by administrations in the offices of the Bureau, and shall be made available in electronic form as soon as possible. (WRC-2000)

ARTICLE 14

Procedure for the review of a finding or other decision of the Bureau

14.1 Any administration may request a review of a finding, a review of the results of a special study under these Regulations or under a regional agreement and plan, or a review of any other decision of the Bureau. The review of a finding may also be undertaken on the initiative of the Bureau itself when it considers this is justified.

14.2 For this purpose, the administration concerned shall submit a request for a review to the Bureau; it shall also cite the relevant provisions of the Radio Regulations and other references and shall state the action it seeks.

14.3 The Bureau shall promptly acknowledge receipt of the request and shall consider the matter forthwith. Thereafter, every effort shall be made with the administration concerned to resolve the matter without adversely affecting the interests of other administrations.

14.4 If the outcome of the review successfully resolves the matter with the requesting administration without adversely affecting the interests of other administrations, the Bureau shall publish an outline of the review, the arguments, the settlement and any implications affecting other administrations for the information of all Members of the Union. If this review results in a modification to a finding previously formulated by the Bureau, the Bureau shall reapply the relevant steps of the procedure under which the previous finding had been formulated, including, if appropriate, removal of the corresponding entries from the Master Register or any consequential effect on notices subsequently received by the Bureau.

14.5 If the outcome of the review does not successfully resolve the matter, or if it would adversely affect the interests of other administrations, the Bureau shall prepare a report and send it in advance to the administration which requested the review and to any others concerned in order to enable them, if they so desire, to address the Board. The Bureau shall then send the report with all supporting documentation to the Board.

14.6 The decision of the Board on the review, to be taken in accordance with the Convention, shall be regarded as final in so far as the Bureau and the Board are concerned. That decision, together with the supporting information, shall be published as under No. **14.4**. If the review results in a modification to a finding previously formulated by the Bureau, the Bureau shall re-apply the relevant steps of the procedure under which the previous finding had been formulated, including, if appropriate, removal of the corresponding entries from the Master Register or any consequential effect on notices subsequently received by the Bureau. However, if the administration which requested the review disagrees with the Board's decision it may raise the matter at a world radiocommunication conference. (WRC-2000)

14.7 The Bureau shall then initiate all other necessary action decided by the Board.

14.8 Following resolution of the matter by a decision at a world radiocommunication conference, the Bureau shall promptly take the consequential actions, including a request to the Board for reviewing all relevant findings, if necessary.

CHAPTER IV

Interferences

ARTICLE 15

Interferences

Section I – Interference from Radio Stations

15.1 § 1 All stations are forbidden to carry out unnecessary transmissions, or the transmission of superfluous signals, or the transmission of false or misleading signals, or the transmission of signals without identification (except as provided for in Article **19**).

15.2 § 2 Transmitting stations shall radiate only as much power as is necessary to ensure a satisfactory service.

15.3 § 3 In order to avoid interference (see also Article **3** and No. **22.1**):

15.4 *a)* locations of transmitting stations and, where the nature of the service permits, locations of receiving stations shall be selected with particular care;

15.5 *b)* radiation in and reception from unnecessary directions shall be minimized by taking the maximum practical advantage of the properties of directional antennas whenever the nature of the service permits;

15.6 *c)* the choice and use of transmitters and receivers shall be in accordance with the provisions of Article **3**;

15.7 *d)* the conditions specified under No. **22.1** shall be fulfilled.

15.8 § 4 Special consideration shall be given to avoiding interference on distress and safety frequencies, those related to distress and safety identified in Article **31** and those related to safety and regularity of flight identified in Appendix **27**. (WRC-07)

15.9 § 5 The class of emission to be employed by a station should be such as to achieve minimum interference and to assure efficient spectrum utilization. In general this requires that in selecting the class of emission to meet these objectives every effort shall be made to minimize the bandwidth occupied, taking into account the operational and technical considerations of the service to be performed.

15.10 § 6 The out-of-band emissions of transmitting stations should not cause harmful interference to services which operate in adjacent bands in accordance with these Regulations and which use receivers in conformity with Nos. **3.3**, **3.11**, **3.12**, **3.13** and relevant ITU-R Recommendations.

15.11 § 7 If, while complying with the provisions of Article **3**, a station causes harmful interference through its spurious emissions, special measures shall be taken to eliminate such interference.

Section II – Interference from electrical apparatus and installations of any kind except equipment used for industrial, scientific and medical applications

15.12 § 8 Administrations shall take all practicable and necessary steps to ensure that the operation of electrical apparatus or installations of any kind, including power and telecommunication distribution networks, but excluding equipment used for industrial, scientific and medical applications, does not cause harmful interference to a radiocommunication service and, in particular, to a radionavigation or any other safety service operating in accordance with the provisions of these Regulations[1].

Section III – Interference from equipment used for industrial, scientific and medical applications

15.13 § 9 Administrations shall take all practicable and necessary steps to ensure that radiation from equipment used for industrial, scientific and medical applications is minimal and that, outside the bands designated for use by this equipment, radiation from such equipment is at a level that does not cause harmful interference to a radiocommunication service and, in particular, to a radionavigation or any other safety service operating in accordance with the provisions of these Regulations[1].

Section IV – Tests

15.14 § 10 1) Before authorizing tests and experiments in any station, each administration, in order to avoid harmful interference, shall prescribe the taking of all possible precautions such as the choice of frequency and of time and the reduction or, in all cases where this is possible, the suppression of radiation. Any harmful interference resulting from tests and experiments shall be eliminated with the least possible delay.

15.15 2) For the identification of transmissions made during tests, adjustments or experiments, see Article **19**.

15.16 3) In the aeronautical radionavigation service, it is undesirable, for safety reasons, to transmit the normal identification during emissions conducted to check or adjust equipment already in service. Unidentified emissions should however be restricted to a minimum.

15.17 4) Signals for testing and adjustment shall be chosen in such a manner that no confusion will arise with a signal, abbreviation, etc., having a special meaning defined by these Regulations or by the International Code of Signals.

15.18 5) For testing stations in the mobile service see No. **57.9**.

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[1] **15.12.1** and **15.13.1** In this matter, administrations should be guided by the latest relevant ITU-R Recommendations.

Section V – Reports of Infringements

15.19 § 11 Infringements of the Constitution, Convention or Radio Regulations shall be reported to their respective administrations by the control organization, stations or inspectors detecting them. For this purpose they shall use forms similar to the specimen given in Appendix **9**.

15.20 § 12 Representations relating to any serious infringement committed by a station shall be made to the administration of the country having jurisdiction over the station, by the administrations which detect it.

15.21 § 13 If an administration has information of an infringement of the Constitution, the Convention or the Radio Regulations (in particular Article 45 of the Constitution and No. **15.1** of the Radio Regulations) committed by a station under its jurisdiction, the administration shall ascertain the facts and take the necessary actions. (WRC-12)

Section VI – Procedure in a case of harmful interference

15.22 § 14 It is essential that Member States exercise the utmost goodwill and mutual assistance in the application of the provisions of Article 45 of the Constitution and of this Section to the settlement of problems of harmful interference.

15.23 § 15 In the settlement of these problems, due consideration shall be given to all factors involved, including the relevant technical and operating factors, such as: adjustment of frequencies, characteristics of transmitting and receiving antennas, time sharing, change of channels within multichannel transmissions.

15.24 § 16 For the purpose of this Section, the term "administration" may include the centralizing office designated by the administration, in accordance with No. **16.3**.

15.25 § 17 Administrations shall cooperate in the detection and elimination of harmful interference, employing where appropriate the facilities described in Article **16** and the procedures detailed in this Section.

15.26 § 18 Where practicable, and subject to agreement by administrations concerned, the case of harmful interference may be dealt with directly by their specially designated monitoring stations or by direct coordination between their operating organizations.

15.27 § 19 Full particulars relating to harmful interference shall, whenever possible, be given in the form indicated in Appendix **10**.

15.28 § 20 Recognizing that transmissions on distress and safety frequencies and frequencies used for the safety and regularity of flight (see Article **31** and Appendix **27**) require absolute international protection and that the elimination of harmful interference to such transmissions is imperative, administrations undertake to act immediately when their attention is drawn to any such harmful interference. (WRC-07)

15.29 § 21 In cases of harmful interference where rapid action is required, communications between administrations shall be transmitted by the quickest means available and, subject to prior authorization by the administrations concerned in such cases, information may be exchanged directly between specially designated stations of the international monitoring system.

15.30 § 22 When a case of such harmful interference is reported by a receiving station, it shall give to the transmitting station whose service is being interfered with all possible information which will assist in determining the source and characteristics of the interference.

15.31 § 23 If a case of harmful interference so justifies, the administration having jurisdiction over the receiving station experiencing the interference shall inform the administration having jurisdiction over the transmitting station whose service is being interfered with, giving all possible information.

15.32 § 24 If further observations and measurements are necessary to determine the source and characteristics of and to establish the responsibility for the harmful interference, the administration having jurisdiction over the transmitting station whose service is being interfered with may seek the cooperation of other administrations, particularly of the administration having jurisdiction over the receiving station experiencing the interference, or of other organizations.

15.33 § 25 When cases of harmful interference occur as a result of emissions from space stations, the administrations having jurisdiction over these interfering stations shall, upon request from the administration having jurisdiction over the station experiencing the interference, furnish current ephemeral data necessary to allow determination of the positions of the space stations when not otherwise known.

15.34 § 26 Having determined the source and characteristics of the harmful interference, the administration having jurisdiction over the transmitting station whose service is being interfered with shall inform the administration having jurisdiction over the interfering station, giving all useful information in order that this administration may take such steps as may be necessary to eliminate the interference.

15.35 § 27 On being informed that a station over which it has jurisdiction is believed to have been the cause of harmful interference, an administration shall, as soon as possible, acknowledge receipt of that information by the quickest means available. Such acknowledgement shall not constitute an acceptance of responsibility. (WRC-2000)

15.36 § 28 When a safety service suffers harmful interference the administration having jurisdiction over the receiving station experiencing the interference may also approach directly the administration having jurisdiction over the interfering station. The same procedure may also be followed in other cases with the prior approval of the administration having jurisdiction over the transmitting station whose service is being interfered with.

15.37 § 29 An administration receiving a communication to the effect that one of its stations is causing harmful interference to a safety service shall promptly investigate the matter and take any necessary remedial action and respond in a timely manner. (WRC-2000)

15.38 § 30 When the service rendered by an earth station suffers harmful interference, the administration having jurisdiction over the receiving station experiencing such interference may also approach directly the administration having jurisdiction over the interfering station.

15.39 § 31 If the harmful interference persists in spite of the action taken in accordance with the procedures outlined above, the administration having jurisdiction over the transmitting station whose service is being interfered with may address to the administration having jurisdiction over the interfering station a report of irregularity or infraction in accordance with the provisions of Section V.

15.40 § 32 If there is a specialized international organization for a particular service, reports of irregularities and of infractions relating to harmful interference caused or suffered by stations in this service may be addressed to such organization at the same time as to the administration concerned.

15.41 § 33 1) If it is considered necessary, and particularly if the steps taken in accordance with the procedures described above have not produced satisfactory results, the administration concerned shall forward details of the case to the Bureau for its information.

15.42 2) In such a case, the administration concerned may also request the Bureau to act in accordance with the provisions of Section I of Article **13**; but it shall then supply the Bureau with the full facts of the case, including all the technical and operational details and copies of the correspondence.

15.43 § 34 1) In the case where an administration has difficulty in identifying a source of harmful interference in the HF bands and urgently wishes to seek the assistance of the Bureau, it shall promptly inform the Bureau.

15.44 2) On receipt of this information, the Bureau shall immediately request the cooperation of appropriate administrations or specially designated stations of the international monitoring system that may be able to help in identifying the source of harmful interference.

15.45 3) The Bureau shall consolidate all reports received in response to requests under No. **15.44** and, using such other information as it has available, shall promptly attempt to identify the source of harmful interference.

15.46 4) The Bureau shall thereafter forward its conclusions and recommendations to the administration reporting the case of harmful interference. These shall also be forwarded to the administration believed to be responsible for the source of harmful interference, together with a request for prompt action.

ARTICLE 16

International monitoring

16.1 To assist to the extent practicable in the implementation of these Regulations, in particular to help ensure efficient and economical use of the radio-frequency spectrum and to help in the prompt elimination of harmful interference, administrations agree to continue the development of monitoring facilities and, to the extent practicable, to cooperate in the continued development of the international monitoring system, taking into account the relevant ITU-R Recommendations.[1]

16.2 The international monitoring system comprises only those monitoring stations which have been so nominated by administrations in the information sent to the Secretary-General in accordance with Resolution ITU-R 23 and the most recent version of Recommendation ITU-R SM.1139. These stations may be operated by an administration or, in accordance with an authorization granted by the appropriate administration, by a public or private enterprise, by a common monitoring service established by two or more countries, or by an international organization. (WRC-15)

16.3 Each administration or common monitoring service established by two or more countries, or international organizations participating in the international monitoring system, shall designate a centralizing office to which all requests for monitoring information shall be addressed and through which monitoring information will be forwarded to the Bureau or to centralizing offices of other administrations.

16.4 However, these provisions shall not affect private monitoring arrangements made for special purposes by administrations, international organizations, or public or private enterprises.

16.5 Administrations shall, as far as they consider practicable, conduct such monitoring as may be requested of them by other administrations or by the Bureau.

16.6 Administrative and procedural requirements for use and operation of the international monitoring system should be in accordance with the most recent version of Recommendation ITU-R SM.1139. (WRC-12)

16.7 The Bureau shall record the results supplied by the monitoring stations participating in the international monitoring system, and shall prepare periodically, for publication by the Secretary-General, summaries of the useful monitoring data received by it including a list of the stations contributing the data.

16.8 When an administration, in supplying monitoring observations from one of its monitoring stations taking part in the international monitoring system, states to the Bureau that a clearly identified emission is not in conformity with these Regulations, the Bureau shall draw the attention of the administration concerned to those observations.

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[1] **16.1.1** Information on this subject is also provided in the ITU-R Handbook on Spectrum Monitoring.

CHAPTER V

Administrative provisions

ARTICLE 17

Secrecy

17.1 In the application of the appropriate provisions of the Constitution and the Convention, administrations bind themselves to take the necessary measures to prohibit and prevent:

17.2 *a)* the unauthorized interception of radiocommunications not intended for the general use of the public;

17.3 *b)* the divulgence of the contents, simple disclosure of the existence, publication or any use whatever, without authorization of information of any nature whatever obtained by the interception of the radiocommunications mentioned in No. **17.2**.

ARTICLE 18

Licences

18.1 § 1 1) No transmitting station may be established or operated by a private person or by any enterprise without a licence issued in an appropriate form and in conformity with the provisions of these Regulations by or on behalf of the government of the country to which the station in question is subject (however, see Nos. **18.2**, **18.8** and **18.11**).

18.2 2) However, the government of a country may conclude with the government of one or more neighbouring countries a special agreement concerning one or several stations of its broadcasting service or of its land mobile services, operating on frequencies above 41 MHz, situated in the territory of a neighbouring country and intended to improve national coverage. This agreement, which shall be compatible with the provisions of the present Regulations as well as of those regional agreements to which the countries concerned are signatories, may allow exceptions to the provisions of No. **18.1** and shall be communicated to the Secretary-General in order that it may be brought to the notice of administrations for their information.

18.3 3) Mobile stations which are registered in a territory or group of territories which does not have full responsibility for its international relations may be considered, in so far as the issue of licences is concerned, as subject to the authority of that territory or group of territories.

18.4 § 2 The holder of a licence is required to preserve the secrecy of telecommunications, as provided in the relevant provisions of the Constitution and the Convention. Moreover, the licence shall mention, specifically or by reference, that if the station includes a receiver, the interception of radiocommunication correspondence, other than that which the station is authorized to receive, is forbidden, and that in cases where such correspondence is involuntarily received, it shall not be reproduced, nor communicated to third parties, nor used for any purpose, and even its existence shall not be disclosed.

18.5 § 3 To facilitate the verification of licences issued to mobile stations and mobile earth stations, a translation of the text in one of the working languages of the Union shall be added, when necessary, to the text written in the national language.

18.6 § 4 1) The government which issues a licence to a mobile station or a mobile earth station shall indicate therein in clear form the particulars of the station, including its name, call sign and, where appropriate, the public correspondence category, as well as the general characteristics of the installation.

18.7 2) For land mobile stations, including stations consisting only of one or more receivers, a clause shall be included in the licence, specifically or by reference, under which the operation of these stations shall be forbidden in countries other than the country in which the licence is issued, except as may be provided by special agreement between the governments of the countries concerned.

18.8 § 5 1) In the case of a new registration of a ship or aircraft in circumstances where delay is likely to occur in the issue of a licence by the country in which it is to be registered, the administration of the country from which the mobile station or mobile earth station wishes to make its voyage or flight may, at the request of the operating company, issue a certificate to the effect that the station complies with these Regulations. This certificate, drawn up in a form determined by the issuing administration, shall give the particulars mentioned in No. **18.6** and shall be valid only for the duration of the voyage or flight to the country in which the registration of the ship or aircraft will be effected, or for a period of three months, whichever is less.

18.9 2) The administration issuing the certificate shall inform the administration responsible for issuing the licence of the action taken.

18.10 3) The holder of the certificate shall comply with the provisions of these Regulations applicable to licence holders.

18.11 § 6 In the case of hire, lease or interchange of aircraft, the administration having authority over the aircraft operator receiving an aircraft under such an arrangement may, by agreement with the administration of the country in which the aircraft is registered, issue a licence in conformity with that specified in No. **18.6** as a temporary substitute for the original licence.

ARTICLE 19

Identification of stations

Section I – General provisions

19.1 § 1 All transmissions shall be capable of being identified either by identification signals or by other means[1].

19.2 § 2 1) All transmissions with false or misleading identification are prohibited.

19.3 2) Where practicable and in appropriate services, identification signals should be automatically transmitted in accordance with relevant ITU-R Recommendations.

19.4 3) All transmissions in the following services should, except as provided in Nos. **19.13** to **19.15**, carry identification signals:

19.5 *a)* amateur service;

19.6 *b)* broadcasting service;

19.7 *c)* fixed service in the bands below 28 000 kHz;

19.8 *d)* mobile service;

19.9 *e)* standard frequency and time signal service.

19.10 4) All operational transmissions by radiobeacons shall carry identification signals. However, it is recognized that, for radiobeacons and for certain other radionavigation services that normally carry identification signals, during periods of malfunction or other non-operational service the deliberate removal of identification signals is an agreed means of warning users that the transmissions cannot safely be used for navigational purposes.

19.11 5) All transmissions by satellite emergency position-indicating radiobeacons (EPIRBs) operating in the frequency band 406-406.1 MHz shall carry identification signals. (WRC-23)

19.12 6) When identification signals are transmitted they shall comply with the provisions of this Article.

19.13 7) However, the requirements for certain transmissions to carry identification signals need not apply to:

19.14 *a)* survival craft stations when transmitting distress signals automatically;

19.15 *b)* emergency position-indicating radiobeacons (except for those in No. **19.11**).

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[1] **19.1.1** In the present state of the technique, it is recognized nevertheless that the transmission of identifying signals for certain radio systems (e.g. radiodetermination, radio relay systems and space systems) is not always possible.

19.16 § 3 In transmissions carrying identification signals a station shall be identified by a call sign, by a maritime mobile service identity or by other recognized means of identification which may be one or more of the following: name of station, location of station, operating agency, official registration mark, flight identification number, selective call number or signal, selective call identification number or signal, characteristic signal, characteristic of emission or other clearly distinguishing features readily recognized internationally.

19.17 § 4 For transmissions carrying identification signals, in order that stations may be readily identified, each station shall transmit its identification as frequently as practicable during the course of transmissions, including those made for tests, adjustments or experiments. During such transmissions, however, identification signals shall be transmitted at least hourly, preferably within the period from five minutes before to five minutes after the hour (UTC) unless to do so would cause unreasonable interruption of traffic, in which case identification shall be given at the beginning and end of transmissions.

19.18 § 5 Identification signals shall wherever practicable be in one of the following forms:

19.19 *a)* speech, using simple amplitude or frequency modulation;

19.20 *b)* international Morse code transmitted at manual speed;

19.21 *c)* a telegraph code compatible with conventional printing equipment;

19.22 *d)* any other form recommended by the Radiocommunication Sector.

19.23 § 6 To the extent possible the identification signal should be transmitted in accordance with relevant ITU-R Recommendations.

19.24 § 7 Administrations should ensure that wherever practicable superimposed identification methods be employed in accordance with ITU-R Recommendations.

19.25 § 8 When a number of stations work simultaneously in a common circuit, either as relay stations, or in parallel on different frequencies, each station shall, as far as practicable, transmit its own identification or those of all the stations concerned.

19.26 § 9 Administrations shall ensure, except in the cases mentioned in Nos. **19.13** to **19.15**, that all transmissions not carrying identification signals can be identified by other means when they are capable of causing harmful interference to the services of another administration operating in accordance with these Regulations.

19.27 § 10 Administrations shall, having regard to the provisions of these Regulations relating to the notification of assignments for recording in the Master Register, adopt their own measures to ensure compliance with the provisions of No. **19.26**.

19.28 § 11 Each Member State reserves the right to establish its own measures for identifying its stations used for national defence. However, it shall use, as far as possible, call signs recognizable as such, and containing the distinctive characters of its nationality.

Section II – Allocation of international series and assignment of call signs

19.28A § 11A 1) For the purpose of the supply of identification signals, a *territory* or *geographical area* shall be understood to mean the territory within the limits of which the station is located. For mobile stations, it shall be understood to mean the territory within the limits of which the responsible administration is located. A territory which does not have full responsibility for its international relations shall also be considered as a geographical area for this purpose.

19.28B 2) In all documents of the Union where the terms *allocation* of call sign series and *assignment* of call signs are to be used, they shall be used with the following meaning:

Identification means	Terms used in these Regulations
International series of call signs (including maritime identification digits (MIDs) and selective call numbers)	Allocation to the administration of a Member State (see definition in No. 1002 of the Constitution)
Call signs (including maritime identification digits (MIDs) and selective call numbers)	Assignment by any administration to stations operating in a territory or geographical area (see No. **19.28A**)

19.29 § 12 1) All stations open to international public correspondence, all amateur stations, and other stations which are capable of causing harmful interference beyond the boundaries of the territory or geographical area in which they are located, shall have call signs from the international series allocated to its administration as given in the Table of Allocation of International Call Sign Series in Appendix **42**.

19.30 2) As the need arises, ship stations and ship earth stations to which the provisions of Chapter **IX** apply, and coast stations, coast earth stations, or other non-shipborne stations capable of communicating with such ship stations, shall have assigned to them maritime mobile service identities in accordance with Section VI of this Article. (WRC-07)

19.31 3) It is not compulsory to assign call signs from the international series to stations identified by maritime mobile service identities or which are easily identified by other means (see No. **19.16**) and whose signals of identification or characteristics of emission are published in international documents.

19.31A 4) Means shall be provided for uniquely identifying mobile stations operating in automated terrestrial or satellite communication systems for the purposes of answering distress calls, for avoiding interference and for billing. Identification of the mobile station by accessing a registration database is satisfactory, provided that the system can associate the mobile station calling number with the particular mobile station user. (WRC-03)

19.32 § 13 Should the available call sign series in Appendix **42** be exhausted, new call sign series may be allocated according to the principles set out in Resolution **13 (Rev.WRC-97)** relating to the formation of call signs and the allocation of new international series.

19.33 § 14 Between radiocommunication conferences, the Secretary-General is authorized to deal with questions relating to changes in the allocation of series of call signs, on a provisional basis, and subject to confirmation by the following conference (see also No. **19.32**).

19.34 § 15 The Secretary-General shall be responsible for allocating maritime identification digits (MIDs) to administrations and shall regularly publish information regarding allocated MIDs.

19.35 § 16 The Secretary-General shall be responsible for allocating additional maritime identification digits (MIDs) to administrations within the limits specified, provided that it is ascertained that the possibilities offered by the MIDs allocated to an administration will soon be exhausted despite judicious ship station identity assignment as outlined in Section VI. (WRC-03)

19.36 § 17 Each administration has been allocated one or more maritime identification digit (MID) for its use. A second or subsequent MID should not be requested[2] unless the previously allocated MID is more than 80% exhausted and the rate of assignments is such that 90% exhaustion is foreseen. (WRC-19)

19.37 § 18 The Secretary-General shall be responsible for supplying series of selective call numbers or signals (see Nos. **19.92** to **19.95**) at the request of the administrations concerned.

19.38 § 19 1) Each administration shall choose the call signs from the international series allocated or supplied to it; and shall notify this information to the Secretary-General together with the information which is to appear in Lists I, IV and V. These notifications do not include call signs assigned to amateur and experimental stations. (WRC-07)

19.39 2) Each administration shall choose the maritime mobile service identities of its stations from the maritime identification digits allocated to it and notify this information to the Secretary-General for inclusion in the relevant lists, as provided for in Article **20**.

19.40 3) The Secretary-General shall ensure that the same call sign, the same maritime mobile service identity, the same selective call number or the same identification number is not assigned more than once and that call signs which might be confused with distress signals, or with other signals of the same nature, are not assigned.

19.41 § 20 1) When a fixed station uses more than one frequency in the international service, each frequency may be identified by a separate call sign used solely for this frequency.

19.35.1 (SUP - WRC-03)

[2] **19.36.1** In no circumstances may an administration claim more MIDs than the total number of its ship stations notified to ITU divided by 1 000, plus one. Administrations shall make every attempt to reuse the Maritime Mobile Service Identities (MMSI) assigned from earlier MID resources, which become redundant after ships leave their national ship registry. Such numbers should be considered for reassignment after being absent from at least two successive editions of List V of the ITU service publications. Administrations seeking additional MID resources must meet the criteria of having notified all previous assignments, in accordance with No. **20.16**. This criteria applies only to MMSIs in the basic category and to all MIDs assigned to the administration. (WRC-07)

19.42 2) When a broadcasting station uses more than one frequency in the international service, each frequency may be identified by a separate call sign used solely for this frequency or by some other appropriate means, such as announcing the name of the place and frequency used.

19.43 3) When a land station uses more than one frequency, each frequency may, if desired, be identified by a separate call sign.

19.44 4) Where practicable, coast stations should use a common call sign for each frequency series[3].

Section III − Formation of call signs

19.45 § 21 1) The twenty-six letters of the alphabet, as well as digits in the cases specified below, may be used to form call signs. Accented letters are excluded.

19.46 2) However, the following combinations shall not be used as call signs:

19.47 *a)* combinations which might be confused with distress signals or with other signals of a similar nature;

19.48 *b)* combinations in Recommendation ITU-R M.1172-0 that are reserved for the abbreviations to be used in the radiocommunication services. (WRC-15)

19.49 (SUP - WRC-03)

19.50 § 22 Call signs in the international series are formed as indicated in Nos. **19.51** to **19.71**. The first two characters shall be two letters or a letter followed by a digit or a digit followed by a letter. The first two characters or in certain cases the first character of a call sign constitute the nationality identification[4].

19.51 *Land and fixed stations*

19.52 § 23 1)

– two characters and one letter, *or*

– two characters and one letter followed by not more than three digits (other than the digits 0 and 1 in cases where they immediately follow a letter).

19.53 2) However, it is recommended that, as far as possible, the call signs of fixed stations consist of:

– two characters and one letter followed by two digits (other than the digits 0 and 1 in cases where they immediately follow a letter).

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[3] **19.44.1** By "frequency series" is meant a group of frequencies each of which belongs to one of the different bands between 4 000 kHz and 27 500 kHz that are allocated exclusively to the maritime mobile service.

[4] **19.50.1** For call sign series beginning with B, F, G, I, K, M, N, R, W and 2, only the first character is required for nationality identification. In the cases of half series (i.e. when the first two characters are allocated to more than one Member State), the first three characters are required for nationality identification. (WRC-03)

19.54 *Ship stations*

19.55 § 24

– two characters and two letters, *or*

– two characters, two letters and one digit (other than the digits 0 or 1), *or*

– two characters (provided that the second is a letter) followed by four digits (other than the digits 0 or 1 in cases where they immediately follow a letter), *or*

– two characters and one letter followed by four digits (other than the digits 0 or 1 in cases where they immediately follow a letter). (WRC-07)

19.56 (SUP - WRC-07)

19.57 *Aircraft stations*

19.58 § 25

– two characters and three letters.

19.59 *Ship's survival craft stations*

19.60 § 26

– the call sign of the parent ship followed by two digits (other than the digits 0 or 1 in cases where they immediately follow a letter).

19.61 *Emergency position-indicating radiobeacon stations*

19.62 § 27

– the Morse letter B and/or the call sign of the parent ship to which the radiobeacon belongs.

19.63 *Aircraft survival craft stations*

19.64 § 28

– the complete call sign of the parent aircraft (see No. **19.58**), followed by a single digit other than 0 or 1.

19.65 *Land mobile stations*

19.66 § 29

– two characters (provided that the second is a letter) followed by four digits (other than the digits 0 or 1 in cases where they immediately follow a letter), *or*

– two characters and one or two letters followed by four digits (other than the digits 0 or 1 in cases where they immediately follow a letter).

19.67 *Amateur and experimental stations*

19.68 § 30 1)

– one character (provided that it is the letter B, F, G, I, K, M, N, R or W) and a single digit (other than 0 or 1), followed by a group of not more than four characters, the last of which shall be a letter, *or*

– two characters and a single digit (other than 0 or 1), followed by a group of not more than four characters, the last of which shall be a letter.[5] (WRC-03)

19.68A 1A) On special occasions, for temporary use, administrations may authorize use of call signs with more than the four characters referred to in No. **19.68**. (WRC-03)

19.69 2) However, the prohibition of the use of the digits 0 and 1 does not apply to amateur stations.

19.70 *Stations in the space service*

19.71 § 31 When call signs for stations in the space service are employed, it is recommended that they consist of:

– two characters followed by two or three digits (other than the digits 0 and 1 in cases where they immediately follow a letter).

Section IV – Identification of stations using radiotelephony

19.72 § 32 Stations using radiotelephony shall be identified as indicated in Nos. **19.73** to **19.82A**. (WRC-03)

19.73 § 33 1) *Coast stations*

– a call sign (see No. **19.52**); *or*

– the geographical name of the place as it appears in the List of Coast Stations and Special Service Stations, followed preferably by the word RADIO or by any other appropriate indication. (WRC-07)

19.74 2) *Ship stations*

– a call sign (see No. **19.55**); *or*

– the official name of the ship preceded, if necessary, by the name of the owner on condition that there is no possible confusion with distress, urgency and safety signals; *or*

– its selective call number or signal.

19.75 3) *Ship's survival craft stations*

– a call sign (see No. **19.60**); *or*

– a signal of identification consisting of the name of the parent ship followed by two digits.

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[5] **19.68.1** In the case of half series (i.e. when the first two characters are allocated to more than one Member State), the first three characters are required for nationality identification. In such cases, the call sign shall consist of three characters followed by a single digit and a group of not more than three characters, the last of which shall be a letter. (WRC-07)

19.76 4) *Emergency position-indicating radiobeacon stations*

When speech transmission is used:

– the name and/or the call sign of the parent ship to which the radiobeacon belongs. (WRC-07)

19.77 § 34 1) *Aeronautical stations*

– the name of the airport or geographical name of the place followed, if necessary, by a suitable word indicating the function of the station.

19.78 2) *Aircraft stations*

– a call sign (see No. **19.58**), which may be preceded by a word designating the owner or the type of aircraft; *or*

– a combination of characters corresponding to the official registration mark assigned to the aircraft; *or*

– a word designating the airline, followed by the flight identification number.

19.79 3) In the exclusive aeronautical mobile frequency bands, aircraft stations using radiotelephony may use other methods of identification, after special agreement between governments, and on condition that they are internationally known.

19.80 4) *Aircraft survival craft stations*

– a call sign (see No. **19.64**).

19.81 § 35 1) *Base stations*

– a call sign (see No. **19.52**); *or*

– the geographical name of the place followed, if necessary, by any other appropriate indication.

19.82 2) *Land mobile stations*

– a call sign (see No. **19.66**); *or*

– the identity of the vehicle or any other appropriate indication.

19.82A § 35A *Amateur stations and experimental stations*

– a call sign (see No. **19.68**). (WRC-03)

Section V − Selective call numbers in the maritime mobile service

19.83 § 36 When stations of the maritime mobile service use selective calling devices in accordance with the most recent versions of Recommendations ITU-R M.476 and ITU-R M.625, their call numbers should be assigned by the responsible administrations in accordance with the provisions below. (WRC-23)

19.84 *Formation of ship station selective call numbers and coast station identification numbers*

19.85 § 37 1) The ten digits from 0 to 9 inclusive shall be used to form selective call numbers.

19.86 2) However, combinations of numbers commencing with the digits 00 (zero, zero) shall not be used when forming the identification numbers for coast stations.

19.87 3) Ship station selective call numbers and coast station identification numbers in the series are formed as indicated in Nos. **19.88**, **19.89** and **19.90**.

19.88 4) *Coast station identification numbers*

– four digits (see No. **19.86**).

19.89 5) *Ship station selective call numbers*

– five digits.

19.90 6) *Predetermined groups of ship stations*

– five digits consisting of:

  – the same digit repeated five times; *or*

  – two different digits repeated alternately.

19.91 *Assignment of ship station selective call numbers and coast station identification numbers*

19.92 § 38 1) In cases where selective call numbers for ship stations and identification numbers for coast stations are required for use in the maritime mobile service, the selective call numbers and identification numbers shall be supplied by the Secretary-General on request. Upon notification by an administration of the introduction of selective calling for use in the maritime mobile service: (WRC-07)

19.93 *a)* selective call numbers for ships will be supplied as required as single numbers or in blocks not exceeding 100 (one hundred); (WRC-12)

19.94 *b)* coast station identification numbers will be supplied in blocks of 10 (ten) to meet actual requirements;

19.95 *c)* selective call numbers for selective calling of predetermined groups of ship stations in accordance with No. **19.90** will be supplied as required as single numbers.

19.96 2) Each administration shall choose the selective call numbers to be assigned to its ship stations from the blocks of the series supplied to it. Administrations shall notify the Bureau immediately in accordance with No. **20.16** when assigning selective call numbers to ship stations.

19.96A (SUP - WRC-23)

19.97 3) Each administration shall choose the coast station identification numbers to be assigned to its coast stations from the blocks of the series supplied to it. (WRC-23)

Section VI – Identities in the maritime mobile service (WRC-12)

19.98 *A – General*

19.99 § 39 When a station[6] operating in the maritime mobile service or the maritime mobile-satellite service is required to use maritime mobile service identities, the responsible administration shall assign the identity to the station in accordance with the provisions described in Annex 1 of Recommendation ITU-R M.585-9. In accordance with No. **20.16**, administrations shall notify the Radiocommunication Bureau immediately when assigning maritime mobile service identities. (WRC-23)

19.100 § 40 1) Maritime mobile service identities are formed of a series of nine digits which are transmitted over the radio path in order to uniquely identify ship stations, ship earth stations, coast stations, coast earth stations, and other non-shipborne stations operating in the maritime mobile service or the maritime mobile-satellite service, and group calls. (WRC-07)

19.101 2) These identities are formed in such a way that the identity or part thereof can be used by telephone and telex subscribers connected to the public telecommunications network principally to call ships automatically in the shore-to-ship direction. Access to public networks may also be achieved by means of free-form numbering plans, so long as the ship can be uniquely identified using the system's registration database (see No. **19.31A**) to obtain the ship station identity, call sign or ship name and nationality. (WRC-03)

19.102 3) The types of maritime mobile service identities shall be as described in Annex 1 to Recommendation ITU-R M.585-9. (WRC-23)

19.103 (SUP - WRC-07)

19.104 (SUP - WRC-07)

19.105 (SUP - WRC-07)

19.106 (SUP - WRC-07)

19.107 (SUP - WRC-07)

19.108 *B – Maritime identification digits (MIDs)*

19.108A § 41 The maritime identification digits $M_1I_2D_3$ are an integral part of the maritime mobile service identity and denote, in principle, the administration responsible for the station so identified. In some cases, $M_1I_2D_3$ may denote a geographical area under the responsibility of a specific administration. Furthermore, as indicated in the most recent version of Recommendation ITU-R M.585, some maritime identification digits are reserved for maritime devices and do not correspond either to an administration or to a geographical area. (WRC-15)

19.109 (SUP - WRC-03)

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[6] **19.99.1** In this Section a reference to a ship station or a coast station may include the respective earth stations.

19.110 *C – Maritime mobile service identities* (WRC-07)

19.111 § 43 1) Administrations shall follow Annex 1 to Recommendation ITU-R M.585-9 concerning the assignment and use of maritime mobile service identities. (WRC-23)

19.112 2) Administrations should: (WRC-07)

19.113 *a)* make optimum use of the possibilities of forming identities from the single MID allocated to them; (WRC-07)

19.114 (SUP - WRC-19)

19.115 (SUP - WRC-03)

19.116 (SUP - WRC-03)

19.117 to **19.126** (SUP - WRC-07)

Section VII – Special provisions

19.127 § 47 1) In the aeronautical mobile service, after communication has been established by means of the complete call sign, the aircraft station may use, if confusion is unlikely to arise, an abbreviated call sign or identification consisting of:

19.128 *a)* in radiotelegraphy, the first character and last two letters of the complete call sign (see No. **19.58**);

19.129 *b)* in radiotelephony:

– the first character of the complete call sign; *or*

– the abbreviation of the name of the owner of the aircraft (company or individual); *or*

– the type of aircraft;

followed by the last two letters of the complete call sign (see No. **19.58**) or by the last two characters of the registration mark.

19.130 2) The provisions of Nos. **19.127**, **19.128** and **19.129** may be amplified or modified by agreement between administrations concerned.

19.131 § 48 The distinguishing signals allotted to ships for visual and aural signalling shall, in general, agree with the call signs of ship stations.

ARTICLE 20

Service publications and online information systems (WRC-07)

Section I − Titles and contents of service publications (WRC-03)

20.1 § 1 The following publications shall be issued by the Secretary-General. As circumstances warrant and in response to individual requests by administrations, the published information shall also be available in various formats and by appropriate means. (WRC-07)

20.2 § 2 *BR IFIC − The International Frequency Information Circular.* (WRC-19)

20.3 The BR IFIC shall contain: (WRC-19)

20.4 *a)* particulars of frequency assignments recorded in the Master International Frequency Register;

20.5 *b)* the frequencies prescribed by these Regulations for common use by certain services; (WRC-07)

20.6 *c)* the allotments in the Allotment Plans included in Appendices **25**, **26** and **27**.

20.7 § 3 *List IV − List of Coast Stations and Special Service Stations.* (WRC-07)

20.8 § 4 *List V − List of Ship Stations and Maritime Mobile Service Identity Assignments.* (WRC-07)

20.9 (SUP - WRC-07)

20.10 (SUP - WRC-07)

20.11 (SUP - WRC-2000)

20.12 § 8 *List VIII − List of International Monitoring Stations.*

20.13 § 9 *List VIII A − List of Stations in the Space Radiocommunication Services and in the Radio Astronomy Service.*

20.14 § 10 *Manual for Use by the Maritime Mobile and Maritime Mobile-Satellite Services.*

Section II − Online information systems (WRC-07)

20.14A § 10A The following online information system(s) are made available by the Radiocommunication Bureau:

the ITU Maritime mobile Access and Retrieval System (MARS). (WRC-07)

Section III − Preparation and amendment of service publications and online information systems (WRC-07)

20.15 § 11 The form, the content and the periodicity of each publication shall be decided by the Radiocommunication Bureau in consultation with administrations and the international organizations concerned. Similar consultation shall be made with regard to the maritime online information systems. (WRC-07)

20.16 § 12 1) Administrations shall take all appropriate measures to notify the Radiocommunication Bureau immediately of any changes in the operational information contained in Lists IV and V, in view of the importance of this information, particularly with regard to safety. In the case of the data published in List V, which is also made available online through MARS, administrations shall communicate those changes at least once a month. In the case of other publications, administrations shall communicate the changes in the information contained in them as soon as possible. (WRC-07)

20.16A 2) The names of the administrations which have failed to notify the Radiocommunication Bureau of the changes in the operational information contained in Lists IV and V shall be published in these Lists. (WRC-07)

20.16B 3) The Radiocommunication Bureau will periodically request administrations to reconfirm the information published in Lists IV and V. If no information has been received by the Radiocommunication Bureau for two consecutive editions of Lists IV and V, unvalidated information shall be deleted. The Radiocommunication Bureau shall however inform the administration concerned before taking such action. (WRC-07)

20.17 § 13 For the purpose of the service publications, a “country” shall be understood to mean the territory within the limits of which the station is located; a territory which does not have full responsibility for its international relations shall also be considered as a country for this purpose. (WRC-03)

CHAPTER VI

Provisions for services and stations

ARTICLE 21

Terrestrial and space services sharing frequency bands above 1 GHz

Section I – Choice of sites and frequencies

21.1 § 1 Sites and frequencies for terrestrial stations and earth stations, operating in frequency bands shared with equal rights between terrestrial radiocommunication and space radiocommunication services, shall be selected having regard to the relevant ITU-R Recommendations with respect to geographical separation between earth stations and terrestrial stations.

21.2 § 2 1) As far as practicable, sites for transmitting[1, 3] stations, in the fixed or mobile service, employing maximum values of equivalent isotropically radiated power (e.i.r.p.) exceeding the values given in Table **21-1** in the frequency bands indicated, should be selected so that the direction of maximum radiation of any antenna will be separated from the geostationary-satellite orbit by at least the angle in degrees shown in the Table, taking into account the effect of atmospheric refraction[2]: (WRC-12)

TABLE **21-1**

Frequency band (GHz)	**e.i.r.p. value (dBW) (see also Nos. 21.2 and 21.4)**	**Minimum separation angle with respect to geostationary-satellite orbit (degrees)**
1-10	+35	2
10-15	+45	1.5
25.25-27.5	+24 (in any 1 MHz band)	1.5
Other bands above 15 GHz	+55	No limit[3]

[1] **21.2.1** For their own protection receiving stations in the fixed or mobile service operating in frequency bands shared with space radiocommunication services (space-to-Earth) should also avoid directing their antennas towards the geostationary-satellite orbit if their sensitivity is sufficiently high that interference from space station transmissions may be significant. In particular, in the frequency bands 13.4-13.65 GHz and 21.4-22 GHz, it is recommended to maintain a minimum separation angle of 1.5° with respect to the direction of the geostationary-satellite orbit. (WRC-15)

[2] **21.2.2** Information on this subject is given in the most recent version of Recommendation ITU-R SF.765. (WRC-23)

21.2.3 Not used.

[3] **21.2.4** For frequency bands above 15 GHz (except 25.25-27.5 GHz), there is no restriction on the angular separation for transmitting stations of the fixed or mobile service. This matter is being studied in ITU-R.

Section II − Power limits for terrestrial stations

21.3 § 3 1) The maximum equivalent isotropically radiated power (e.i.r.p.) of a station in the fixed or mobile service shall not exceed +55 dBW.

21.4 2) Where compliance with No. **21.2** for frequency bands between 1 GHz and 10 GHz is impracticable, the maximum equivalent isotropically radiated power (e.i.r.p.) of a station in the fixed or mobile service shall not exceed:

+47 dBW in any direction within 0.5° of the geostationary-satellite orbit; or

+47 dBW to +55 dBW, on a linear decibel scale (8 dB per degree), in any direction between 0.5° and 1.5° of the geostationary-satellite orbit, taking into account the effect of atmospheric refraction[4].

21.5 3) The power delivered by a transmitter to the antenna of a station in the fixed or mobile services shall not exceed +13 dBW in frequency bands between 1 GHz and 10 GHz, or +10 dBW in frequency bands above 10 GHz, except as cited in No. **21.5A**. (WRC-2000)

21.5A As an exception to the power levels given in No. **21.5**, the sharing environment within which the Earth exploration-satellite (passive) and space research (passive) services shall operate in the band 18.6-18.8 GHz is defined by the following limitations on the operation of the fixed service: the power of each RF carrier frequency delivered to the input of each antenna of a station in the fixed service in the band 18.6-18.8 GHz shall not exceed −3 dBW. (WRC-2000)

21.6 4) The limits given in Nos. **21.2**, **21.3**, **21.4**, **21.5** and **21.5A** apply, where applicable, to the services and frequency bands indicated in Table **21-2** for reception by space stations where the frequency bands are shared with equal rights with the fixed or mobile services: (WRC-2000)

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[4] **21.4.1** Information on this subject is given in the most recent version of Recommendation ITU-R SF.765. (WRC-23)

TABLE **21-2** (Rev.WRC-23)

Frequency band	Service	Limit as specified in Nos.
1 427-1 429 MHz 1 610-1 645.5 MHz (No. **5.359**) 1 646.5-1 660 MHz (No. **5.359**) 1 980-2 010 MHz 2 010-2 025 MHz (Region 2) 2 025-2 110 MHz 2 200-2 290 MHz 2 655-2 670 MHz [5] (Regions 2 and 3) 2 670-2 690 MHz [5] (Regions 2 and 3) 5 670-5 725 MHz (Nos. **5.453** and **5.455**) 5 725-5 755 MHz [5] (Region 1 countries listed in Nos. **5.453** and **5.455**) 5 755-5 850 MHz [5] (Region 1 countries listed in Nos. **5.453** and **5.455)** 5 850-7 075 MHz 7 145-7 235 MHz* 7 900-8 400 MHz	Fixed-satellite Meteorological-satellite Space research Space operation Earth exploration-satellite Mobile-satellite	**21.2**, **21.3**, **21.4** and **21.5**
10.7-11.7 GHz [5] (Region 1) 12.5-12.75 GHz [5] (Nos. **5.494** and **5.496**) 12.7-12.75 GHz [5] (Region 2) 12.75-13.25 GHz 13.75-14 GHz (Nos. **5.499** and **5.500**) 14.0-14.25 GHz (No. **5.505**) 14.25-14.3 GHz (Nos. **5.505** and **5.508**) 14.3-14.4 GHz [5] (Regions 1 and 3) 14.4-14.5 GHz 14.5-14.8 GHz 51.4-52.4 GHz	Fixed-satellite	**21.2**, **21.3** and **21.5**
17.7-18.4 GHz 18.6-18.8 GHz 19.3-19.7 GHz 22.55-23.55 GHz 24.45-29.5 GHz	Fixed-satellite Earth exploration-satellite Space research Inter-satellite	**21.2, 21.3, 21.5** and **21.5A**

NOTE: Additional frequency bands above 29.5 GHz may be considered for inclusion in Table **21-2** by a future competent conference.

21.7 5) Transhorizon systems in the 1 700-1 710 MHz, 1 980-2 010 MHz, 2 025-2 110 MHz and 2 200-2 290 MHz bands may exceed the limits given in Nos. **21.3** and **21.5**, but the provisions of Nos. **21.2** and **21.4** should be observed. Considering the difficult sharing conditions with other services, administrations are urged to keep the number of transhorizon systems in these bands to a minimum. (WRC-2000)

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[5] **21.6.1** The equality of right to operate when a band of frequencies is allocated in different Regions to different services of the same category is established in No. **4.8**. Therefore any limits concerning inter-Regional interference which may appear in ITU-R Recommendations should, as far as practicable, be observed by administrations.

* For this frequency band only the limits of Nos. **21.3** and **21.5** apply.

Section III − Power limits for earth stations

21.8 § 4 1) The equivalent isotropically radiated power (e.i.r.p.) transmitted in any direction towards the horizon by an earth station shall not exceed the following limits except as provided in No. **21.10** or **21.11**:

a) in frequency bands between 1 GHz and 15 GHz

+40 dBW in any 4 kHz band for $\theta \leq 0°$

+40 + 3 θ dBW in any 4 kHz band for $0° < \theta \leq 5°$; and

b) in frequency bands above 15 GHz

+64 dBW in any 1 MHz band for $\theta \leq 0°$

+64 + 3 θ dBW in any 1 MHz band for $0° < \theta \leq 5°$,

where θ is the angle of elevation of the horizon viewed from the centre of radiation of the antenna of the earth station and measured in degrees as positive above the horizontal plane and negative below it.

21.9 2) For angles of elevation of the horizon greater than 5° there shall be no restriction as to the equivalent isotropically radiated power (e.i.r.p.) transmitted by an earth station towards the horizon.

21.10 3) As an exception to the limits given in No. **21.8**, the equivalent isotropically radiated power (e.i.r.p.) towards the horizon for an earth station in the space research service (deep space) shall not exceed +55 dBW in any 4 kHz band in frequency bands between 1 GHz and 15 GHz, or +79 dBW in any 1 MHz band in frequency bands above 15 GHz.

21.11 4) The limits given in Nos. **21.8** and **21.10**, as applicable, may be exceeded by not more than 10 dB. However, when the resulting coordination area extends into the territory of another country, such increase shall be subject to agreement by the administration of that country.

21.12 5) The limits given in No. **21.8** apply, where applicable, to the services and frequency bands indicated in Table **21-3** below for transmission by earth stations where the frequency bands are shared with equal rights with the fixed or mobile service:

TABLE **21-3** (Rev.WRC-19)

Frequency band		Services
2 025-2 110 MHz		Earth exploration-satellite
5 670-5 725 MHz	(for the countries listed in No. **5.454** with respect to the countries listed in Nos. **5.453** and **5.455**)	Fixed-satellite Meteorological-satellite Mobile-satellite
5 725-5 755 MHz [6]	(for Region 1 with respect to the countries listed in Nos. **5.453** and **5.455**)	Space operation
5 755-5 850 MHz [6]	(for Region 1 with respect to the countries listed in Nos. **5.453** and **5.455**)	Space research
5 850-7 075 MHz		
7 190-7 250 MHz		
7 900-8 400 MHz		
10.7-11.7 GHz [6]	(for Region 1)	
12.5-12.75 GHz [6]	(for Region 1 with respect to the countries listed in No. **5.494**)	
12.7-12.75 GHz [6]	(for Region 2)	
12.75-13.25 GHz		
14.0-14.25 GHz	(with respect to the countries listed in No. **5.505**)	
14.25-14.3 GHz	(with respect to the countries listed in Nos. **5.505** and **5.508**)	
14.3-14.4 GHz [6]	(for Regions 1 and 3)	
14.4-14.8 GHz		
17.7-18.1 GHz		Fixed-satellite
22.55-23.15 GHz		Earth exploration-satellite
27.0-27.5 GHz [6]	(for Regions 2 and 3)	Mobile-satellite
27.5-29.5 GHz		Space research
31.0-31.3 GHz	(for the countries listed in No. **5.545**)	
34.2-35.2 GHz	(for the countries listed in No. **5.550** with respect to the countries listed in No. **5.549**)	
51.4-52.4 GHz		Fixed-satellite

21.13 6) The equivalent isotropically radiated power (e.i.r.p.) transmitted in any direction by an earth station in the radiodetermination-satellite service in the band 1 610-1 626.5 MHz shall not exceed −3 dBW in any 4 kHz band.

[6] **21.12.1** The equality of right to operate when a band of frequencies is allocated in different Regions to different services of the same category is established in No. **4.8**. Therefore any limits concerning inter-Regional interference which may appear in ITU-R Recommendations should, as far as practicable, be observed by administrations.

21.13A 7) In the band 13.75-14 GHz, the level of off-axis e.i.r.p. emitted by an earth station of a geostationary fixed-satellite service network with an antenna diameter smaller than 4.5 m shall not exceed the following values:

Angle off-axis (degrees)	*Maximum e.i.r.p. in any 1 MHz band (dBW)*
$2 \leq \varphi \leq 7$	$43 - 25 \log \varphi$
$7 < \varphi \leq 9.2$	22
$9.2 < \varphi \leq 48$	$46 - 25 \log \varphi$
$\varphi > 48$	4

(WRC-03)

Section IV – Minimum angle of elevation of earth stations

21.14 § 5 1) Earth station antennas shall not be employed for transmission at elevation angles of less than 3° measured from the horizontal plane to the direction of maximum radiation, except when agreed to by administrations concerned and those whose services may be affected. In case of reception by an earth station, the above value shall be used for coordination purposes if the operating angle of elevation is less than that value.

21.15 2) As an exception to No. **21.14**, earth station antennas in the space research service (near Earth) shall not be employed for transmission at elevation angles of less than 5°, and earth station antennas in the space research service (deep space) shall not be employed for transmission at elevation angles of less than 10°, both angles being those measured from the horizontal plane to the direction of maximum radiation. In the case of reception by an earth station, the above values shall be used for coordination purposes if the operating angle of elevation is less than those values.

Section V – Limits of power flux-density from space stations

21.16 § 6 1) The power flux-density at the Earth's surface produced by emissions from a space station, including emissions from a reflecting satellite, for all conditions and for all methods of modulation, shall not exceed the limit given in Table **21-4**. The limit relates to the power flux-density which would be obtained under assumed free-space propagation conditions and applies to emissions by a space station of the service indicated where the frequency bands are shared with equal rights with the fixed or mobile service, unless otherwise stated.

TABLE **21-4** (Rev.WRC-23)

Frequency band	**Service***	**Limit in dB(W/m²) for angles of arrival (δ) above the horizontal plane**				**Reference bandwidth**
		0°-5°	**5°-25°**		**25°-90°**	
1 670-1 700 MHz	Earth exploration-satellite Meteorological-satellite	−133 (value based on sharing with meteorological aids service)				1.5 MHz
1 518-1 525 MHz (Applicable to the territory of the United States in Region 2 between the longitudes 71° W and 125° W)	Mobile-satellite (space-to-Earth)	**0° ≤ δ ≤ 4°**	**4° < δ ≤ 20°**	**20° < δ ≤ 60°**	**60° < δ ≤ 90°**	4 kHz
		−181.0	−193.0 + 20 log δ	−213.3 + 35.6 log δ	−150.0	
1 518-1 525 MHz (Applicable to all other territory of the United States in Region 2)	Mobile-satellite (space-to-Earth)	**0° ≤ δ ≤ 43.4°**	**43.4° < δ ≤ 60°**		**60° < δ ≤ 90°**	4 kHz
		−155.0	−213.3 + 35.6 log δ		−150.0	
1 525-1 530 MHz [7] (Region 1, Region 3) 1 670-1 690 MHz [12] 1 690-1 700 MHz (Nos. **5.381** and **5.382**) 1 700-1 710 MHz 2 025-2 110 MHz 2 200-2 300 MHz	Meteorological-satellite (space-to-Earth) Space research (space-to-Earth) (space-to-space) Space operation (space-to-Earth) (space-to-space) Earth exploration-satellite (space-to-Earth) (space-to-space)	**0°-5°**	**5°-25°**		**25°-90°**	4 kHz
		−154 [9]	−154 + 0.5(δ − 5) [9]		−144 [9]	
2 500-2 690 MHz 2 520-2 670 MHz 2 500-2 516.5 MHz (No. **5.404**) 2 500-2 520 MHz 2 520-2 535 MHz (No. **5.403**)	Fixed-satellite Broadcasting-satellite Radiodetermination-satellite Mobile-satellite Mobile-satellite (except aeronautical mobile-satellite)	−136 [10]	−136 + 11/20(δ − 5) [10]		−125 [10]	1 MHz
3 400-4 200 MHz	Fixed-satellite (space-to-Earth) (geostationary-satellite orbit)	−152	−152 + 0.5(δ − 5)		−142	4 kHz
3 400-4 200 MHz	Fixed-satellite (space-to-Earth) (non-geostationary-satellite orbit)	−138 − Y [22, 23]	−138 − Y + (12 + Y)(δ − 5)/20 [22, 23]		−126 [23]	1 MHz

TABLE **21-4** (*continued*) (Rev.WRC-23)

Frequency band	**Service***	**Limit in dB(W/m²) for angles of arrival (δ) above the horizontal plane**			**Reference bandwidth**
		0°-5°	**5°-25°**	**25°-90°**	
4 500-4 800 MHz 5 670-5 725 MHz (Nos. **5.453** and **5.455**) 7 250-7 900 MHz	Fixed-satellite (space-to-Earth) Meteorological-satellite (space-to-Earth) Mobile-satellite Space research	−152	−152 + 0.5(δ − 5)	−142	4 kHz
5 150-5 216 MHz	Fixed-satellite (space-to-Earth)	−164			4 kHz
6 700-6 825 MHz	Fixed-satellite (space-to-Earth)	−137 [17]	−137 + 0.5(δ − 5)	−127	1 MHz
6 825-7 075 MHz	Fixed-satellite (space-to-Earth)	−154 and −134	−154 + 0.5(δ − 5) and −134 + 0.5(δ − 5)	−144 and −124	4 kHz 1 MHz
8 025-8 500 MHz	Earth exploration-satellite (space-to-Earth) Space research (space-to-Earth)	−150	−150 + 0.5(δ − 5)	−140	4 kHz
9 900-10 400 MHz	Earth exploration-satellite (active)	**0°-5.7°**	**5.7°-53°**	**53°-90°**	1 MHz
		−113 [18]	−109 + 25 log(δ − 5) [18]	−66.6 [18]	
10.7-11.7 GHz	Fixed-satellite (space-to-Earth) (geostationary-satellite orbit)	**0°-5°**	**5°-25°**	**25°-90°**	4 kHz
		−150	−150 + 0.5(δ − 5)	−140	
10.7-11.7 GHz	Fixed-satellite (space-to-Earth) (non-geostationary-satellite orbit) [25]	−126	−126 + 0.5(δ − 5)	−116	1 MHz
10.7-11.7 GHz 11.7-12.5 GHz (Region 1) 12.5-12.75 GHz (Region 1 countries listed in Nos. **5.494** and **5.496**) 11.7-12.7 GHz (Region 2) 11.7-12.75 GHz (Region 3)	Fixed-satellite (space-to-Earth) (non-geostationary-satellite orbit) [24]	−129 [23]	−129 + 0.75(δ − 5) [23]	−114 [23]	1 MHz

TABLE **21-4** (*continued*) (Rev.WRC-23)

Frequency band	**Service***	**Limit in dB(W/m²) for angles of arrival (δ) above the horizontal plane**				**Reference bandwidth**
		0°-5°	**5°-25°**		**25°-90°**	
11.7-12.5 GHz (Region 1) 12.5-12.75 GHz (Region 1 countries listed in Nos. **5.494** and **5.496**) 11.7-12.7 GHz (Region 2) 11.7-12.75 GHz (Region 3)	Fixed-satellite (space-to-Earth) (non-geostationary-satellite orbit) [25]	−124	−124 + 0.5(δ − 5)		−114	1 MHz
12.2-12.75 GHz [7] (Region 3) 12.5-12.75 GHz [7] (Region 1 countries listed in Nos. **5.494** and **5.496**)	Fixed-satellite (space-to-Earth) (geostationary-satellite orbit)	−148	−148 + 0.5(δ − 5)		−138	4 kHz
13.4-13.65 GHz (Region 1)	Fixed-satellite (space-to-Earth) (geostationary-satellite orbit)	**0°-25°**	**25°-80°**	**80°-84°**	**84°-90°**	4 kHz
		−159 + 0.4δ [19]	−149 [19]	−149 − 0.5(δ − 80) [19]	−151 [19]	
17.7-19.3 GHz [7, 8]	Fixed-satellite (space-to-Earth) Inter-satellite Meteorological-satellite (space-to-Earth)	**0°-5°**	**5°-25°**		**25°-90°**	1 MHz
		−115 [14, 15] or −115 − X [13]	−115 + 0.5(δ − 5) [14, 15] or −115 − X + ((10 + X)/20) (δ − 5) [13]		−105 [14, 15] or −105 [13]	
17.7-19.3 GHz [7, 8]	Fixed-satellite (space-to-Earth) Inter-satellite	**0°-3°**	**3°-12°**	**12°-25°**	−105 [16]	1 MHz
		−120 [16]	−120 + (8/9) (δ − 3) [16]	−112 + (7/13) (δ − 12) [16]		
19.3-19.7 GHz	Fixed-satellite (space-to-Earth) Inter-satellite	**0°-3°**	**3°-12°**	**12°-25°**	−105 [16]	1 MHz
		−120 [16]	−120 + (8/9) (δ − 3) [16]	−112 + (7/13) (δ − 12) [16]		

TABLE **21-4** (*continued*) (Rev.WRC-23)

Frequency band	**Service***	**Limit in dB(W/m²) for angles of arrival (δ) above the horizontal plane**			**Reference bandwidth**
		0°-5°	**5°-25°**	**25°-90°**	
19.3-19.7 GHz 21.4-22 GHz (Regions 1 and 3) 22.55-23.55 GHz 24.45-24.75 GHz 25.25-27.5 GHz	Fixed-satellite (space-to-Earth) Broadcasting-satellite Earth exploration-satellite (space-to-Earth) Inter-satellite Space research (space-to-Earth)	−115 [15]	−115 + 0.5(δ − 5) [15]	−105 [15]	1 MHz
27.500-27.501 GHz	Fixed-satellite (space-to-Earth)	−115	−115 + 0.5(δ − 5)	−105	1 MHz
27.5-30.0 GHz	Inter-satellite (non-geostationary satellite orbit)[26]	−120	−120 + 0.5(δ − 5)	−110	1 MHz
31.0-31.3 GHz 34.7-35.2 GHz (space-to-Earth transmissions referred to in No. **5.550** on the territories of countries listed in No. **5.549**)	Space research	−115	−115 + 0.5(δ − 5)	−105	1 MHz
31.8-32.3 GHz	Space research	−120 [20]	−120 + 0.75(δ − 5) [20]	−105	1 MHz
32.3-33 GHz	Inter-satellite	−135	−135 + (δ − 5)	−115	1 MHz
37-38 GHz	Space research (non-geostationary-satellite orbit)	−120 [20]	−120 + 0.75(δ − 5) [20]	−105	1 MHz
37-38 GHz	Space research (geostationary-satellite orbit)	−125	−125 + (δ − 5)	−105	1 MHz
37.5-40 GHz	Fixed-satellite (non-geostationary-satellite orbit) Mobile-satellite (non-geostationary-satellite orbit)	−120 [11, 21]	−120 + 0.75(δ − 5) [11, 21]	−105 [11, 21]	1 MHz
37.5-40 GHz	Fixed-satellite (geostationary-satellite orbit) Mobile-satellite (geostationary-satellite orbit)	**0°-5°** −127 [21]	**5°-20°** −127 + (4/3) (δ − 5) [21]	**20°-25°** −107 + 0.4 (δ − 20) [21]	**25°-90°** −105 [21]	1 MHz
40-40.5 GHz	Fixed-satellite Mobile-satellite	−115	−115 + 0.5(δ − 5)	−105	1 MHz
40.5-42 GHz	Fixed-satellite (non-geostationary-satellite orbit) Broadcasting-satellite (non-geostationary-satellite orbit)	−115 [11, 21]	−115 + 0.5(δ − 5) [11, 21]	−105 [11, 21]	1 MHz

TABLE **21-4** (*end*) (Rev.WRC-23)

Frequency band	**Service***	**Limit in dB(W/m²) for angles of arrival (δ) above the horizontal plane**				**Reference bandwidth**
		0°-5°	**5°-25°**		**25°-90°**	
40.5-42 GHz	Fixed-satellite (geostationary-satellite orbit) Broadcasting-satellite (geostationary-satellite orbit)	−120 [21]	**5°-15°**	**15°-25°**	−105 [21]	1 MHz
			−120 + (δ − 5) [21]	−110 + 0.5 (δ − 15) [21]		
42-42.5 GHz	Fixed-satellite (non-geostationary-satellite orbit) Broadcasting-satellite (non-geostationary-satellite orbit)	−120 [11, 21]	**5°-25°**		−105 [11, 21]	1 MHz
			−120 + 0.75(δ − 5) [11, 21]			
42-42.5 GHz	Fixed-satellite (geostationary-satellite orbit) Broadcasting-satellite (geostationary-satellite orbit)	−127 [21]	**5°-20°**	**20°-25°**	−105 [21]	1 MHz
			−127 + (4/3) (δ − 5) [21]	−107 + 0.4 (δ − 20) [21]		
In Region 1: 47.5-47.9 GHz 48.2-48.54 GHz 49.44-50.2 GHz	Fixed-satellite (geostationary-satellite orbit)	−115	**5°-25°**		−105	1 MHz
			−115 + 0.5(δ − 5)			

* The references to services are those services which have allocations in Article **5**.

[7] **21.16.1** The equality of right to operate when a frequency band is allocated in different Regions to different services of the same category is established in No. **4.8**. Therefore, any limits concerning inter-Regional interference which may appear in ITU-R Recommendations should, as far as practicable, be observed by administrations.

[8] **21.16.2** In addition to the limits given in Table **21-4**, in the band 18.6-18.8 GHz the sharing environment within which the Earth exploration-satellite (passive) and space research (passive) services shall operate is defined by the following limitations on the operation of the fixed-satellite service: the power flux-density across the 200 MHz band 18.6-18.8 GHz produced at the surface of the Earth by emissions from a space station under assumed free-space propagation conditions shall not exceed −95 dB(W/m²), except for less than 5% of time, when the limit may be exceeded by up to 3 dB. The provisions of No. **21.17** do not apply in this band. (WRC-2000)

[9] **21.16.3** These power flux-density values are derived on the basis of protecting the fixed service using line-of-sight techniques. Where a fixed service using tropospheric scatter operates in the bands listed in the first column and there is insufficient frequency separation, there must be sufficient angular separation between the direction to the space station and the direction of maximum radiation of the antenna of the receiving station of the fixed service using tropospheric scatter, in order to ensure that the interference power at the receiver input of the fixed-service station does not exceed −168 dBW in any 4 kHz band.

[10] **21.16.3A** Resolution **903 (Rev.WRC-19)** shall apply. (WRC-19)

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[11] **21.16.4** The values given in this table entry shall apply to emissions of space stations of non-geostationary satellites in systems operating with 99 or fewer satellites. Further study concerning the applicability of these values is necessary in order to apply them to systems operating with 100 or more satellites. (WRC-2000)

[12] **21.16.5** These values are applicable where this band is shared with equal rights with meteorological aids service.

[13] **21.16.6** The function X is defined as a function of the number, N, of satellites in the non-geostationary satellite constellation in the fixed-satellite service and N_v, as follows:

$X = 0$	dB	for	$N \leq 50$
$X = \frac{5}{119}(N - 50)$	dB	for	$50 < N \leq 288$
$X = \frac{1}{69}(N + 402)$	dB	for	$288 < N \leq 999$
$X = max\ \{20.3;\ 10 \log_{10}(N_v)\}$	dB	for	$1\,000 \leq N \leq 6\,000$
$X = 10 \log_{10}(N_v) + 1$	dB	for	$N > 6\,000$

where:

N_v* is the maximum number of visible space stations – considering a minimum elevation angle equal to 0 degrees – from any location on the surface of the Earth and within the *service* area of the non-GSO system. N_v does not depend on latitude; it encompasses the maximum number of visible satellites across all latitudes within the service area of the relevant non-GSO system.

In the frequency band 18.8-19.3 GHz, these limits apply to emissions of any space station in a non-geostationary-satellite system

– in the fixed-satellite service for which complete coordination or notification information, as appropriate, has been received by the Radiocommunication Bureau since 17 November 1995 and which was not operational by that date, and

– in the inter-satellite service.

* Where N_v is determined as follows: $N_v = \text{Max}(N_v(j = 0,1,2...))$ with $N_v(j) = \text{Max}(N_v(j(t)), N_v(j(t-1)))$, where $N_v(j(t))$ represents all visible satellites (with elevation ≥ 0 degrees) at each time-step (t) on any point on the surface of the Earth (j).

(WRC-23)

[14] **21.16.6A** These limits apply to emissions of a space station in the meteorological-satellite service and of a geostationary satellite in the fixed-satellite and inter-satellite services. They also apply to emissions of any space station in a non-geostationary-satellite system in the fixed-satellite service in the band 18.8-19.3 GHz for which complete coordination or notification information has been received by the Radiocommunication Bureau by 17 November 1995, or which was in operation by that date. (WRC-23)

[15] **21.16.6B** These limits also apply to fixed-satellite service space stations using highly-inclined orbits having an apogee altitude greater than 18 000 km and an orbital inclination between 35° and 145° in the band 17.7-19.7 GHz to which Resolution **147 (WRC-07)** applies. (WRC-07)

[16] **21.16.6C** These limits apply to all space stations that use highly-inclined orbits having an apogee altitude greater than 18 000 km and an orbital inclination between 35° and 145° in the band 17.7-19.7 GHz in the fixed-satellite service and that are not covered by Resolution **147 (WRC-07)**, and for which complete coordination or notification information, as appropriate, was received by the Radiocommunication Bureau after 16 November 2007, and in the inter-satellite service. (WRC-23)

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[17] **21.16.7** These power flux-density limits are subject to review by ITU-R and shall apply until they are revised by a competent world radiocommunication conference.

[18] **21.16.8** The pfd values given for EESS (active) are mean pfd values defined as follows:

$$pfd(\delta) = P + 10\log(\tau) + 10\log(PRF) - 30 - 10\log(Bc) + G_t(\delta) - 10\log\left(4\pi d^2(\delta)\right)$$

where:

P: RF peak power at the input of the antenna of the SAR satellite (dBW)

τ: SAR pulse length (μs)

PRF: SAR pulse repetition frequency (kHz)

δ: elevation angle of the EESS SAR satellite above ground, in the vertical plane (perpendicular to the satellite orbit) (°)

Bc: SAR emission bandwidth (MHz)

$G_t(\delta)$: transmit antenna gain of the SAR satellite in the vertical plane (perpendicular to the satellite orbit) for the elevation angle δ considered (dBi)

$d(\delta)$: distance between the SAR satellite and the ground for the elevation angle δ considered (m). (WRC-15)

[19] **21.16.9** These values are also based on sharing with the Earth exploration-satellite (active) and space research services. (WRC-15)

[20] **21.16.10** During the launch and near-Earth operational phase of deep-space facilities, non-geostationary satellite systems in the space research service shall not exceed a power flux-density value of:

–115	dB(W/m^2)	for $\delta < 5°$
–115 + 0.5 (δ – 5)	dB(W/m^2)	for $5° \leq \delta \leq 25°$
–105	dB(W/m^2)	for $\delta > 25°$

in any 1 MHz band, where δ is the angle of arrival above the horizontal plane. (WRC-2000)

21.16.11 (SUP - WRC-03)

21.16.12 (SUP - WRC-03)

21.16.13 (SUP - WRC-03)

[21] **21.16.14** When addressing the sharing conditions between the fixed service and the fixed-satellite service in the bands 37.5-40 GHz and 40.5-42.5 GHz, the power flux-density at the Earth's surface from any FSS satellite should be no greater than the level(s) required to meet the FSS link availability and performance objectives of the subject applications, taking into account the technical and operational requirements of the overall design of the satellite network. In any case, the levels shall not exceed the applicable power flux-density limits in Table **21-4**. (WRC-03)

[22] **21.16.15** The value of Y is defined as $Y = 0$ for $\max(N_N, N_S) \leq 2$; $Y = 5\log(\max(N_N, N_S))$ for $\max(N_N, N_S) > 2$, where N_N is the maximum number of space stations in a system simultaneously transmitting on a co-frequency basis in the fixed-satellite service in the Northern Hemisphere, and N_S is the maximum number of space stations in the same system simultaneously transmitting on a co-frequency basis in the fixed-satellite service in the Southern Hemisphere. In determining N_N and N_S, two space stations simultaneously transmitting during periods of short-duration handover shall be considered as one satellite. (WRC-03)

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[23] **21.16.16** The applicability of these limits may need to be reviewed by a future competent conference if the number of co-frequency non-geostationary systems brought into use and simultaneously operating in the same hemisphere is greater than five. (WRC-03)

[24] **21.16.17** These limits apply to non-geostationary fixed-satellite service space stations employing an orbit with an inclination angle between 35° and 145° and apogee altitude greater than 18 000 km. (WRC-03)

[25] **21.16.18** These limits apply to non-geostationary fixed-satellite service space stations that are not covered by No. **21.16.17**. (WRC-03)

[26] **21.16.19** The methodology included in Annex 2 to Resolution **679 (WRC-23)** shall be applied to calculate the pfd produced at the surface of the Earth by emissions from a non-geostationary-satellite space station transmitting in the frequency band 27.5-30.0 GHz. (WRC-23)

21.17 2) The limits given in Table **21-4** may be exceeded on the territory of any country whose administration has so agreed.

Section VI – Protection of aeronautical radionavigation service systems from aggregate emissions of space stations of radionavigation-satellite service systems in the 1 164-1 215 MHz band (WRC-03)

21.18 § 7 Administrations operating or planning to operate radionavigation-satellite service systems or networks in the 1 164-1 215 MHz frequency band, for which complete coordination or notification information, as appropriate, was received by the Bureau after 2 June 2000, shall, in accordance with *resolves* 2 of Resolution **609 (WRC-03)***, take all necessary steps to ensure that the actual aggregate interference into aeronautical radionavigation service systems caused by such radionavigation-satellite service systems or networks operating co-frequency in these frequency bands does not exceed the equivalent power flux-density level shown in *resolves* 1 of Resolution **609 (WRC-03)***. (WRC-03)

* *Note by the Secretariat:* This Resolution was revised by WRC-07.

ARTICLE 22

Space services[1]

Section I – Cessation of emissions

22.1 § 1 Space stations shall be fitted with devices to ensure immediate cessation of their radio emissions by telecommand, whenever such cessation is required under the provisions of these Regulations.

Section II – Control of interference to geostationary-satellite systems

22.2 § 2 1) Non-geostationary-satellite systems shall not cause unacceptable interference to and, unless otherwise specified in these Regulations, shall not claim protection from geostationary-satellite networks in the fixed-satellite service and the broadcasting-satellite service operating in accordance with these Regulations. No. **5.43A** does not apply in this case. (WRC-07)

22.3 2) Whenever the emissions from geostationary satellites in the inter-satellite service are directed towards space stations at distances from Earth greater than that of the geostationary-satellite orbit, the boresight of the antenna mainbeam of the geostationary satellite shall not be pointed within 15° of any point on the geostationary-satellite orbit.

22.4 § 3 In the frequency band 29.95-30 GHz space stations in the Earth exploration-satellite service on board geostationary satellites and operating with space stations in the same service on board non-geostationary satellites shall have the following restriction:

Whenever the emissions from the geostationary satellites are directed towards the geostationary-satellite orbit and cause unacceptable interference to any geostationary-satellite space system in the fixed-satellite service, these emissions shall be reduced to a level at or less than accepted interference.

22.5 § 4 In the frequency band 8 025-8 400 MHz, which the Earth exploration-satellite service using non-geostationary satellites shares with the fixed-satellite service (Earth-to-space) or the meteorological-satellite service (Earth-to-space), the maximum power flux-density produced at the geostationary-satellite orbit by any Earth exploration-satellite service space station shall not exceed −174 dB(W/m^2) in any 4 kHz band.

22.5A § 5 In the frequency band 6 700-7 075 MHz, the maximum aggregate power flux-density produced at the geostationary-satellite orbit and within ± 5° of inclination around the geostationary-satellite orbit by a non-geostationary-satellite system in the fixed-satellite service shall not exceed −168 dB(W/m^2) in any 4 kHz band. The maximum aggregate power flux-density shall be calculated in accordance with Recommendation ITU-R S.1256-0. (WRC-15)

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[1] **A.22.1** In applying the provisions of this Article, the level of accepted interference (see No. **1.168**) shall be fixed by agreement between the administrations concerned, using the relevant ITU-R Recommendations as a guide.

22.5B (SUP - WRC-2000)

22.5C § 6 1) The equivalent power flux-density[2], epfd↓, at any point on the Earth's surface visible from the geostationary-satellite orbit, produced by emissions from all the space stations of a non-geostationary-satellite system in the fixed-satellite service in the frequency bands listed in Tables **22-1A** to **22-1E**, including emissions from a reflecting satellite, for all conditions and for all methods of modulation, shall not exceed the limits given in Tables **22-1A** to **22-1E** for the given percentages of time. These limits relate to the equivalent power flux-density which would be obtained under free-space propagation conditions, into a reference antenna and in the reference bandwidth specified in Tables **22-1A** to **22-1E**, for all pointing directions towards the geostationary-satellite orbit. (WRC-03)

22.5CA 2) The limits given in Tables **22-1A** to **22-1E** may be exceeded on the territory of any country whose administration has so agreed (see also Resolution **140 (Rev.WRC-23)**). (WRC-23)

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[2] **22.5C.1** The equivalent power flux-density is defined as the sum of the power flux-densities produced at a geostationary-satellite system receive station on the Earth's surface or in the geostationary orbit, as appropriate, by all the transmit stations within a non-geostationary-satellite system, taking into account the off-axis discrimination of a reference receiving antenna assumed to be pointing in its nominal direction. The equivalent power flux-density is calculated using the following formula:

$$epfd = 10\log_{10}\left[\sum_{i=1}^{N_a} 10^{\frac{P_i}{10}} \cdot \frac{G_t(\theta_i)}{4\pi d_i^2} \cdot \frac{G_r(\varphi_i)}{G_{r,max}}\right]$$

where:

N_a: number of transmit stations in the non-geostationary-satellite system that are visible from the geostationary-satellite system receive station considered on the Earth's surface or in the geostationary orbit, as appropriate

i: index of the transmit station considered in the non-geostationary-satellite system

P_i: RF power at the input of the antenna of the transmit station, considered in the non-geostationary-satellite system (dBW) in the reference bandwidth

θ_i: off-axis angle between the boresight of the transmit station considered in the non-geostationary-satellite system and the direction of the geostationary-satellite system receive station

$G_t(\theta_i)$: transmit antenna gain (as a ratio) of the station considered in the non-geostationary-satellite system in the direction of the geostationary-satellite system receive station

d_i: distance (m) between the transmit station considered in the non-geostationary-satellite system and the geostationary-satellite system receive station

φ_i: off-axis angle between the boresight of the antenna of the geostationary-satellite system receive station and the direction of the i-th transmit station considered in the non-geostationary-satellite system

$G_r(\varphi_i)$: receive antenna gain (as a ratio) of the geostationary-satellite system receive station in the direction of the i-th transmit station considered in the non-geostationary-satellite system

$G_{r,max}$: maximum gain (as a ratio) of the antenna of the geostationary-satellite system receive station

epfd: computed equivalent power flux-density (dB(W/m^2)) in the reference bandwidth. (WRC-2000)

TABLE **22-1A** (WRC-03)

Limits to the epfd↓ radiated by non-geostationary-satellite systems in the fixed-satellite service systems in certain frequency bands [3, 4, 5, 6]

Frequency band (GHz)	**epfd↓ (dB(W/m²))**	**Percentage of time during which epfd↓ may not be exceeded**	**Reference bandwidth (kHz)**	**Reference antenna diameter and reference radiation pattern**[7]
10.7-11.7 in all Regions; 11.7-12.2 in Region 2; 12.2-12.5 in Region 3 and 12.5-12.75 in Regions 1 and 3	−175.4	0	40	60 cm Recommendation ITU-R S.1428-1
	−174	90		
	−170.8	99		
	−165.3	99.73		
	−160.4	99.991		
	−160	99.997		
	−160	100		
	−181.9	0	40	1.2 m Recommendation ITU-R S.1428-1
	−178.4	99.5		
	−173.4	99.74		
	−173	99.857		
	−164	99.954		
	−161.6	99.984		
	−161.4	99.991		
	−160.8	99.997		
	−160.5	99.997		
	−160	99.9993		
	−160	100		

[3] **22.5C.2** For certain geostationary fixed-satellite service system receive earth stations, see also Nos. **9.7A** and **9.7B**. (WRC-2000)

[4] **22.5C.3** In meeting these limits, the administrations intending to develop such systems shall ensure that the assignments appearing in the Plan of Appendix **30B** will be fully protected. (WRC-2000)

[5] **22.5C.4** In addition to the limits shown in Table **22-1A**, the following single-entry epfd↓ limits apply to all antenna sizes greater than 60 cm in the frequency bands listed in Table **22-1A**:

100% of the time epfd↓ (dB(W/(m² · 40 kHz)))	**Latitude (North or South) (degrees)**
–160	0 < |Latitude| ≤ 57.5
–160 + 3.4 (57.5 – |Latitude|)/4	57.5 < |Latitude| ≤ 63.75
–165.3	63.75 < |Latitude|

(WRC-2000)

[6] **22.5C.5** For each reference antenna diameter, the limit consists of the complete curve on a plot which is linear (dB) for the epfd↓ levels and logarithmic for the time percentages, with straight lines joining the data points. (WRC-2000)

[7] **22.5C.6** For this Table, reference patterns of Recommendation ITU-R S.1428-1 shall be used only for the calculation of interference from non-geostationary-satellite systems in the fixed-satellite service systems into geostationary-satellite systems in the fixed-satellite service. (WRC-03)

TABLE **22-1A** (*end*) (WRC-03)

Frequency band (GHz)	**epfd↓ (dB(W/m²))**	**Percentage of time during which epfd↓ may not be exceeded**	**Reference bandwidth (kHz)**	**Reference antenna diameter and reference radiation pattern**[7]
	−190.45	0	40	3 m Recommendation ITU-R S.1428-1
	−189.45	90		
	−187.45	99.5		
	−182.4	99.7		
	−182	99.855		
	−168	99.971		
	−164	99.988		
	−162	99.995		
	−160	99.999		
	−160	100		
	−195.45	0	40	10 m Recommendation ITU-R S.1428-1
	−195.45	99		
	−190	99.65		
	−190	99.71		
	−172.5	99.99		
	−160	99.998		
	−160	100		

TABLE **22-1B** (Rev.WRC-23)

Limits to the epfd↓ radiated by non-geostationary-satellite systems in the fixed-satellite service in certain frequency bands[3, 6, 8, 8*bis*]

Frequency band (GHz)	epfd↓ (dB(W/m²))	Percentage of time during which epfd↓ may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter and reference radiation pattern[7]
17.3-17.7 in Region 2; 17.8-18.6	−175.4 −175.4 −172.5 −167 −164 −164	0 90 99 99.714 99.971 100	40	1 m Recommendation ITU-R S.1428-1
	−161.4 −161.4 −158.5 −153 −150 −150	0 90 99 99.714 99.971 100	1 000	
	−178.4 −178.4 −171.4 −170.5 −166 −164 −164	0 99.4 99.9 99.913 99.971 99.977 100	40	2 m Recommendation ITU-R S.1428-1
	−164.4 −164.4 −157.4 −156.5 −152 −150 −150	0 99.4 99.9 99.913 99.971 99.977 100	1 000	
	−185.4 −185.4 −180 −180 −172 −164 −164	0 99.8 99.8 99.943 99.943 99.998 100	40	5 m Recommendation ITU-R S.1428-1
	−171.4 −171.4 −166 −166 −158 −150 −150	0 99.8 99.8 99.943 99.943 99.998 100	1 000	

8 **22.5C.7** A non-geostationary-satellite system shall meet the limits of this Table in both the 40 kHz and the 1 MHz reference bandwidths. (WRC-2000)

8*bis* **22.5C.13** In Region 2, a non-geostationary-satellite system in the fixed-satellite service shall meet the limits of this table for the 17.3-17.7 GHz band with respect to geostationary-satellite systems in the broadcasting-satellite service and shall utilize the reference patterns of Recommendation ITU-R BO.1443-3. (WRC-23)

TABLE **22-1C** (WRC-03)

Limits to the epfd↓ radiated by non-geostationary-satelllite systems in the fixed-satellite service in certain frequency bands[3, 6, 8]

Frequency band (GHz)	**epfd↓ (dB(W/m²))**	**Percentage of time during which epfd↓ may not be exceeded**	**Reference bandwidth (kHz)**	**Reference antenna diameter and reference radiation pattern**[7]
19.7-20.2	−187.4 −182 −172 −154 −154	0 71.429 97.143 99.983 100	40	70 cm Recommendation ITU-R S.1428-1
	−173.4 −168 −158 −140 −140	0 71.429 97.143 99.983 100	1 000	
	−190.4 −181.4 −170.4 −168.6 −165 −160 −154 −154	0 91 99.8 99.8 99.943 99.943 99.997 100	40	90 cm Recommendation ITU-R S.1428-1
	−176.4 −167.4 −156.4 −154.6 −151 −146 −140 −140	0 91 99.8 99.8 99.943 99.943 99.997 100	1 000	
	−196.4 −162 −154 −154	0 99.98 99.99943 100	40	2.5 m Recommendation ITU-R S.1428-1
	−182.4 −148 −140 −140	0 99.98 99.99943 100	1 000	
	−200.4 −189.4 −187.8 −184 −175 −164.2 −154.6 −154 −154	0 90 94 97.143 99.886 99.99 99.999 99.9992 100	40	5 m Recommendation ITU-R S.1428-1
	−186.4 −175.4 −173.8 −170 −161 −150.2 −140.6 −140 −140	0 90 94 97.143 99.886 99.99 99.999 99.9992 100	1 000	

TABLE **22-1D** (Rev.WRC-15)

Limits to the epfd↓ radiated by non-geostationary-satellite systems in the fixed-satellite service in certain frequency bands into 30 cm, 45 cm, 60 cm, 90 cm, 120 cm, 180 cm, 240 cm and 300 cm broadcasting-satellite service antennas[6, 9, 10, 11]

Frequency band (GHz)	epfd↓ (dB(W/m²))	Percentage of time during which epfd↓ may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter and reference radiation pattern[12]
11.7-12.5 in Region 1; 11.7-12.2 and 12.5-12.75 in Region 3; 12.2-12.7 in Region 2	−165.841 −165.541 −164.041 −158.6 −158.6 −158.33 −158.33	0 25 96 98.857 99.429 99.429 100	40	30 cm Recommendation ITU-R BO.1443-3, Annex 1
	−175.441 −172.441 −169.441 −164 −160.75 −160 −160	0 66 97.75 99.357 99.809 99.986 100	40	45 cm Recommendation ITU-R BO.1443-3, Annex 1
	−176.441 −173.191 −167.75 −162 −161 −160.2 −160 −160	0 97.8 99.371 99.886 99.943 99.971 99.997 100	40	60 cm Recommendation ITU-R BO.1443-3, Annex 1

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9 **22.5C.8** For broadcasting-satellite service antenna diameters 180 cm, 240 cm and 300 cm, in addition to the single-entry limits shown in Table **22-1D**, the following single-entry 100% of the time epfd↓ limits also apply in the frequency bands listed in Table **22-1D**:

100% of the time epfd↓ (dB(W/(m2 · 40 kHz)))	Latitude (North or South) (degrees)
–160	0 < |Latitude| ≤ 57.5
–160 + 3.4 (57.5 – |Latitude|)/4	57.5 < |Latitude| ≤ 63.75
–165.3	63.75 < |Latitude|

(WRC-2000)

10 **22.5C.9** For a broadcasting-satellite service earth station antenna diameter of 240 cm, in addition to the single-entry 100% of the time epfd↓ limit specified in No. **22.5C.8** to this Table, a single-entry 100% of the time operational epfd↓ limit is specified in Table **22-4C***. (WRC-2000)

* *Note by the Secretariat:* Table **22-4C** has been suppressed by WRC-19.

11 **22.5C.10** In meeting these limits, the administrations intending to develop such systems shall ensure that the assignments appearing in the Plans of Appendix **30** will be fully protected. (WRC-2000)

12 **22.5C.11** For this Table, reference patterns of Annex 1 to Recommendation ITU-R BO.1443-3 shall be used only for the calculation of interference from non-geostationary satellite systems in the fixed-satellite service into geostationary-satellite systems in the broadcasting-satellite service. (WRC-15)

TABLE **22-1D** (*end*) (Rev.WRC-15)

Frequency band (GHz)	**epfd↓ (dB(W/m²))**	**Percentage of time during which epfd↓ may not be exceeded**	**Reference bandwidth (kHz)**	**Reference antenna diameter and reference radiation pattern[12]**
11.7-12.5 in Region 1; 11.7-12.2 and 12.5-12.75 in Region 3; 12.2-12.7 in Region 2	−178.94 −178.44 −176.44 −171 −165.5 −163 −161 −160 −160	0 33 98 99.429 99.714 99.857 99.943 99.991 100	40	90 cm Recommendation ITU-R BO.1443-3, Annex 1
	−182.44 −180.69 −179.19 −178.44 −174.94 −173.75 −173 −169.5 −167.8 −164 −161.9 −161 −160.4 −160	0 90 98.9 98.9 99.5 99.68 99.68 99.85 99.915 99.94 99.97 99.99 99.998 100	40	120 cm Recommendation ITU-R BO.1443-3, Annex 1
	−184.941 −184.101 −181.691 −176.25 −163.25 −161.5 −160.35 −160 −160	0 33 98.5 99.571 99.946 99.974 99.993 99.999 100	40	180 cm Recommendation ITU-R BO.1443-3, Annex 1
	−187.441 −186.341 −183.441 −178 −164.4 −161.9 −160.5 −160 −160	0 33 99.25 99.786 99.957 99.983 99.994 99.999 100	40	240 cm Recommendation ITU-R BO.1443-3, Annex 1
	−191.941 −189.441 −185.941 −180.5 −173 −167 −162 −160 −160	0 33 99.5 99.857 99.914 99.951 99.983 99.991 100	40	300 cm Recommendation ITU-R BO.1443-3, Annex 1

TABLE **22-1E** (WRC-03)

Limits to the epfd↓ radiated by non-geostationary-satellite systems in the fixed-satellite service in certain frequency bands

Frequency band (MHz)	epfd↓ (dB(W/m²))	Percentage of time during which epfd↓ may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter and reference radiation pattern (m)
3 700-4 200	−195.4	100	4	1.8 [13]
	−197.9	100	4	2.4 [13]
	−201.6	100	4	3.7 [13]
	−203.3	100	4	4.5 [13]
	−204.5	100	4	5.5 [13]
	−207.5	100	4	8 [13]
	−208.5	100	4	10 [13]
	−212.0	100	4	15 [13]

[13] **22.5C.12** The associated reference radiation pattern is defined as follows:

a) for values of $\left(\frac{D}{\lambda}\right) \geq 100$:

$G(\varphi) = G_{max} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda}\varphi\right)^2$ for $0 \leq \varphi < \varphi_m$

$G(\varphi) = G_1$ for $\varphi_m \leq \varphi < \varphi_r$

$G(\varphi) = 29 - 25 \log \varphi$ for $\varphi_r \leq \varphi < 20°$

$G(\varphi) = -3.5$ for $20° \leq \varphi < 26.3°$

$G(\varphi) = 32 - 25 \log \varphi$ for $26.3° \leq \varphi < 48°$

$G(\varphi) = -10$ for $48° \leq \varphi \leq 180°$

b) for values of $42 \leq \left(\frac{D}{\lambda}\right) < 100$:

$G(\varphi) = G_{max} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda}\varphi\right)^2$ for $0 \leq \varphi < \varphi_m$

$G(\varphi) = G_1$ for $\varphi_m \leq \varphi < 100 \left(\frac{\lambda}{D}\right)$

$G(\varphi) = 29 - 25 \log \varphi$ for $100 \left(\frac{\lambda}{D}\right) \leq \varphi < 20°$

$G(\varphi) = -3.5$ for $20° \leq \varphi < 26.3°$

$G(\varphi) = 32 - 25 \log \varphi$ for $26.3° \leq \varphi < 48°$

$G(\varphi) = -10$ for $48° \leq \varphi \leq 180°$

22.5D 3) The equivalent power flux-density[14], epfd↑, produced at any point in the geostationary-satellite orbit by emissions from all the earth stations in a non-geostationary-satellite system in the fixed-satellite service in the frequency bands listed in Table **22-2**, for all conditions and for all methods of modulation, shall not exceed the limits given in Table **22-2** for the specified percentages of time. These limits relate to the equivalent power flux-density which would be obtained under free-space propagation conditions, into a reference antenna and in the reference bandwidth specified in Table **22-2**, for all pointing directions towards the Earth's surface visible from any given location in the geostationary-satellite orbit. (WRC-2000)

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[13] **22.5C.12** (*continued*)

c) for values of $\left(\frac{D}{\lambda}\right) < 42$:

$$G(\varphi) = G_{max} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda}\varphi\right)^2 \quad \text{for} \quad 0 \le \varphi < \varphi_m$$

$$G(\varphi) = G_1 \quad \text{for} \quad \varphi_m \le \varphi < 100\left(\frac{\lambda}{D}\right)$$

$$G(\varphi) = 32 - 25 \log \varphi \quad \text{for} \quad 100\left(\frac{\lambda}{D}\right) \le \varphi < 48°$$

$$G(\varphi) = -10 \quad \text{for} \quad 48° \le \varphi \le 180°$$

where:

D: antenna diameter
λ: wavelength
} expressed in the same units

φ: off-axis angle of the antenna (degrees)

G_1: gain of the first side lobe $= 2 + 15 \log \left(\frac{D}{\lambda}\right)$ dBi

$$\varphi_m = \frac{20\lambda}{D}\sqrt{G_{max} - G_1} \quad \text{degrees}$$

$$\varphi_r = 15.85 \left(\frac{D}{\lambda}\right)^{-0.6} \quad \text{degrees}$$

$$G_{max} = 7.7 + 20 \log \left(\frac{D}{\lambda}\right) \quad \text{dBi}$$

(WRC-03)

[14] **22.5D.1** See No. **22.5C.1**. (WRC-2000)

TABLE **22-2** (WRC-03)

Limits to the epfd↑ radiated by non-geostationary-satellite systems in the fixed-satellite service in certain frequency bands[15]

Frequency band	**epfd↑ (dB(W/m²))**	**Percentage of time epfd↑ level may not be exceeded**	**Reference bandwidth (kHz)**	**Reference antenna beamwidth and reference radiation pattern**[16]
5 925-6 725 MHz	−183.0	100	4	1.5° Recommendation ITU-R S.672-4, *Ls* = −20
12.5-12.75 GHz 12.75-13.25 GHz 13.75-14.5 GHz	−160	100	40	4° Recommendation ITU-R S.672-4, *Ls* = −20
17.3-18.1 GHz (Regions 1 and 3) 17.8-18.1 GHz (Region 2) [17]	−160	100	40	4° Recommendation ITU-R S.672-4, *Ls* = −20
27.5-28.6 GHz	−162	100	40	1.55° Recommendation ITU-R S.672-4, *Ls* = −10
29.5-30 GHz	−162	100	40	1.55° Recommendation ITU-R S.672-4, *Ls* = −10

22.5E (SUP - WRC-2000)

22.5F 4) The equivalent power flux-density[18], $epfd_{is}$, produced at any point in the geostationary-satellite orbit by emissions from all the space stations in a non-geostationary-satellite system in the fixed-satellite service in the frequency bands listed in Table **22-3**, including emissions from a reflecting satellite, for all conditions and for all methods of modulation, shall not exceed the limits given in Table **22-3** for the specified percentages of time. These limits relate to the equivalent power flux-density which would be obtained under free-space propagation conditions into a reference antenna and in the reference bandwidth specified in Table **22-3**, for all pointing directions towards the Earth's surface visible from any given location in the geostationary-satellite orbit. (WRC-2000)

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[15] **22.5D.2** In meeting these limits, the administrations intending to develop such systems shall ensure that the assignments appearing in the Plans of Appendices **30A** and **30B** will be fully protected. (WRC-2000)

[16] **22.5D.3** For this Table, reference patterns of Recommendation ITU-R S.672-4 shall be used only for the calculation of interference from non-geostationary-satellite systems in the fixed-satellite service into geostationary-satellite systems in the fixed-satellite service. For the case of *Ls* = −10, the values *a* = 1.83 and *b* = 6.32 shall be used in the equations in Annex 1 to Recommendation ITU-R S.672-4 for single-feed circular beams. In all cases of *Ls*, the parabolic main beam equation shall start at zero. (WRC-2000)

[17] **22.5D.4** This epfd↑ level also applies to the frequency band 17.3-17.8 GHz to protect broadcasting-satellite service feeder links in Region 2 from non-geostationary fixed-satellite service Earth-to-space transmissions in Regions 1 and 3. (WRC-2000)

[18] **22.5F.1** See No. **22.5C.1**. (WRC-2000)

TABLE **22-3** (Rev.WRC-23)

Limits to the epfd$_{is}$ radiated by non-geostationary-satellite systems in the fixed-satellite service in certain frequency bands[19, 19*bis*]

Frequency band (GHz)	**epfd$_{is}$ (dB(W/m^2))**	**Percentage of time during which epfd$_{is}$ level may not be exceeded**	**Reference bandwidth (kHz)**	**Reference antenna beamwidth and reference radiation pattern**[20]
10.7-11.7 (Region 1) 12.5-12.75 (Region 1) 12.7-12.75 (Region 2)	−160	100	40	4° Recommendation ITU-R S.672-4, *Ls* = −20
17.3-17.7 (Regions 1 and 2) 17.8-18.4	−160	100	40	4° Recommendation ITU-R S.672-4, *Ls* = −20

22.5G (SUP - WRC-2000)

22.5H 5) The limits specified in Nos. **22.5C** (except for Table **22-1E**) to **22.5D** (except for Table **22-2** for the frequency band 5 925-6 725 MHz) and **22.5F** apply to non-geostationary-satellite systems in the fixed-satellite service for which complete coordination or notification information, as appropriate, has been received by the Bureau after 22 November 1997. The limits specified in Table **22-1E** and those specified in Table **22-2** for the frequency band 5 925-6 725 MHz apply to non-geostationary-satellite systems in the fixed-satellite service for which complete notification information has been received by the Bureau after 5 July 2003. The limits in Tables **22-4A**, **22-4A1** and **22-4B** do not apply to non-geostationary-satellite systems in the fixed-satellite service for which complete coordination or notification information, as appropriate, has been received by the Bureau before 22 November 1997. (WRC-19)

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[19] **22.5F.2** In meeting these limits, the administrations intending to develop such systems shall ensure that the assignments appearing in the feeder-link Plans of Appendix **30A** will be fully protected. (WRC-2000)

[19*bis*] **22.5F.4** A non-geostationary-satellite system operating in Region 1 or 2, at any position in the orbit, shall meet the limits of this table for the 17.3-17.7 GHz band with respect to a receiving space station in the broadcasting-satellite feeder link of Appendix **30A**, in all three Regions. (WRC-23)

[20] **22.5F.3** In this Table, the reference pattern of Recommendation ITU-R S.672-4 shall be used only for the calculation of interference from non-geostationary-satellite systems in the fixed-satellite service into geostationary-satellite systems in the fixed-satellite service. In applying the equations of Annex 1 to Recommendation ITU-R S.672-4, the parabolic main beam equation shall start at zero. (WRC-2000)

22.5I 6) An administration operating a non-geostationary-satellite system in the fixed-satellite service which is in compliance with the limits in Nos. **22.5C**, **22.5D** and **22.5F** shall be considered as having fulfilled its obligations under No. **22.2** with respect to any geostationary-satellite network, irrespective of the dates of receipt by the Bureau of the complete coordination or notification information, as appropriate, for the non-geostationary-satellite system and the geostationary-satellite network, provided that the epfd↓ radiated by the non-geostationary-satellite system in the fixed-satellite service into any operating geostationary fixed-satellite service earth station does not exceed the operational and additional operational limits given in Tables **22-4A**, **22-4A1** and **22-4B**, when the diameter of the earth station antenna is equal to the values given in Table **22-4A** or **22-4A1**, or the gain of the earth station is equal to or greater than the values given in Table **22-4B** for the corresponding orbital inclination of the geostationary fixed-satellite service satellite. Except as otherwise agreed between concerned administrations, an administration operating a non-geostationary-satellite system in the fixed-satellite service that is subject to the limits in Nos. **22.5C**, **22.5D** and **22.5F** and which radiates epfd↓ into any operating geostationary fixed-satellite service earth station at levels in excess of the operational or additional operational limits given in Tables **22-4A**, **22-4A1** and **22-4B**, when the diameter of the earth station antenna is equal to the values given in Table **22-4A** or **22-4A1**, or the gain of the earth station is equal to or greater than the values given in Table **22-4B** for the corresponding orbital inclination of the geostationary fixed-satellite service satellite, shall be considered to be in violation of its obligations under No. **22.2**, and the provisions of Article **15** (Section V) apply. In addition, administrations are encouraged to use the relevant ITU-R Recommendations to determine whether such a violation has occurred. (WRC-19)

TABLE **22-4A** (REV.WRC-07)

Operational limits to the epfd↓ radiated by non-geostationary-satellite systems in the fixed-satellite service in certain frequency bands[21, 22, 23]

Frequency band (GHz)	**epfd↓ (dB(W/m²))**	**Percentage of time during which epfd↓ may not be exceeded**	**Reference bandwidth (kHz)**	**Geostationary-satellite system receive earth station antenna diameter[24] (m)**	**Orbital inclination of the geostationary satellite (degrees)**
10.7-11.7 in all Regions 11.7-12.2 in Region 2 12.2-12.5 in Region 3, and 12.5-12.75 in Regions 1 and 3 (prior to 31 December 2005)	−163 −166 −167.5 −169.5	100	40	3 6 9 ≥ 18	≤ 2.5
	−160 −163 −164.5 −166.5	100	40	3 6 9 ≥ 18	> 2.5 and ≤ 4.5
10.7-11.7 in all Regions 11.7-12.2 in Region 2 12.2-12.5 in Region 3, and 12.5-12.75 in Regions 1 and 3 (from 31 December 2005)	−161.25 −164 −165.5 −167.5	100	40	3 6 9 ≥ 18	≤ 2.5
	−158.25 −161 −162.5 −164.5	100	40	3 6 9 ≥ 18	> 2.5 and ≤ 4.5

[21] **22.5H.1** For certain geostationary fixed-satellite service receive earth stations, see also Nos. **9.7A** and **9.7B**. (WRC-2000)

[22] **22.5H.2** In addition to the operational limits shown in Table **22-4A**, the additional operational limits in Table **22-4A1** apply to certain geostationary fixed-satellite service earth station antenna sizes in the frequency bands listed in Table **22-4A**. (WRC-2000)

[23] **22.5H.3** The operational limits on the epfd↓ radiated by non-geostationary-satellite systems in the fixed-satellite service shall be the values given in No. **22.5C.4** or Table **22-4A**, whichever are the more stringent. (WRC-2000)

[24] **22.5H.4** For antenna diameters between the values given in this Table, the limits are given by linear interpolation using a linear scale for epfd↓ (dB) and a logarithmic scale for antenna diameter (m). (WRC-2000)

TABLE **22-4A1** (WRC-2000)

Additional operational limits to the epfd↓ radiated by non-geostationary-satellite systems in the fixed-satellite service into 3 m and 10 m geostationary fixed-satellite service earth station antennas

epfd↓ (dB(W/(m^2 · 40 kHz)))	Percentage of time during which epfd↓ may not be exceeded	Geostationary-satellite system receive earth station antenna diameter (m)
−182 −179 −176 −171 −168 −165 −163 −161.25 −161.25	99.9 99.94 99.97 99.98 99.984 99.993 99.999 99.99975 100	3
−185 −183 −179 −175 −171 −168 −166 −166	99.97 99.98 99.99 99.996 99.998 99.999 99.9998 100	10

TABLE **22-4B** (Rev.WRC-23)

Operational limits to the epfd↓ radiated by non-geostationary-satellite systems in the fixed-satellite service in certain frequency bands[21, 25]

Frequency band (GHz)	epfd↓ (dB(W/m^2))	Percentage of time during which epfd↓ may not be exceeded	Reference bandwidth (kHz)	Geostationary-satellite system receive earth station antenna gain (dBi)	Orbital inclination of geostationary satellite (degrees)
19.7-20.2	−157 −157 −155	100 100 100	40 40 40	≥ 49 ≥ 43 [25] ≥ 49	≤ 2.5 ≤ 2.5 > 2.5 and ≤ 4.5
19.7-20.2	−143 −143 −141	100 100 100	1 000 1 000 1 000	≥ 49 ≥ 43 [25] ≥ 49	≤ 2.5 ≤ 2.5 > 2.5 and ≤ 4.5
17.3-17.7 in Region 2 17.8-18.6	−164 −162	100 100	40 40	≥ 49 ≥ 49	≤ 2.5 > 2.5 and ≤ 4.5
17.3-17.7 in Region 2 17.8-18.6	−150 −148	100 100	1 000 1 000	≥ 49 ≥ 49	≤ 2.5 > 2.5 and ≤ 4.5

[25] **22.5H.5** The operational limit applies to non-geostationary-satellite systems operating at altitudes of 7 000 km or above in order to protect geostationary-satellite systems in the fixed-satellite service employing adaptive coding. (WRC-2000)

22.5H.6 (SUP - WRC-19)

22.5J 7) In case of *force majeure*, telecommand and ranging carriers transmitted to non-geostationary satellites in the fixed-satellite service are not subject to the limits given in Table **22-2**. (WRC-2000)

22.5K 8) Administrations operating or planning to operate non-geostationary-satellite systems in the fixed-satellite service in the frequency bands listed in Tables **22-1A** to **22-1D** of No. **22.5C** will apply the provisions of Resolution **76 (Rev.WRC-15)*** to ensure that the actual aggregate interference into geostationary fixed-satellite service and geostationary broadcasting-satellite service networks caused by such systems operating co-frequency in these frequency bands does not exceed the aggregate power levels shown in Tables 1A to 1D of Resolution **76 (Rev.WRC-15)*** In the event that an administration operating a geostationary-satellite network in conformity with the Radio Regulations identifies equivalent power flux-density levels from non-geostationary-satellite systems in the fixed-satellite service which may be in excess of the aggregate limits contained in Tables 1A to 1D of Resolution **76 (Rev.WRC-15)***, the administrations responsible for the non-geostationary-satellite systems in the fixed-satellite service will apply the provisions contained in *resolves* 2 of Resolution **76 (Rev.WRC-15)***. (WRC-19)

22.5L 9) A non-geostationary-satellite system in the fixed-satellite service in the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space) shall not exceed:

– a single-entry increase of 3% of the time allowance for the *C*/*N* value associated with the shortest percentage of time specified in the short-term performance objective of the generic[26] geostationary-satellite orbit reference links; and

– a single-entry permissible allowance of at most 3% reduction in time-weighted average spectral efficiency calculated on an annual basis for the generic geostationary-satellite orbit reference links using adaptive coding and modulation. (WRC-19)

22.5M 10) Administrations operating or planning to operate non-geostationary-satellite systems in the fixed-satellite service in the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space) shall ensure that the aggregate interference to geostationary-satellite FSS, MSS, and BSS networks caused by all non-geostationary-satellite FSS systems operating in these frequency bands does not exceed:

– an increase of 10% of the time allowance for the *C*/*N* value associated with the shortest percentage of time specified in the short-term performance objective of the generic geostationary-satellite orbit reference links; and

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* *Note by the Secretariat:* This Resolution was revised by WRC-23.

[26] **22.5L.1** Generic geostationary-satellite orbit reference links are comprised of parametric link budget parameters and are used for the purpose of determining the compliance of a non-geostationary-satellite system with respect to No. **22.5L**. The generic geostationary-satellite orbit reference link parameters are found in Table 1 of Annex 1 to Resolution **770 (WRC-19)****.

The procedures and methodologies specified in Resolution **770 (WRC-19)**** shall be used for the calculations. The equivalent power flux-density levels from the non-geostationary-satellite FSS system should be derived using the most recent version of Recommendation ITU-R S.1503. (WRC-19)

** *Note by the Secretariat:* This Resolution was revised by WRC-23.

– a reduction of at most 8% in a calculated annual time-weighted average spectral efficiency for the generic geostationary-satellite orbit reference links using adaptive coding and modulation, taking into account that the methodology ensures that the degradation of time-weighted average spectral efficiency on each link is lower than the maximum permissible reduction,

for each generic geostationary-satellite orbit reference link in Annex 1 to Resolution **770 (WRC-19)***;

and:

– an increase of 10% of the time allowance for the *C*/*N* values associated with the short-term performance objectives of the supplemental geostationary-satellite orbit links; and

– a reduction of at most 8% in a calculated annual time-weighted average spectral efficiency for the supplemental geostationary-satellite orbit links associated with notified and brought into use frequency assignments using adaptive coding and modulation, taking into account that the methodology ensures that the degradation of time-weighted average spectral efficiency on each link is lower than the maximum permissible reduction.

Resolution **769 (WRC-19)** shall also apply. (WRC-19)

Section III – Station keeping of space stations[27]

22.6 § 6 1) Space stations on board geostationary satellites which use any frequency band allocated to the fixed-satellite service or the broadcasting-satellite service[28]:

22.7 *a)* shall have the capability of maintaining their positions within ±0.1° of the longitude of their nominal positions;

22.8 *b)* shall maintain their positions within ±0.1° of longitude of their nominal positions; *but*

22.9 *c)* experimental stations on board geostationary satellites need not comply with No. **22.7** nor No. **22.8**, but shall maintain their positions within ±0.5° of longitude of their nominal positions;

22.10 *d)* however, space stations need not comply with No. **22.8** nor No. **22.9** as appropriate as long as the satellite network to which the space station belongs does not cause unacceptable interference to any other satellite network whose space station complies with the limits given in Nos. **22.8** and **22.9**.

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* *Note by the Secretariat:* This Resolution was revised by WRC-23.

[27] **A.22.III.1** In the case of space stations on board geosynchronous satellites with circular orbits having an angle of inclination greater than 5°, the positional tolerance shall relate to the nodal point.

[28] **22.6.1** Space stations in the broadcasting-satellite service on geostationary satellites operating in the band 11.7-12.7 GHz are exempted from these provisions but shall maintain their positions in accordance with Appendix **30**.

22.11 2) Space stations on board geostationary satellites which do not use any frequency band allocated to the fixed-satellite service or the broadcasting-satellite service:

22.12 *a)* shall have the capability of maintaining their positions within ±0.5° of the longitude of their nominal positions;

22.13 *b)* shall maintain their positions within ±0.5° of longitude of their nominal positions; *but*

22.14 *c)* need not comply with No. **22.13** as long as the satellite network to which the space station belongs does not cause unacceptable interference to any other satellite network whose space station complies with the limits given in No. **22.13**.

22.15 3) Space stations[29] on board geostationary satellites which are put into service prior to 1 January 1987, with the advance publication information for the network having been published before 1 January 1982, are exempted from the provisions of Nos. **22.6** to **22.14** inclusive; however they

22.16 *a)* shall have the capability of maintaining their positions within ±1° of the longitude of their nominal positions, but efforts should be made to achieve a capability of maintaining their positions at least within ±0.5° of the longitude of their nominal positions;

22.17 *b)* shall maintain their positions within ±1° of longitude of their nominal positions; *but*

22.18 *c)* need not comply with No. **22.17** as long as the satellite network to which the space station belongs does not cause unacceptable interference to any other satellite network whose space station complies with the limits given in No. **22.17**.

Section IV – Pointing accuracy of antennas on geostationary satellites

22.19 § 7 1) The pointing direction of maximum radiation of any earthward beam of antennas on geostationary satellites[30] shall be capable of being maintained within:

a) 10 % of the half-power beamwidth relative to the nominal pointing direction, or

b) 0.3° relative to the nominal pointing direction, whichever is greater. This position applies only when such a beam is intended for less than global coverage.

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[29] **22.15.1** Space stations in the broadcasting-satellite service on geostationary satellites operating in the band 11.7-12.7 GHz are exempted from these provisions but shall maintain their positions in accordance with Appendix **30**.

[30] **22.19.1** Transmitting antennas of space stations in the broadcasting-satellite service operating in the band 11.7-12.7 GHz are not subject to these provisions but shall maintain their pointing accuracy in accordance with § 3.14.1 of Annex 5 to Appendix **30**.

22.20 2) In the event that the beam is not rotationally symmetrical about the axis of maximum radiation, the tolerance in any plane containing this axis shall be related to the half power beamwidth in that plane.

22.21 3) This accuracy shall be maintained only if it is required to avoid unacceptable interference to other systems.

Section V − Radio astronomy in the shielded zone of the Moon

22.22 § 8 1) In the shielded zone of the Moon[31] emissions causing harmful interference to radio astronomy observations[32] and to other users of passive services shall be prohibited in the entire frequency spectrum except in the following bands:

22.23 *a)* the frequency bands allocated to the space research service using active sensors;

22.24 *b)* the frequency bands allocated to the space operation service, the Earth exploration-satellite service using active sensors, and the radiolocation service using stations on spaceborne platforms, which are required for the support of space research, as well as for radiocommunications and space research transmissions within the lunar shielded zone.

22.25 2) In frequency bands in which emissions are not prohibited by Nos. **22.22** to **22.24**, radio astronomy observations and passive space research in the shielded zone of the Moon may be protected from harmful interference by agreement between administrations concerned.

Section VI − Off-axis power limits on earth stations of a geostationary-satellite network in the fixed-satellite service[33, 34] (WRC-2000)

22.26 § 9 The level of equivalent isotropically radiated power (e.i.r.p.) emitted by an earth station of a geostationary-satellite network shall not exceed the following values for any off-axis angle φ which is 3° or more off the main-lobe axis of an earth station antenna:

Off-axis angle	*Maximum e.i.r.p.*
$3° \leq \varphi \leq 7°$	$42 - 25 \log \varphi$ dB(W/40 kHz)
$7° < \varphi \leq 9.2°$	21 dB(W/40 kHz)
$9.2° < \varphi \leq 48°$	$45 - 25 \log \varphi$ dB(W/40 kHz)
$48° < \varphi \leq 180°$	3 dB(W/40 kHz)

(WRC-2000)

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[31] **22.22.1** The shielded zone of the Moon comprises the area of the Moon's surface and an adjacent volume of space which are shielded from emissions originating within a distance of 100 000 km from the centre of the Earth.

[32] **22.22.2** The level of harmful interference is determined by agreement between the administrations concerned, with the guidance of the relevant ITU-R Recommendations.

[33] **22.VI.1** The provisions of this section shall not be used for coordination of, or to evaluate interference between, geostationary fixed-satellite service networks (see No. **9.50.1**). (WRC-2000)

[34] **22.VI.2** Although the provisions of this section cover off-axis power limitations in all directions, the radiation pattern of geostationary fixed-satellite service earth station antennas in more than two orthogonal planes is not required. (WRC-2000)

22.27 For frequency-modulated television emissions with energy dispersal, the limits in No. **22.26** above may be exceeded by up to 3 dB, provided that the off-axis total e.i.r.p. of the transmitted frequency-modulated television carrier does not exceed the following values:

Off-axis angle	*Maximum e.i.r.p.*
$3° \leq \varphi \leq 7°$	$56 - 25 \log \varphi$ dBW
$7° < \varphi \leq 9.2°$	35 dBW
$9.2° < \varphi \leq 48°$	$59 - 25 \log \varphi$ dBW
$48° < \varphi \leq 180°$	17 dBW

(WRC-2000)

22.28 Frequency-modulated television carriers which operate without energy dispersal should be modulated at all times with programme material or appropriate test patterns. In this case, the off-axis total e.i.r.p. of the emitted frequency-modulated television carrier shall not exceed the following values:

Off-axis angle	*Maximum e.i.r.p.*
$3° \leq \varphi \leq 7°$	$56 - 25 \log \varphi$ dBW
$7° < \varphi \leq 9.2°$	35 dBW
$9.2° < \varphi \leq 48°$	$59 - 25 \log \varphi$ dBW
$48° < \varphi \leq 180°$	17 dBW

(WRC-2000)

22.29 The e.i.r.p. limits given in Nos. **22.26**, **22.27** and **22.28** are applicable in the following frequency bands allocated to the fixed-satellite service (Earth-to-space):

12.75-13.25 GHz

13.75-14 GHz

14-14.5 GHz. (WRC-97)

22.30 The e.i.r.p. limits given in Nos. **22.26**, **22.27**, **22.28** and **22.32** do not apply to earth station antennas in service or ready to be in service[35] prior to 2 June 2000, nor to earth stations associated with a satellite network in the fixed-satellite service for which complete coordination or notification information has been received before 2 June 2000. (WRC-2000)

22.31 Telecommand and ranging[36] carriers transmitted to geostationary satellites in the fixed-satellite service in normal mode of operation (i.e. earth station transmitting telecommand and ranging carriers to a directional receiving antenna on the space station) may exceed the levels given in No. **22.26** by no more than 16 dB in the frequency bands 12.75-13.25 GHz and 13.75-14.5 GHz. In all other modes of operation, and in case of *force majeure*, telecommand and ranging carriers transmitted to geostationary satellites in the fixed-satellite service are exempted from the levels given in No. **22.26**. (WRC-2000)

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[35] **22.30.1** "Ready to be in service" relates to the case where antennas have been installed but the start of service has been delayed due to *force majeure*. (WRC-2000)

[36] **22.31.1** Measurement of the distance to the satellite. (WRC-2000)

22.32 § 10 The level of equivalent isotropically radiated power (e.i.r.p.) density emitted by an earth station in a geostationary-satellite network in the 29.5-30 GHz frequency band shall not exceed the following values for any off-axis angle φ which is 3° or more off the main-lobe axis of an earth station antenna:

Off-axis angle	*Maximum e.i.r.p. density*
$3° \leq \varphi \leq 7°$	28 – 25 log φ dB(W/40 kHz)
$7° < \varphi \leq 9.2°$	7 dB(W/40 kHz)
$9.2° < \varphi \leq 48°$	31 – 25 log φ dB(W/40 kHz)
$48° < \varphi \leq 180°$	–1 dB(W/40 kHz)

(WRC-2000)

22.33 Not used. (WRC-2000)

22.34 Telecommand and ranging carriers transmitted to geostationary satellites in the fixed-satellite service in normal mode of operation (i.e. earth station transmitting telecommand and ranging carriers to a directional receiving antenna on the space station) may exceed the levels given in No. **22.32** by no more than 10 dB in the frequency band 29.5-30 GHz. In all other modes of operation, and in case of *force majeure*, telecommand and ranging carriers transmitted to geostationary satellites in the fixed-satellite service are exempted from the levels given in No. **22.32**. (WRC-2000)

22.35 For geostationary-satellite systems in which the earth stations are expected to transmit simultaneously in the same 40 kHz band, e.g. for geostationary-satellite systems employing code-division multiple access, the maximum e.i.r.p. values given in No. **22.32** should be decreased by 10 log(N) dB, where N is the number of earth stations which are in the receive satellite beam of the satellite with which these earth stations are communicating and which are expected to transmit simultaneously on the same frequency. (WRC-2000)

22.36 Earth stations operating in the frequency band 29.5-30 GHz should be designed in such a manner that 90% of their peak off-axis e.i.r.p. density levels do not exceed the values given in No. **22.32**. Further study is needed to determine the off-axis angular range over which these exceedences would be permitted, taking into account the interference level into adjacent satellites. The statistical processing of the off-axis e.i.r.p. density peaks should be carried out using the method given in the most recent version of Recommendation ITU-R S.732. (WRC-07)

22.37 The limits given in Nos. **22.26** to **22.28** and **22.32** apply under clear-sky conditions. During rain-fade conditions, the limits may be exceeded by earth stations when using uplink power control. (WRC-2000)

22.38 Earth stations in the fixed-satellite service operating in the 29.5-30 GHz band, which have lower elevation angles to the geostationary-satellite orbit, will require higher e.i.r.p. levels relative to the same terminals at higher elevation angles to achieve the same power flux-densities at the geostationary-satellite orbit, due to the combined effect of increased distance and atmospheric absorption. Earth stations with low elevation angles may exceed the levels given in No. **22.32** by the following amounts:

Elevation angle to geostationary-satellite orbit, ε	*Increase in e.i.r.p. density (dB)*	
$\varepsilon \leq 5°$	2.5	
$5° < \varepsilon \leq 30°$	$0.1(25 - \varepsilon) + 0.5$	(WRC-2000)

22.39 The values in No. **22.32** applicable to the off-axis angle range from 48° to 180° are intended to account for spillover effects. (WRC-2000)

Section VII – Limits to the interference into the frequency band 14.5-14.8 GHz by the fixed-satellite service (Earth-to-space) not for feeder links for the broadcasting satellite service (WRC-15)

22.40 Under assumed free-space propagation conditions, the power flux-density emitted by an earth station of a geostationary-satellite network not for feeder links for the broadcasting-satellite service in the frequency bands 14.5-14.75 GHz in countries listed in Resolution **163 (WRC-15)** and 14.5-14.8 GHz in countries listed in Resolution **164 (WRC-15)** shall not exceed the value of −76 dB(W/(m^2 · 27 MHz)) at any point in the geostationary-satellite orbit. (WRC-23)

ARTICLE 23

Broadcasting services

Section I – Broadcasting service

23.1 *A – General*

23.2 § 1 1) The establishment and use of broadcasting stations (sound broadcasting and television broadcasting stations) on board ships, aircraft or any other floating or airborne objects outside national territories is prohibited.

23.3 2) In principle, except in the frequency band 3 900-4 000 kHz, broadcasting stations using frequencies below 5 060 kHz or above 41 MHz shall not employ power exceeding that necessary to maintain economically an effective national service of good quality within the frontiers of the country concerned.

23.4 *B – Broadcasting in the Tropical Zone*

23.5 § 2 1) In these Regulations, the expression "broadcasting in the Tropical Zone" indicates a type of broadcasting for internal national use in countries in the zone defined in Nos. **5.16** to **5.21**, where it may be shown that because of the difficulty of high atmospheric noise level and propagation it is not possible to provide economically a more satisfactory service by using low, medium, or very high frequencies.

23.6 2) The use by the broadcasting service of the bands listed below is restricted to the Tropical Zone:

2 300-2 498 kHz	(Region 1)
2 300-2 495 kHz	(Regions 2 and 3)
3 200-3 400 kHz	(all Regions)
4 750-4 995 kHz	(all Regions)
5 005-5 060 kHz	(all Regions).

23.7 3) The carrier power of the transmitters operating in this service in the bands listed in No. **23.6** shall not exceed 50 kW.

23.8 4) Within the Tropical Zone, the broadcasting service has priority over the other services with which it shares the bands listed in No. **23.6**.

23.9 5) However, in that part of Libya north of parallel 30° North the broadcasting service in the bands listed in No. **23.6** has equal rights to operate with other services in the Tropical Zone with which it shares these bands.

23.10 6) The broadcasting service operating inside the Tropical Zone, and other services operating outside this zone, are subject to the provisions of No. **4.8**.

23.11 *C − HF bands allocated to the broadcasting service except the bands as referred to in No. **23.6*** (WRC-03)

23.12 § 3 Transmitting stations of the broadcasting service operating in the HF bands allocated to the broadcasting service, except the bands as referred to in No. **23.6**, shall meet the system specifications contained in Appendix **11**. (WRC-03)

Section II − Broadcasting-satellite service

23.13 § 4 In devising the characteristics of a space station in the broadcasting-satellite service, all technical means available shall be used to reduce, to the maximum, the radiation over the territory of other countries unless an agreement has been previously reached with such countries.

23.13A If the Bureau receives an indication of a written agreement under No. **23.13**, it shall include reference to that agreement when the assignments to the system are recorded with reference to No. **23.13** in the Remarks column of the Master International Frequency Register or included in the Regions 1 and 3 List. (WRC-2000)

23.13B If, within the four-month period following the publication of the Special Section for a broadcasting-satellite service (except sound broadcasting) network submitted for coordination under Article **9** or Appendix **30**, an administration informs the Bureau that all technical means have not been used to reduce the radiation over its territory, the Bureau shall draw the attention of the responsible administration to the comments received. The Bureau shall request the two administrations to make every effort possible in order to resolve the issue. Either administration may request the Bureau to study the matter and submit its report to the administrations concerned. If no agreement can be reached, then the Bureau shall delete the territory of the objecting administration from the service area without adversely affecting the rest of the service area and inform the responsible administration. (WRC-2000)

23.13C If, after the four-month period mentioned above, an administration objects to remaining in the service area, the Bureau shall delete the territory of the objecting administration from the service area of the broadcasting-satellite service (except sound broadcasting) network concerned without adversely affecting the rest of the service area and inform the responsible administration. (WRC-2000)

ARTICLE 24

Fixed service

24.1 Administrations are urged to discontinue, in the fixed service, the use of double-sideband radiotelephone (class A3E) transmissions.

24.2 Class F3E or G3E emissions are prohibited in the fixed service in the bands below 30 MHz.

24.3 (SUP - WRC-03)

24.4 (SUP - WRC-03)

24.5 (SUP - WRC-03)

24.6 (SUP - WRC-03)

ARTICLE 25

Amateur services

Section I – Amateur service

25.1 § 1 Radiocommunication between amateur stations of different countries shall be permitted unless the administration of one of the countries concerned has notified that it objects to such radiocommunications. (WRC-03)

25.2 § 2 1) Transmissions between amateur stations of different countries shall be limited to communications incidental to the purposes of the amateur service, as defined in No. **1.56** and to remarks of a personal character. (WRC-03)

25.2A 1A) Transmissions between amateur stations of different countries shall not be encoded for the purpose of obscuring their meaning, except for control signals exchanged between earth command stations and space stations in the amateur-satellite service. (WRC-03)

25.3 2) Amateur stations may be used for transmitting international communications on behalf of third parties only in case of emergencies or disaster relief. An administration may determine the applicability of this provision to amateur stations under its jurisdiction. (WRC-03)

25.4 (SUP - WRC-03)

25.5 § 3 1) Administrations shall determine whether or not a person seeking a licence to operate an amateur station shall demonstrate the ability to send and receive texts in Morse code signals. (WRC-03)

25.6 2) Administrations shall verify the operational and technical qualifications of any person wishing to operate an amateur station. Guidance for standards of competence may be found in the most recent version of Recommendation ITU-R M.1544. (WRC-03)

25.7 § 4 The maximum power of amateur stations shall be fixed by the administrations concerned. (WRC-03)

25.8 § 5 1) All pertinent Articles and provisions of the Constitution, the Convention and of these Regulations shall apply to amateur stations. (WRC-03)

25.9 2) During the course of their transmissions, amateur stations shall transmit their call sign at short intervals.

25.9A § 5A Administrations are encouraged to take the necessary steps to allow amateur stations to prepare for and meet communication needs in support of disaster relief. (WRC-03)

25.9B § 5B An administration may determine whether or not to permit a person who has been granted a licence to operate an amateur station by another administration to operate an amateur station while that person is temporarily in its territory, subject to such conditions or restrictions it may impose. (WRC-03)

Section II – Amateur-satellite service

25.10 § 6 The provisions of Section I of this Article shall apply equally, as appropriate, to the amateur-satellite service.

25.11 § 7 Administrations authorizing space stations in the amateur-satellite service shall ensure that sufficient earth command stations are established before launch to ensure that any harmful interference caused by emissions from a station in the amateur-satellite service can be terminated immediately (see No. **22.1**). (WRC-03)

ARTICLE 26

Standard frequency and time signal service

26.1 § 1 1) To facilitate more efficient use of the radio frequency spectrum and to assist other technical and scientific activities, administrations providing or intending to provide a standard frequency and time signal service shall coordinate, in accordance with the provisions in this Article, the establishment and operation of such a service on a worldwide basis. Attention should be given to the extension of this service to those areas of the world not adequately served.

26.2 2) To this end, each administration shall take steps to coordinate, with the assistance of the Bureau, any new standard frequency or time signal transmission or any change in existing transmissions in the standard frequency bands. For this purpose, administrations shall exchange between themselves, and furnish to the Bureau, all relevant information. On this matter, the Bureau shall consult other international organizations having a direct and substantial interest in the subject.

26.3 3) In so far as is practicable, a new frequency assignment in the standard frequency bands should not be made or notified to the Bureau until appropriate coordination has been completed.

26.4 § 2 Administrations shall cooperate in reducing interference in the frequency bands to which the standard frequency and time signal service is allocated.

26.5 § 3 Administrations which provide this service shall cooperate through the Bureau in the collation and distribution of the results of the measurements of standard frequencies and time signals, as well as details concerning adjustments to the frequencies and time signals.

26.6 § 4 In selecting the technical characteristics of standard frequency and time signal transmissions, administrations shall be guided by the relevant ITU-R Recommendations.

ARTICLE 27

Experimental stations

27.1 § 1 1) An experimental station may enter into communication with an experimental station of another country only after it has been authorized to do so by its administration. Each administration shall notify other administrations concerned when such authorizations are issued.

27.2 2) The administrations concerned determine by special arrangement the conditions under which communications may be established.

27.3 § 2 Administrations shall take such measures as they judge necessary to verify the operational and technical qualifications of any person wishing to operate the apparatus of an experimental station.

27.4 § 3 The administrations concerned shall fix the maximum power of experimental stations, having regard to the purpose for which their establishment has been authorized and the conditions under which they are to operate.

27.5 § 4 1) All the general rules of the Constitution, the Convention and of these Regulations shall apply to experimental stations. In particular, experimental stations shall comply with the technical conditions imposed upon transmitters operating in the same frequency bands, except where the technical principles of the experiments prevent this. In such a case, the administration which authorizes the operation of these stations may grant a dispensation in an appropriate form.

27.6 2) During the course of their transmissions, experimental stations shall transmit, at short intervals, their call sign or any other recognized form of identification (see Article **19**).

27.7 § 5 Where there is no risk of an experimental station causing harmful interference to a service of another country, the administration concerned may, if considered desirable, adopt different provisions from those contained in this Article.

ARTICLE 28

Radiodetermination services

Section I – General provisions

28.1 § 1 Administrations which have established a radiodetermination service shall take the necessary steps to ensure the effectiveness and regularity of that service; however they accept no responsibility for the consequences that might arise from the use of inaccurate information furnished, defective working, or failure of their stations.

28.2 § 2 In the case of doubtful or unreliable observations, the station taking the bearing or fixing the position shall, whenever possible, notify the station to which this information is given of any such doubt or unreliability.

28.3 § 3 Administrations shall notify to the Bureau the characteristics of each radiodetermination station providing an international service of value to the maritime mobile service and, if considered necessary, for each station or group of stations, the sectors in which the information furnished is normally reliable. This information is published in the List of Coast Stations and Special Service Stations (List IV), and the Bureau shall be notified of any change of a permanent nature. (WRC-07)

28.4 § 4 The method of identification of radiodetermination stations shall be so chosen as to avoid any doubt as to their identity.

28.5 § 5 Signals sent by radiodetermination stations shall be such as to permit accurate and precise measurements.

28.6 § 6 Any information concerning modification or irregularity of working of a radiodetermination station shall be notified without delay in the following manner:

28.7 *a)* land stations of countries operating a radiodetermination service shall send out daily, if necessary, notices of modifications or irregularities in working until such time as normal working is restored or, if a permanent alteration has been made, until such time as it can reasonably be taken that all navigators interested have been warned;

28.8 *b)* permanent alterations or irregularities of long duration shall be published as soon as possible in the relevant notices to navigators.

Section II – Provisions for the radiodetermination-satellite service

28.9 § 7 1) The provisions of Nos. **28.1** to **28.8**, excluding No. **28.2**, shall be applied to the maritime radionavigation-satellite service.

28.10 2) The provisions of Nos. **28.1** to **28.8**, excluding Nos. **28.2** and **28.3**, shall be applied to the aeronautical radionavigation-satellite service.

28.11 3) The provisions of Nos. **28.1** to **28.8**, excluding Nos. **28.2** and **28.3**, shall be applied to the radiodetermination-satellite service.

Section III – Radio direction-finding stations

28.12 § 8 1) In the maritime radionavigation service, the radiotelegraph frequency normally used for radio direction-finding is 410 kHz. All direction-finding stations of the maritime radionavigation service using radiotelegraphy shall be able to use this frequency. They shall, in addition, be able to take bearings on 500 kHz, especially for locating stations sending signals of distress, alarm and urgency.

28.13 2) Where a radio direction-finding service is provided in the authorized bands between 1 606.5 kHz and 2 850 kHz, the radio direction-finding stations should be able to take bearings on the radiotelephone distress and calling frequency 2 182 kHz. (WRC-03)

28.14 3) Where a radio direction-finding station as defined in No. **1.12**, operates in the bands between 156 MHz and 174 MHz, it should be able to take bearings on the VHF distress and calling frequency 156.8 MHz and on the VHF digital selective calling frequency 156.525 MHz.

28.15 Not used.

28.16 § 9 In the absence of prior arrangements, an aircraft station which calls a radio direction-finding station for a bearing shall use for this purpose a frequency on which the station called normally keeps watch.

28.17 § 10 In the aeronautical radionavigation service, the procedure contemplated for radio direction-finding in this Section is applicable, except where special procedures are in force as a result of arrangements concluded between the administrations concerned.

Section IV – Radiobeacon stations

28.18 § 11 When an administration thinks it desirable in the interests of navigation to organize a service of radiobeacon stations, it may use for this purpose:

28.19 *a)* radiobeacons properly so-called, established on land or on ships permanently moored or, exceptionally, on ships navigating in a restricted area, the limits of which are known and published. The emissions of these radiobeacons may have either directional or non-directional patterns;

28.20 *b)* fixed stations, coast stations or aeronautical stations designated to function as radiobeacons, at the request of mobile stations.

28.21 § 12 1) Radiobeacons properly so-called shall use the frequency bands which are available to them under Chapter **II**.

28.22 2) Other stations notified as radiobeacons shall use for this purpose their normal working frequency and their normal class of emission.

28.23 3) The power radiated by each radiobeacon properly so-called shall be adjusted to the value necessary to produce the stipulated field strength at the limit of the range required (see Appendix **12**).

28.24 § 13 Special rules applicable to aeronautical radio beacons operating in the bands between 160 kHz and 535 kHz and to the maritime radio beacons operating in the bands between 283.5 kHz and 335 kHz are given in Appendix **12**.

ARTICLE 29

Radio astronomy service

Section I – General provisions

29.1 § 1 Administrations shall cooperate in protecting the radio astronomy service from interference, bearing in mind:

29.2 *a)* the exceptionally high sensitivity of radio astronomy stations;

29.3 *b)* the frequent need for long periods of observation without harmful interference; *and*

29.4 *c)* that the small number of radio astronomy stations in each country and their known locations often make it practicable to give special consideration to the avoidance of interference.

29.5 § 2 The locations of the radio astronomy stations to be protected and their frequencies of observation shall be notified to the Bureau in accordance with No. **11.12** and published in accordance with No. **20.16** for communication to Member States.

Section II – Measures to be taken in the radio astronomy service

29.6 § 3 The locations of radio astronomy stations shall be selected with due regard to the possibility of harmful interference to these stations.

29.7 § 4 All practicable technical means shall be adopted at radio astronomy stations to reduce their susceptibility to interference. The development of improved techniques for reducing susceptibility to interference shall be pursued, including participation in cooperative studies through the Radiocommunication Sector.

Section III – Protection of the radio astronomy service

29.8 § 5 The status of the radio astronomy service in the various frequency bands is specified in the Table of Frequency Allocations (Article **5**). Administrations shall provide protection from interference to stations in the radio astronomy service in accordance with the status of this service in those bands (see also Nos. **4.6**, **22.22** to **22.24** and **22.25**).

29.9 § 6 In providing protection from interference to the radio astronomy service on a permanent or temporary basis, administrations shall use appropriate means such as geographical separation, site shielding, antenna directivity and the use of time-sharing and the minimum practicable transmitter power.

29.10 § 7 In bands adjacent to those in which observations are carried out in the radio astronomy service, operating in accordance with these Regulations, administrations are urged, when assigning frequencies to stations of other services, to take all practicable steps to protect the radio astronomy service from harmful interference in accordance with No. **4.5**. In addition to the measures referred to in No. **29.9**, technical means for minimizing the power radiated at frequencies within the band used for radio astronomy should be given special consideration (see also No. **4.6**).

29.11 § 8 When assigning frequencies to stations in other bands, administrations are urged, as far as practicable, to take into consideration the need to avoid spurious emissions which could cause harmful interference to the radio astronomy service operating in accordance with these Regulations (see also No. **4.6**).

29.12 § 9 In applying the measures outlined in this Section, administrations should bear in mind that the radio astronomy service is extremely susceptible to interference from space and airborne transmitters (for further information, see the most recent version of Recommendation ITU-R RA.769). (WRC-03)

29.13 § 10 Administrations shall take note of the relevant ITU-R Recommendations with the aim of limiting interference to the radio astronomy service from other services.

ARTICLE 29A

Radio services related to Earth observation

29A.1 § 1 Radio services related to Earth observations include the Earth exploration-satellite service (EESS), meteorological-satellite service (MetSat), meteorological aids service (MetAids) and specific applications of the radiolocation service (e.g. meteorological or oceanographic radars, wind profiler radars). In this respect, see Resolution **673 (Rev.WRC-12)***. (WRC-12)

* *Note by the Secretariat:* This Resolution was revised by WRC-23.

ARTICLE 29B

Radio service related to space weather observations

29B.1 § 1 Space weather sensors may operate under the meteorological aids service in the subset MetAids (space weather) allocations. (WRC-23)

29B.2 § 2 The importance of space weather observations and their service designation are highlighted in Resolution **675 (WRC-23)**. (WRC-23)

CHAPTER VII

Distress and safety communications[1]

[1] **C.VII** For the purposes of this Chapter, distress and safety communications include distress, urgency and safety calls and messages.

ARTICLE 30

General provisions

Section I – Introduction

30.1 § 1 This Chapter contains the provisions for the operational use of the global maritime distress and safety system (GMDSS), whose functional requirements, system elements and equipment carriage requirements are set forth in the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended. This Chapter also contains provisions for initiating distress, urgency and safety communications by means of radiotelephony on the frequency 156.8 MHz (VHF channel 16). (WRC-07)

30.2 § 2 No provision of these Regulations prevents the use by a mobile station or a mobile earth station in distress of any means at its disposal to attract attention, make known its position, and obtain help (see also No. **4.9**).

30.3 § 3 No provision of these Regulations prevents the use by stations on board aircraft, ships engaged in search and rescue operations, land stations, or coast earth stations, in exceptional circumstances, of any means at their disposal to assist a mobile station or a mobile earth station in distress (see also Nos. **4.9** and **4.16**).

Section II – Maritime provisions

30.4 § 4 The provisions specified in this Chapter are obligatory in the maritime mobile service and the maritime mobile-satellite service for all stations using the frequencies and techniques prescribed for the functions set out herein (see also No. **30.5**). (WRC-07)

30.5 § 5 The International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended, prescribes which ships and which of their survival craft shall be provided with radio equipment, and which ships shall carry portable radio equipment for use in survival craft. It also prescribes the requirements which shall be met by such equipment.

30.6 § 6 Ship earth stations located at rescue coordination centres[1] may be authorized by an administration to communicate for distress and safety purposes with any other station using bands allocated to the maritime mobile-satellite service, when special circumstances make it essential, notwithstanding the methods of working provided for in these Regulations.

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[1] **30.6.1** The term "rescue coordination centre", as defined in the International Convention on Maritime Search and Rescue (1979) refers to a unit responsible for promoting the efficient organization of search and rescue services and for coordinating the conduct of search and rescue operations within a search and rescue region.

30.7 § 7 Mobile stations[2] of the maritime mobile service may communicate, for safety purposes, with stations of the aeronautical mobile service. Such communications shall normally be made on the frequencies authorized, and under the conditions specified in Section I of Article **31** (see also No. **4.9**).

Section III − Aeronautical provisions

30.8 § 8 The procedure specified in this Chapter is obligatory for communications between stations on board aircraft and stations of the maritime mobile-satellite service, wherever this service or stations of this service are specifically mentioned.

30.9 § 9 Certain provisions of this Chapter are applicable to the aeronautical mobile service, except in the case of special arrangements between the governments concerned.

30.10 § 10 Mobile stations of the aeronautical mobile service may communicate, for distress and safety purposes, with stations of the maritime mobile service in conformity with the provisions of this Chapter.

30.11 § 11 Any station on board an aircraft required by national or international regulations to communicate for distress, urgency or safety purposes with stations of the maritime mobile service that comply with the provisions of this Chapter, shall be capable of transmitting and receiving class J3E emissions when using the carrier frequency 2 182 kHz, or class J3E emissions when using the carrier frequency 4 125 kHz, or class G3E emissions when using the frequency 156.8 MHz and, optionally, the frequency 156.3 MHz.

30.11A § 11A Aircraft, when conducting search and rescue operations, are also permitted to operate digital selective calling (DSC) equipment on the VHF DSC frequency 156.525 MHz, and automatic identification system (AIS) equipment on the AIS frequencies 161.975 MHz and 162.025 MHz. (WRC-07)

Section IV − Land mobile provisions

30.12 § 12 Stations of the land mobile service in uninhabited, sparsely populated or remote areas may, for distress and safety purposes, use the frequencies provided for in this Chapter.

30.13 § 13 The procedure specified in this Chapter is obligatory for stations of the land mobile service when using frequencies provided in these Regulations for distress and safety communications.

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[2] **30.7.1** Mobile stations communicating with the stations of the aeronautical mobile (R) service in bands allocated to the aeronautical mobile (R) service shall conform to the provisions of the Regulations which relate to that service and, as appropriate, to any special arrangements between the governments concerned by which the aeronautical mobile (R) service is regulated.

ARTICLE 31

Frequencies for the global maritime distress and safety system (GMDSS)

Section I – General

31.1 § 1 The frequencies to be used for the transmission of distress and safety information under the GMDSS are contained in Appendix **15**. In addition to the frequencies listed in Appendix **15**, ship stations and coast stations should use other appropriate frequencies for the transmission of safety messages and general radiocommunications to and from shore-based radio systems or networks. (WRC-07)

31.2 § 2 Any emission causing harmful interference to distress and safety communications on any of the discrete frequencies identified in Appendix **15** is prohibited. (WRC-07)

31.3 § 3 The number and duration of test transmissions shall be kept to a minimum on the frequencies identified in Appendix **15**; they should be coordinated with a competent authority, as necessary, and, wherever practicable, be carried out on artificial antennas or with reduced power. However, testing on the distress and safety calling frequencies should be avoided, but where this is unavoidable, it should be indicated that these are test transmissions.

31.4 § 4 Before transmitting for other than distress purposes on any of the frequencies identified in Appendix **15** for distress and safety, a station shall, where practicable, listen on the frequency concerned to make sure that no distress transmission is being sent.

31.5 Not used.

Section II – Survival craft stations

31.6 § 5 1) Equipment for radiotelephony use in survival craft stations shall, if capable of operating on any frequency in the bands between 156 MHz and 174 MHz, be able to transmit and receive on 156.8 MHz and at least one other frequency in these bands.

31.7 2) Equipment for transmitting locating signals from survival craft stations shall be capable of operating in the frequency band 9 200-9 500 MHz or on 161.975 MHz (AIS 1 of Appendix **18**) and 162.025 MHz (AIS 2 of Appendix **18**). (WRC-23)

31.8 3) Equipment with digital selective calling facilities for use in survival craft shall, if capable of operating:

31.9 *a)* in the bands between 1 606.5 kHz and 2 850 kHz, be able to transmit on 2 187.5 kHz; (WRC-03)

31.10 *b)* in the bands between 4 000 kHz and 27 500 kHz, be able to transmit on 8 414.5 kHz;

31.11 *c)* in the bands between 156 MHz and 174 MHz, be able to transmit on 156.525 MHz.

Section III − Watchkeeping

31.12 *A − Coast stations*

31.13 § 6 Those coast stations assuming a watch-keeping responsibility in the GMDSS shall maintain an automatic digital selective calling watch on frequencies and for periods of time as indicated in the information published in the List of Coast Stations and Special Service Stations (List IV). (WRC-07)

31.14 *B − Coast earth stations*

31.15 § 7 Those coast earth stations assuming a watch-keeping responsibility in the GMDSS shall maintain a continuous automatic watch for appropriate distress alerts relayed by space stations.

31.16 *C − Ship stations*

31.17 § 8 1) Ship stations, where so equipped, shall, while at sea, maintain an automatic digital selective calling watch on the appropriate distress and safety calling frequencies in the frequency bands in which they are operating. Ship stations, where so equipped, shall also maintain watch on the appropriate frequencies for the automatic reception of transmissions of meteorological and navigational warnings and other urgent information to ships. (WRC-07)

31.18 2) Ship stations complying with the provisions of this Chapter should, where practicable, maintain a watch on the frequency 156.8 MHz (VHF channel 16). (WRC-07)

31.19 *D − Ship earth stations*

31.20 § 9 Ship earth stations complying with the provisions of this Chapter shall, while at sea, maintain watch except when communicating on a working channel.

ARTICLE 32

Operational procedures for distress communications in the global maritime distress and safety system (GMDSS) (WRC-07)

Section I – General

32.1 § 1 Distress communications rely on the use of terrestrial MF, HF and VHF radiocommunications and communications using satellite techniques. Distress communications shall have absolute priority over all other transmissions. The following terms apply:

a) The distress alert is a digital selective call (DSC) using a distress call format, in the bands used for terrestrial radiocommunication, or a distress message format, in which case it is relayed through space stations.

b) The distress call is the initial voice or text procedure.

c) The distress message is the subsequent voice or text procedure.

d) The distress alert relay is a DSC transmission on behalf of another station.

e) The distress call relay is the initial voice or text procedure for a station not itself in distress. (WRC-07)

32.2 § 2 1) The distress alert shall be sent through a satellite either with absolute priority in general communication channels, on exclusive distress and safety frequencies reserved for satellite EPIRBs in the Earth-to-space direction or on the distress and safety frequencies designated in the MF, HF and VHF bands for digital selective calling (see Appendix **15**). (WRC-07)

32.2A 1A) The distress call shall be sent on the distress and safety frequencies designated in the MF, HF and VHF bands for radiotelephony. (WRC-07)

32.3 2) The distress alert or call and subsequent messages shall be sent only on the authority of the person responsible for the ship, aircraft or other vehicle carrying the mobile station or the mobile earth station. (WRC-07)

32.4 § 3 All stations which receive a distress alert or call transmitted on the distress and safety frequencies in the MF, HF and VHF bands shall immediately cease any transmission capable of interfering with distress traffic and prepare for subsequent distress traffic. (WRC-07)

32.5 § 4 Distress alerts or distress alert relays using DSC should use the technical structures and content set forth in the most recent version of Recommendations ITU-R M.493 and ITU-R M.541. (WRC-07)

32.5A § 4A Each administration shall ensure that suitable arrangements are made for assigning and registering identities used by ships participating in the GMDSS, and shall make registration information available to rescue coordination centres on a 24-hour day, 7-day week basis. Where appropriate, administrations shall notify responsible organizations immediately of additions, deletions and other changes in these assignments (see Nos. **19.39**, **19.96** and **19.99**). Registration information submitted shall be in accordance with Resolution **340 (WRC-97)***. (WRC-07)

32.5B § 4B Any GMDSS shipboard equipment which is capable of transmitting position coordinates as part of a distress alert and which does not have an integral electronic position-fixing system receiver shall be interconnected to a separate navigation receiver, if one is installed, to provide that information automatically. (WRC-07)

32.6 § 5 Transmissions by radiotelephony shall be made slowly and distinctly, each word being clearly pronounced to facilitate transcription.

32.7 § 6 The phonetic alphabet and figure code in Appendix **14** and the abbreviations and signals in accordance with the most recent version of Recommendation ITU-R M.1172 should be used where applicable[1]. (WRC-03)

Section II – Distress alerting and distress calling (WRC-07)

32.8 *A – General*

32.9 § 7 1) The transmission of a distress alert or a distress call indicates that a mobile unit[2] or person[3] is threatened by grave and imminent danger and requires immediate assistance. (WRC-07)

32.10 2) The distress alert shall provide[4] the identification of the station in distress and its position.

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* *Note by the Secretariat:* This Resolution was abrogated by WRC-07.

[1] **32.7.1** The use of the Standard Marine Communication Phrases (SMCP) and, where language difficulties exist, the International Code of Signals, both published by the International Maritime Organization (IMO), is also recommended. It should be noted that the pronunciations for figures in Appendix **14** and IMO SMCP are different. (WRC-23)

[2] **32.9.1** Mobile unit: a ship, aircraft or other vehicle.

[3] **32.9.2** In this Article, where the case is of a person in distress, the application of the procedures may require adaptation to meet the needs of the particular circumstances.

32.9.3 (SUP - WRC-07)

[4] **32.10.1** The distress alert may also contain information regarding the nature of the distress, the type of assistance required, the course and speed of the mobile unit, the time that this information was recorded and any other information which might facilitate rescue.

32.10A § 7A 1) A distress alert is false if it was transmitted without any indication that a mobile unit or person was in distress and required immediate assistance (see No. **32.9**). Administrations receiving a false distress alert shall report this infringement in accordance with Section V of Article **15**, if that alert:

a) was transmitted intentionally;

b) was not cancelled in accordance with No. **32.53A** and Resolution **349 (Rev.WRC-23)**;

c) could not be verified as a result of either the ship's failure to keep watch on appropriate frequencies in accordance with Nos. **31.16** to **31.20**, or its failure to respond to calls from an authorized rescue authority;

d) was repeated; or

e) was transmitted using a false identity.

Administrations receiving such a report shall take appropriate steps to ensure that the infringement does not recur. No action should normally be taken against any ship or mariner for reporting and cancelling a false distress alert. (WRC-23)

32.10B 2) Administrations shall take practicable and necessary steps to ensure the avoidance of false distress alerts, including those transmitted inadvertently. (WRC-07)

32.11 *B − Transmission of a distress alert or a distress call* (WRC-07)

B1 − Transmission of a distress alert or a distress call by a ship station or a ship earth station (WRC-07)

32.12 § 8 Ship-to-shore distress alerts or calls are used to alert rescue coordination centres via coast stations or coast earth stations that a ship is in distress. These alerts are based on the use of transmissions via satellites (from a ship earth station or a satellite emergency position-indicating radiobeacon (EPIRB)) and terrestrial services (from ship stations). (WRC-23)

32.13 § 9 1) Ship-to-ship distress alerts are used to alert other ships in the vicinity of the ship in distress and are based on the use of digital selective calling in the VHF and MF bands. Additionally, the HF band may be used. (WRC-07)

32.13A 2) Ship stations equipped for digital selective calling procedures may transmit a distress call and distress message immediately following the distress alert in order to attract attention from as many ship stations as possible. (WRC-07)

32.13B 3) Ship stations not equipped for digital selective calling procedures shall, where practical, initiate the distress communications by transmitting a radio telephony distress call and message on the frequency 156.8 MHz (VHF channel 16). (WRC-07)

32.13BA § 9A The radiotelephone distress signal consists of the word MAYDAY pronounced as the French expression "m'aider". (WRC-07)

32.13C § 9B 1) The distress call sent on the frequency 156.8 MHz (VHF channel 16) shall be given in the following form, taking into account Nos. **32.6** and **32.7**:

– the distress signal "MAYDAY", spoken three times;

– the words "THIS IS";

– the name of the vessel in distress, spoken three times;

– the call sign or other identification;

– the MMSI (if the initial alert has been sent by DSC). (WRC-12)

32.13D 2) The distress message which follows the distress call should be given in the following form, taking into account Nos. **32.6** and **32.7**:

– the distress signal "MAYDAY";

– the name of the vessel in distress;

– the call sign or other identification;

– the MMSI (if the initial alert has been sent by DSC);

– the position, given as the latitude and longitude, or if the latitude and longitude are not known or if time is insufficient, in relation to a known geographical location;

– the nature of the distress;

– the kind of assistance required;

– any other useful information. (WRC-12)

32.13E § 9C DSC procedures use a combination of automated functions and manual intervention to generate the appropriate distress call format in the most recent version of Recommendation ITU-R M.541. A distress alert sent by DSC consists of one or more distress alert attempts in which a message format is transmitted identifying the station in distress, giving its last recorded position and, if entered, the nature of the distress. In MF and HF bands, distress alert attempts may be sent as a single-frequency attempt or a multi-frequency attempt on up to six frequencies within one minute. In VHF bands, only single-frequency call attempts are used. The distress alert will repeat automatically at random intervals, a few minutes apart, until an acknowledgement sent by DSC is received. (WRC-07)

B2 − Transmission of a shore-to-ship distress alert relay or a distress call relay (WRC-07)

32.14 § 10 1) A station or a rescue coordination centre which receives a distress alert or call and a distress message shall initiate the transmission of a shore-to-ship distress alert relay addressed, as appropriate, to all ships, to a selected group of ships, or to a specific ship, by satellite and/or terrestrial means. (WRC-07)

32.15 2) The distress alert relay and the distress call relay shall contain the identification of the mobile unit in distress, its position and all other information which might facilitate rescue. (WRC-07)

B3 − Transmission of a distress alert relay or a distress call relay by a station not itself in distress (WRC-07)

32.16 § 11 A station in the mobile or mobile-satellite service which learns that a mobile unit is in distress (for example, by a radio call or by observation) shall initiate and transmit a distress alert relay or a distress call relay on behalf of the mobile unit in distress once it has ascertained that any of the following circumstances apply: (WRC-07)

32.17 *a)* on receiving a distress alert or call which is not acknowledged by a coast station or another vessel within five minutes (see also Nos. **32.29**A and **32.31**); (WRC-07)

32.18 *b)* on learning that the mobile unit in distress is otherwise unable or incapable of participating in distress communications, if the master or other person responsible for the mobile unit not in distress considers that further help is necessary. (WRC-07)

32.19 § 12 1) The distress relay on behalf of a mobile unit in distress shall be sent in a form appropriate to the circumstances (see Nos. **32.19A** to **32.19D**) using either a distress call relay by radiotelephony (see Nos. **32.19D** and **32.19E**), an individually addressed distress alert relay by DSC (see No. **32.19B**), or a distress priority message through a ship earth station. (WRC-07)

32.19A 2) A station transmitting a distress alert relay or a distress call relay in accordance with Nos. **32.16** to **32.18** shall indicate that it is not itself in distress. (WRC-07)

32.19B 3) A distress alert relay sent by DSC should use the call format, as found in the most recent version of Recommendations ITU-R M.493 and ITU-R M.541, and should preferably be addressed to an individual coast station or rescue coordination centre[5]. (WRC-07)

32.19C 4) However, a ship shall not transmit a distress alert relay to all ships by digital selective calling on the VHF or MF distress frequencies following receipt of a distress alert sent by digital selective calling by the ship in distress. (WRC-07)

32.19D 5) When an aural watch is being maintained on shore and reliable ship-to-shore communications can be established by radiotelephony, a distress call relay is sent by radiotelephony and addressed to the relevant coast station or rescue coordination centre[6] on the appropriate frequency. (WRC-07)

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[5] **32.19B.1** Vessels making a distress alert relay or a distress call relay should ensure that a suitable coast station or rescue coordination centre is informed of any distress communications previously exchanged. (WRC-07)

[6] **32.19D.1** Vessels making a distress call relay should ensure that a suitable coast station or rescue coordination centre is informed of any distress communications previously exchanged. (WRC-07)

32.19E 6) The distress call relay sent by radiotelephony should be given in the following form, taking into account Nos. **32.6** and **32.7**:

– the distress signal "MAYDAY RELAY", spoken three times;

– the words "ALL STATIONS" or coast station name, as appropriate, spoken three times;

– the words "THIS IS";

– the name of the relaying station, spoken three times;

– the call sign or other identification of the relaying station;

– the MMSI (if the initial alert has been sent by DSC) of the relaying station (the vessel not in distress). (WRC-12)

32.19F 7) This call shall be followed by a distress message which shall, as far as possible, repeat the information[7] contained in the original distress alert or distress message. (WRC-07)

32.19G 8) When no aural watch is being maintained on shore, or there are other difficulties in establishing reliable ship-to-shore communications by radiotelephony, an appropriate coast station or rescue coordination centre may be contacted by sending an individual distress alert relay by DSC, addressed solely to that station and using the appropriate call formats. (WRC-07)

32.19H 9) In the event of continued failure to contact a coast station or rescue coordination centre directly, it may be appropriate to send a distress call relay by radiotelephony addressed to all ships, or to all ships in a certain geographical area. See also No. **32.19C**. (WRC-07)

32.20 *C − Receipt and acknowledgement of distress alerts and distress calls* (WRC-07)

C1 − Procedure for acknowledgement of receipt of distress alerts or a distress call (WRC-07)

32.21 § 13 1) Acknowledgement of receipt of a distress alert, including a distress alert relay, shall be made in the manner appropriate to the method of transmission of the alert and within the time-scale appropriate to the role of the station in receipt of the alert. Acknowledgement by satellite shall be sent immediately. (WRC-07)

32.21A 2) When acknowledging receipt of a distress alert sent by DSC[8], the acknowledgement in the terrestrial services shall be made by DSC or radiotelephony on the associated distress and safety frequency in the same band in which the distress alert was received, taking due account of the directions given in the most recent versions of Recommendations ITU-R M.493 and ITU-R M.541. (WRC-23)

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[7] **32.19F.1** If the station in distress cannot be identified, then it will be necessary to originate the distress message as well, using, for example, terms such as "Unidentified trawler" to refer to the mobile unit in distress. (WRC-07)

[8] **32.21A.1** In order to ensure that no unnecessary delay occurs before the shore-based authorities become aware of a distress incident, the acknowledgement by DSC to a distress alert sent by DSC shall normally only be made by a coast station or a rescue coordination centre. An acknowledgement by DSC will cancel any further automated repetition of the distress alert using DSC. (WRC-07)

32.21B Acknowledgement by DSC of a distress alert sent by DSC addressed to stations in the maritime mobile service shall be addressed to all stations[8]. (WRC-07)

32.22 (SUP - WRC-07)

32.23 § 15 When acknowledging by radiotelephony the receipt of a distress alert or a distress call from a ship station or a ship earth station, the acknowledgement should be given in the following form, taking into account Nos. **32.6** and **32.7**:

– the distress signal "MAYDAY";

– the name followed by the call sign, or the MMSI or other identification of the station sending the distress message;

– the words "THIS IS";

– the name and call sign or other identification of the station acknowledging receipt;

– the word "RECEIVED";

– the distress signal "MAYDAY". (WRC-23)

32.24 (SUP - WRC-23)

32.25 (SUP - WRC-07)

C2 − Receipt and acknowledgement by a coast station, a coast earth station or a rescue coordination centre (WRC-07)

32.26 § 17 Coast stations and the appropriate coast earth stations in receipt of distress alerts or distress calls shall ensure that they are routed as soon as possible to a rescue coordination centre. In addition, receipt of a distress alert or a distress call is to be acknowledged as soon as possible by a coast station, or by a rescue coordination centre via a coast station or an appropriate coast earth station. A shore-to-ship distress alert relay or a distress call relay (see Nos. **32.14** and **32.15**) shall also be made when the method of receipt warrants a broadcast alert to shipping or when the circumstances of the distress incident indicate that further help is necessary. (WRC-07)

32.27 § 18 A coast station using DSC to acknowledge a distress alert shall transmit the acknowledgement on the distress calling frequency on which the distress alert was received and should address it to all ships. The acknowledgement shall include the identification of the ship whose distress alert is being acknowledged. (WRC-07)

C3 − Receipt and acknowledgement by a ship station or ship earth station (WRC-07)

32.28 § 19 1) Ship or ship earth stations in receipt of a distress alert or a distress call shall, as soon as possible, inform the master or person responsible for the ship of the contents of the distress alert. (WRC-07)

32.29 2) In areas where reliable communications with one or more coast stations are practicable, ship stations in receipt of a distress alert or a distress call from another vessel should defer acknowledgement for a short interval so that a coast station may acknowledge receipt in the first instance. (WRC-07)

32.29A 3) Ship stations in receipt of a distress call sent by radiotelephony on the frequency 156.8 MHz (VHF channel 16) shall, if the call is not acknowledged by a coast station or another vessel within five minutes, acknowledge receipt to the vessel in distress and use any means available to relay the distress call to an appropriate coast station or coast earth station (see also Nos. **32.16** to **32.19F**). (WRC-07)

32.30 § 20 1) Ship stations operating in areas where reliable communications with a coast station are not practicable which receive a distress alert or call from a ship station which is, beyond doubt, in their vicinity, shall, as soon as possible and if appropriately equipped, acknowledge receipt to the vessel in distress and inform a rescue coordination centre through a coast station or coast earth station (see also Nos. **32.16** to **32.19H**). (WRC-07)

32.31 2) However, in order to avoid making unnecessary or confusing transmissions in response, a ship station, which may be at a considerable distance from the incident, receiving an HF distress alert, shall not acknowledge it but shall observe the provisions of Nos. **32.36** and **32.37**, and shall, if the distress alert is not acknowledged by a coast station within five minutes, relay the distress alert, but only to an appropriate coast station or coast earth station (see also Nos. **32.16** to **32.19H**). (WRC-23)

32.32 § 21 A ship station acknowledging receipt of a distress alert sent by DSC should, in accordance with No. **32.29** or No. **32.30**: (WRC-07)

32.33 *a)* in the first instance, acknowledge receipt of the distress alert by using radiotelephony on the distress and safety traffic frequency in the band used for the alert, taking into account any instructions which may be issued by a responding coast station; (WRC-07)

32.34 *b)* if acknowledgement by radiotelephony of the distress alert received on the MF or VHF distress alerting frequency is unsuccessful, acknowledge receipt of the distress alert by responding with a digital selective call on the appropriate frequency.

32.34A § 21A However, unless instructed to do so by a coast station or a rescue coordination centre, a ship station may only send an acknowledgement by DSC in the event that:

a) no acknowledgement by DSC from a coast station has been observed; and

b) no other communication by radiotelephony to or from the vessel in distress has been observed; and

c) at least five minutes have elapsed and the distress alert by DSC has been repeated (see No. **32.21A.1**). (WRC-23)

32.35 § 22 A ship station in receipt of a shore-to-ship distress alert relay or distress call relay (see No. **32.14**) should establish communication as directed and render such assistance as required and appropriate. (WRC-07)

32.36 *D − Preparations for handling of distress traffic*

32.37 § 23 On receipt of a distress alert or a distress call, ship stations and coast stations shall set watch on the radiotelephone distress and safety traffic frequency associated with the distress and safety calling frequency on which the distress alert was received. (WRC-07)

32.38 (SUP - WRC-23)

Section III − Distress traffic

32.39 *A − General and search and rescue coordinating communications*

32.40 § 25 Distress traffic consists of all messages relating to the immediate assistance required by the ship in distress, including search and rescue communications and on-scene communications. The distress traffic shall as far as possible be on the frequencies contained in Article **31**.

32.41 (SUP - WRC-07)

32.42 § 26 For distress traffic by radiotelephony, when establishing communications, calls shall be prefixed by the distress signal MAYDAY.

32.43 (SUP - WRC-23)

32.44 (SUP - WRC-23)

32.45 § 28 1) The rescue coordination centre responsible for controlling a search and rescue operation shall also coordinate the distress traffic relating to the incident or may appoint another station to do so. (WRC-07)

32.46 2) The rescue coordination centre coordinating distress traffic, the unit coordinating search and rescue operations[9] or the coast station involved may impose silence on stations which interfere with that traffic. This instruction shall be addressed to all stations or to one station only, according to circumstances. In either case, the following shall be used:

32.47 in radiotelephony, the signal SEELONCE MAYDAY, pronounced as the French expression "silence, m'aider". (WRC-23)

32.48 (SUP - WRC-23)

32.49 § 29 Until they receive the message indicating that normal working may be resumed (see No. **32.51**), all stations which are aware of the distress traffic, and which are not taking part in it, and which are not in distress, are forbidden to transmit on the frequencies in which the distress traffic is taking place.

32.50 § 30 A station of the mobile service which, while following distress traffic, is able to continue its normal service, may do so when the distress traffic is well established and on condition that it observes the provisions of No. **32.49** and that it does not interfere with distress traffic.

32.51 § 31 When distress traffic has ceased on frequencies which have been used for distress traffic, the station controlling the search and rescue operation shall initiate a message for transmission on these frequencies indicating that distress traffic has finished. (WRC-07)

32.52 § 32 In radiotelephony, the message referred to in No. **32.51** should consist of the following taking into account Nos. **32.6** and **32.7**:

– the distress signal "MAYDAY";

– the words "ALL STATIONS", spoken three times;

– the words "THIS IS";

– the name of the station sending that message, spoken three times;

– the call sign or other identification of the station sending the message;

– the time of handing in of the message;

– the MMSI (if the initial alert has been sent by DSC), the name and the call sign of the mobile station which was in distress;

– the words "SEELONCE FEENEE" pronounced as the French words "silence fini". (WRC-23)

32.53 (SUP - WRC-23)

32.53A *Cancellation of an inadvertent distress alert* (WRC-07)

32.53B § 32A 1) A station transmitting an inadvertent distress alert or call shall cancel the transmission. (WRC-07)

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[9] **32.46.1** In accordance with the International Convention on Maritime Search and Rescue (1979) this is the on-scene commander (OSC) or the coordinator surface search (CSS).

32.53C 2) An inadvertent DSC alert shall be cancelled by DSC, if the DSC equipment is so capable. The cancellation should be in accordance with the most recent version of Recommendation ITU-R M.493. In all cases, cancellations shall also be transmitted by radiotelephone in accordance with **32.53E**. (WRC-07)

32.53D 3) An inadvertent distress call shall be cancelled by radiotelephone in accordance with the procedure in **32.53E**. (WRC-07)

32.53E 4) Inadvertent distress transmissions shall be cancelled orally on the associated distress and safety frequency in the same band on which the distress transmission was sent, using the following procedure, taking into account Nos. **32.6** and **32.7**:

– the words "ALL STATIONS", spoken three times;

– the words "THIS IS";

– the name of the vessel, spoken three times;

– the call sign or other identification;

– the MMSI (if the initial alert has been sent by DSC);

– the words "PLEASE CANCEL MY DISTRESS ALERT OF" followed by the time in UTC.

Monitor the same band on which the inadvertent distress transmission was sent and respond to any communications concerning that distress transmission as appropriate. (WRC-12)

32.54 *B – On-scene communications*

32.55 § 33 1) On-scene communications are those between the mobile unit in distress and assisting mobile units, and between the mobile units and the unit coordinating search and rescue operations[10].

32.56 2) Control of on-scene communications is the responsibility of the unit coordinating search and rescue operations[10]. Simplex communications shall be used so that all on-scene mobile stations may share relevant information concerning the distress incident. (WRC-23)

32.57 § 34 1) The preferred frequencies in radiotelephony for on-scene communications are 156.8 MHz and 2 182 kHz. (WRC-23)

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[10] **32.55.1**, **32.56.1** and **32.59.1** In accordance with the International Convention on Maritime Search and Rescue (1979) this is the on-scene commander (OSC) or the coordinator surface search (CSS).

32.58 2) In addition to 156.8 MHz and 2 182 kHz, the frequencies 3 023 kHz, 4 125 kHz, 5 680 kHz, 123.1 MHz and 156.3 MHz may be used for ship-to-aircraft on-scene communications.

32.59 § 35 The selection or designation of on-scene frequencies is the responsibility of the unit coordinating search and rescue operations[10]. Normally, once an on-scene frequency is established, a continuous aural watch is maintained by all participating on-scene mobile units on the selected frequency. (WRC-23)

32.60 *C − Locating and homing signals*

32.61 § 36 1) Locating signals are radio transmissions intended to facilitate the finding of a mobile unit in distress or the location of survivors. These signals include those transmitted by searching units, and those transmitted by the mobile unit in distress, by survival craft, by satellite emergency position-indicating radiobeacons (EPIRBs), by radar search and rescue transmitters (SARTs) and by automatic identification system search and rescue transmitters (AIS-SARTs) to assist the searching units. (WRC-23)

32.62 2) Homing signals are those locating signals which are transmitted by mobile units in distress, or by survival craft, for the purpose of providing searching units with a signal that can be used to determine the bearing to the transmitting stations.

32.63 3) Locating signals may be transmitted in the following frequency bands:

117.975-137 MHz;

156-174 MHz;

406-406.1 MHz; and

9 200-9 500 MHz. (WRC-07)

32.64 (SUP - WRC-07)

ARTICLE 33

Operational procedures for urgency and safety communications in the global maritime distress and safety system (GMDSS)

Section I – General

33.1 § 1 1) Urgency and safety communications include: (WRC-07)

33.2 *a)* navigational and meteorological warnings and urgent information;

33.3 *b)* ship-to-ship safety of navigation communications;

33.4 *c)* ship reporting communications;

33.5 *d)* support communications for search and rescue operations;

33.6 *e)* other urgency and safety messages; and

33.7 *f)* communications relating to the navigation, movements and needs of ships and weather observation messages destined for an official meteorological service.

33.7A 2) Urgency communications shall have priority over all other communications, except distress. (WRC-07)

33.7B 3) Safety communications shall have priority over all other communications, except distress and urgency. (WRC-07)

Section II – Urgency communications

33.7C § 1A The following terms apply:

a) The urgency announcement is a digital selective call using an urgency call format[1], in the bands used for terrestrial radiocommunication, or an urgency message format, in which case it is relayed through space stations.

b) The urgency call is the initial voice or text procedure.

c) The urgency message is the subsequent voice or text procedure. (WRC-07)

33.8 § 2 1) In a terrestrial system, urgency communications consist of an announcement, transmitted using digital selective calling, followed by the urgency call and message transmitted using radiotelephony or data. The announcement of the urgency message shall be made on one or more of the distress and safety calling frequencies specified in Section I of Article **31** using either digital selective calling and the urgency call format, or if not available, radio telephony procedures and the urgency signal. Announcements using digital selective calling should use the technical structure and content set forth in the most recent version of Recommendations ITU-R M.493 and ITU-R M.541. A separate announcement need not be made if the urgency message is to be transmitted through the maritime mobile-satellite service. (WRC-23)

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[1] **33.7C.1** The format of urgency calls and urgency messages should be in accordance with the relevant ITU-R Recommendations. (WRC-07)

33.8A 2) Ship stations not equipped for digital selective calling procedures may announce an urgency call and message by transmitting the urgency signal by radiotelephony on the frequency 156.8 MHz (channel 16), while taking into account that other stations outside VHF range may not receive the announcement. (WRC-07)

33.8B 3) In the maritime mobile service, urgency communications may be addressed either to all stations or to a particular station. When using digital selective calling techniques, the urgency announcement shall indicate which frequency is to be used to send the subsequent message and, in the case of a message to all stations, shall use the "All Ships" format setting. (WRC-07)

33.8C 4) Urgency announcements from a coast station may also be directed to a group of vessels or to vessels in a defined geographical area. (WRC-07)

33.9 § 3 1) The urgency call and message shall be transmitted on one or more of the distress and safety traffic frequencies specified in Section I of Article **31**. (WRC-07)

33.9A 2) However, in the maritime mobile service, the urgency message shall be transmitted on a working frequency:

a) in the case of a long message or a medical call; *or*

b) in areas of heavy traffic when the message is being repeated.

An indication to this effect shall be included in the urgency announcement or call. (WRC-07)

33.9B 3) In the maritime mobile-satellite service, a separate urgency announcement or call does not need to be made before sending the urgency message. However, if available, the appropriate network priority access settings should be used for sending the message. (WRC-07)

33.10 § 4 The urgency signal consists of the words PAN PAN. In radiotelephony each word of the group shall be pronounced as the French word "panne".

33.11 § 5 1) The urgency call format and the urgency signal indicate that the calling station has a very urgent message to transmit concerning the safety of a mobile unit or a person. (WRC-07)

33.11A 2) Communications concerning medical advice may be preceded by the urgency signal. Mobile stations requiring medical advice may obtain it through any of the land stations shown in the List of Coast Stations and Special Service Stations. (WRC-07)

33.11B 3) Urgency communications to support search and rescue operations need not be preceded by the urgency signal. (WRC-07)

33.12 § 6 The urgency call should consist of the following, taking into account Nos. **32.6** and **32.7**:

– the urgency signal "PAN PAN", spoken three times;

– the name of the called station or "ALL STATIONS", spoken three times;

– the words "THIS IS";

– the name of the station transmitting the urgency message, spoken three times;

– the call sign or any other identification;

– the MMSI (if the initial announcement has been sent by DSC),

followed by the urgency message or followed by the details of the channel to be used for the message in the case where a working channel is to be used.

In radiotelephony, on the selected working frequency, the urgency call and message consist of the following, taking into account Nos. **32.6** and **32.7**:

– the urgency signal "PAN PAN", spoken three times;

– the name of the called station or "ALL STATIONS", spoken three times;

– the words "THIS IS";

– the name of the station transmitting the urgency message, spoken three times;

– the call sign or any other identification;

– the MMSI (if the initial announcement has been sent by DSC);

– the text of the urgency message. (WRC-23)

33.13 (SUP - WRC-23)

33.14 § 7 1) The urgency call format or urgency signal shall be sent only on the authority of the person responsible for the ship, aircraft or other vehicle carrying the mobile station or mobile earth station. (WRC-07)

33.15 2) The urgency call format or the urgency signal may be transmitted by a land station or a coast earth station with the approval of the responsible authority.

33.15A § 7A 1) Ship stations in receipt of an urgency announcement or call addressed to all stations shall not acknowledge. (WRC-07)

33.15B 2) Ship stations in receipt of an urgency announcement or call of an urgency message shall monitor the frequency or channel indicated for the message for at least five minutes. If, at the end of the five-minute monitoring period, no urgency message has been received, a coast station should, if possible, be notified of the missing message. Thereafter, normal working may be resumed. (WRC-07)

33.15C 3) Coast and ship stations which are in communication on frequencies other than those used for the transmission of the urgency signal or the subsequent message may continue their normal work without interruption, provided that the urgency message is not addressed to them nor broadcast to all stations. (WRC-07)

33.16 § 8 When an urgency announcement or call and message has been transmitted to more than one station and action is no longer required, an urgency cancellation should be sent by the station responsible for its transmission.

The urgency cancellation should consist of the following, taking into account Nos. **32.6** and **32.7**:

– the urgency signal "PAN PAN", spoken three times;

– the words "ALL STATIONS", spoken three times;

– the words "THIS IS";

– the name of the station transmitting the urgency message, spoken three times;

– the call sign or any other identification;

– the MMSI (if the initial announcement has been sent by DSC);

– the words "PLEASE CANCEL URGENCY MESSAGE OF" followed by the time in UTC. (WRC-12)

33.17 (SUP - WRC-23)

33.18 (SUP - WRC-23)

Section III − Medical transports

33.19 § 10 The term "medical transports", as defined in the 1949 Geneva Conventions and Additional Protocols, refers to any means of transportation by land, water or air, whether military or civilian, permanent or temporary, assigned exclusively to medical transportation and under the control of a competent authority of a party to a conflict or of neutral States and of other States not parties to an armed conflict, when these ships, craft and aircraft assist the wounded, the sick and the shipwrecked.

33.20 § 11 1) For the purpose of announcing and identifying medical transports which are protected under the above-mentioned Conventions, the procedure of Section II of this Article is used. The urgency call shall be followed by the addition of the single word MAY-DEE-CAL pronounced as in French "médical", in radiotelephony. (WRC-23)

33.20A 2) When using digital selective calling techniques, the urgency announcement on the appropriate Digital Selective Calling distress and safety frequencies shall always be addressed to all stations on VHF and to a specified geographical area on MF and HF and shall indicate "Medical transport" in accordance with the most recent version of Recommendations ITU-R M.493 and ITU-R M.541. (WRC-07)

33.20B 3) Medical transports may use one or more of the distress and safety traffic frequencies specified in Section I of Article **31** for the purpose of self-identification and to establish communications. As soon as practicable, communications shall be transferred to an appropriate working frequency. (WRC-07)

33.21 § 12 The use of the signals described in Nos. **33.20** and **33.20A** indicates that the message which follows concerns a protected medical transport. The message shall convey the following data: (WRC-07)

33.22 *a)* call sign or other recognized means of identification of the medical transport;

33.23 *b)* position of the medical transport;

33.24 *c)* number and type of vehicles in the medical transport;

33.25 *d)* intended route;

33.26 *e)* estimated time en route and of departure and arrival, as appropriate;

33.27 *f)* any other information, such as flight altitude, radio frequencies guarded, languages used and secondary surveillance radar modes and codes.

33.28 (SUP - WRC-07)

33.29 (SUP - WRC-07)

33.30 § 13 The use of radiocommunications for announcing and identifying medical transports is optional; however, if they are used, the provisions of these Regulations and particularly of this Section and of Articles **30** and **31** shall apply.

Section IV − Safety communications

33.30A § 14 The following terms apply:

a) the safety announcement is a digital selective call using a safety call format in the bands used for terrestrial radiocommunication or a safety message format, in which case it is relayed through space stations;

b) the safety call is the initial voice or text procedure;

c) the safety message is the subsequent voice or text procedure. (WRC-07)

33.31 § 15 1) In a terrestrial system, safety communications consist of a safety announcement, transmitted using digital selective calling, followed by the safety call and message transmitted using radiotelephony or data. The announcement of the safety message shall be made on one or more of the distress and safety calling frequencies specified in Section I of Article **31** using either digital selective-calling techniques and the safety call format, or radiotelephony procedures and the safety signal. (WRC-23)

33.31A 2) However, in order to avoid unnecessary loading of the distress and safety calling frequencies specified for use with digital selective calling techniques:

a) safety messages transmitted by coast stations in accordance with a predefined timetable should not be announced by digital selective calling techniques;

b) safety messages which only concern vessels sailing in the vicinity should be announced using radiotelephony procedures. (WRC-07)

33.31B 3) In addition, ship stations not equipped for digital selective calling procedures may announce a safety message by transmitting the safety call by radiotelephony. In such cases the announcement shall be made using the frequency 156.8 MHz (VHF channel 16), while taking into account that other stations outside VHF range may not receive the announcement. (WRC-07)

33.31C 4) In the maritime mobile service, safety messages shall generally be addressed to all stations. In some cases, however, they may be addressed to a particular station. When using digital selective calling techniques, the safety announcement shall indicate which frequency is to be used to send the subsequent message and, in the case of a message to all stations, shall use the "All Ships" format setting. (WRC-07)

33.32 § 16 1) In the maritime mobile service, the safety message shall, where practicable, be transmitted on a working frequency in the same band(s) as those used for the safety announcement or call. A suitable indication to this effect shall be made at the end of the safety call. In the case that no other option is practicable, the safety message may be sent by radiotelephony on the frequency 156.8 MHz (VHF channel 16). (WRC-07)

33.32A 2) In the maritime mobile-satellite service, a separate safety announcement or call does not need to be made before sending the safety message. However, if available, the appropriate network priority access settings should be used for sending the message. (WRC-07)

33.33 § 17 The safety signal consists of the word SECURITE. In radiotelephony, it shall be pronounced as in French.

33.34 § 18 1) The safety call format or the safety signal indicates that the calling station has an important navigational or meteorological warning to transmit. (WRC-07)

33.34A 2) Messages from ship stations containing information concerning the presence of cyclones shall be transmitted, with the least possible delay, to other mobile stations in the vicinity and to the appropriate authorities through a coast station, or through a rescue coordination centre via a coast station or an appropriate coast earth station. These transmissions shall be preceded by the safety announcement or call. (WRC-07)

33.34B 3) Messages from ship stations, containing information on the presence of dangerous ice, dangerous wrecks, or any other imminent danger to marine navigation, shall be transmitted as soon as possible to other ships in the vicinity, and to the appropriate authorities through a coast station, or through a rescue coordination centre via a coast station or an appropriate coast earth station. These transmissions shall be preceded by the safety announcement or call. (WRC-07)

33.35 § 19 The complete safety call should consist of the following, taking into account Nos. **32.6** and **32.7**:

– the safety signal "SECURITE", spoken three times;

– the name of the called station or "ALL STATIONS", spoken three times;

– the words "THIS IS";

– the name of the station transmitting the safety message, spoken three times;

– the call sign or any other identification;

– the MMSI (if the initial announcement has been sent by DSC),

followed by the safety message or followed by the details of the channel to be used for the message in the case where a working channel is to be used.

In radiotelephony, on the selected working frequency, the safety call and message should consist of the following, taking into account Nos. **32.6** and **32.7**:

– the safety signal "SECURITE", spoken three times;

– the name of the called station or "ALL STATIONS", spoken three times;

– the words “THIS IS”;

– the name of the station transmitting the safety message, spoken three times;

– the call sign or any other identification;

– the MMSI (if the initial alert has been sent by DSC);

– the text of the safety message. (WRC-23)

33.36 (SUP - WRC-23)

33.37 (SUP - WRC-23)

33.38 (SUP - WRC-23)

33.38A § 20A 1) Ship stations in receipt of a safety announcement using digital selective calling techniques and the “All Ships” format setting, or otherwise addressed to all stations, shall not acknowledge. (WRC-07)

33.38B 2) Ship stations in receipt of a safety announcement or safety call and message shall monitor the frequency or channel indicated for the message and shall listen until they are satisfied that the message is of no concern to them. They shall not make any transmission likely to interfere with the message. (WRC-07)

Section V – Transmission of maritime safety information[2]

33.39 *A – General*

33.39A (SUP - WRC-07)

33.39B (SUP - WRC-07)

33.40 (SUP - WRC-07)

33.40A § 21 The transmission of maritime safety information using the NAVTEX system and/or the NAVDAT system is the responsibility of the administration, which shall inform the International Maritime Organization (IMO) in order to update the IMO Master Plan of shore-based facilities for the global maritime distress and safety system (GMDSS) (GMDSS Master Plan). (WRC-23)

33.41 § 22 The mode and format of the transmissions mentioned in Nos. **33.43**, **33.45**, **33.46**, **33.46B** and **33.48** should be in accordance with the relevant ITU-R Recommendations. (WRC-23)

33.42 *B – International NAVTEX system*

33.43 § 23 Where maritime safety information is transmitted using the international NAVTEX system, taking into account No. **33.40A**, by means of narrow-band direct-printing telegraphy with forward error correction, the frequency 518 kHz shall be used (see Appendix **15**). (WRC-23)

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[2] **33.V.1** Maritime safety information includes navigation and meteorological warnings, meteorological forecasts and other urgent messages pertaining to safety transmitted from coast stations or coast earth stations. (WRC-07)

33.44 *C − 490 kHz and 4 209.5 kHz*

33.45 § 24 1) The frequency 490 kHz may be used for the transmission of maritime safety information by means of narrow-band direct-printing telegraphy with forward error correction (see Appendix **15**). (WRC-03)

33.46 2) The frequency 4 209.5 kHz is used exclusively for NAVTEX-type transmission by means of narrow-band direct-printing telegraphy with forward error correction.

33.46A *D − International NAVDAT system* (WRC-23)

33.46B § 24A Where maritime safety information is transmitted using the international NAVDAT system, taking into account No. **33.40A**, the frequency 500 kHz and/or the frequency 4 226 kHz shall be used (see Appendix **15**). (WRC-23)

33.47 *E − High seas maritime safety information* (WRC-23)

33.48 § 25 The transmission of maritime safety information by means of narrow-band direct-printing telegraphy with forward error correction uses the frequencies 4 210 kHz, 6 314 kHz, 8 416.5 kHz, 12 579 kHz, 16 806.5 kHz, 19 680.5 kHz, 22 376 kHz and 26 100.5 kHz. The transmission of maritime safety information by means of the NAVDAT system uses the frequencies 6 337.5 kHz, 8 443 kHz, 12 663.5 kHz, 16 909.5 kHz and 22 450.5 kHz. (WRC-23)

33.49 *F − Maritime safety information via satellite* (WRC-23)

33.50 § 26 Maritime safety information may be transmitted via satellite in the maritime mobile-satellite service using the frequency bands 1 530-1 545 MHz, 1 621.35-1 626.5 MHz and 2 483.59-2 499.91 MHz (see Appendix **15**). For the maritime mobile-satellite service in the frequency band 2 483.59-2 499.91 MHz, Resolution **365 (WRC-23)** applies when used for the global maritime distress and safety system (GMDSS). (WRC-23)

Section VI − Intership navigation safety communications

33.51 § 27 1) Intership navigation safety communications are those VHF radiotelephone communications conducted between ships for the purpose of contributing to the safe movement of ships.

33.52 2) The frequency 156.650 MHz is used for intership navigation safety communications (see also Appendix **15** and note *k*) in Appendix **18**).

Section VII − Use of other frequencies for safety (WRC-07)

33.53 § 28 Radiocommunications for safety purposes concerning ship reporting communications, communications relating to the navigation, movements and needs of ships and weather observation messages may be conducted on any appropriate communications frequency, including those used for public correspondence. In terrestrial systems, the frequency bands 415-535 kHz (see Article **52**), 1 606.5-4 000 kHz (see Article **52**), 4 000-27 500 kHz (see Appendix **17**) and 156-174 MHz (see Appendix **18**) are used for this function. In the maritime mobile-satellite service, frequencies in the frequency bands 1 530-1 544 MHz, 1 614.4225-1 618.725 MHz or 1 616.3-1 620.38 MHz (Earth-to-space) (see *resolves* 5 of Resolution **365 (WRC-23)**), 1 621.35-1 626.5 MHz, 1 626.5-1 645.5 MHz and 2 483.59-2 499.91 MHz (space-to-Earth) are used for this function as well as for distress alerting purposes (see No. **32.2**). For the frequency bands 1 614.4225-1 618.725 MHz or 1 616.3-1 620.38 MHz (Earth-to-space) (see *resolves* 5 of Resolution **365 (WRC-23)**) and 2 483.59-2 499.91 MHz (space-to-Earth) when used for the GMDSS, Resolution **365 (WRC-23)** applies. (WRC-23)

33.54 (SUP - WRC-07)

33.55 (SUP - WRC-07)

ARTICLE 34

Alerting signals in the global maritime distress and safety system (GMDSS)

Section I − Satellite emergency position-indicating radiobeacon signals (WRC-23)

34.1 § 1 The emergency position-indicating radiobeacon signal in the frequency band 406-406.1 MHz shall be in accordance with Recommendation ITU-R M.633-5. (WRC-23)

Section II − Digital selective calling

34.2 § 2 The characteristics of the "distress call" (see No. **32.9**) in the digital selective calling system should be in accordance with the most recent version of Recommendation ITU-R M.493. (WRC-12)

CHAPTER VIII

Aeronautical services

ARTICLE 35

Introduction

35.1 § 1 With the exception of Articles **36**, **37**, **39**, **42**, **43** and No. **44.2**, the other provisions of this Chapter may be governed by special arrangements concluded pursuant to Article 42 of the Constitution of the International Telecommunication Union (Geneva, 1992), or by intergovernmental agreements[1] provided their implementation does not cause harmful interference to the radio services of other countries.

[1] **35.1.1** For example, the International Civil Aviation Organization (ICAO) has agreed upon standards and recommended practices adapted to the needs of aircraft operation which have been proven in practice and are well established in current use.

ARTICLE 36

Authority of the person responsible for the station

36.1 § 1 The service of a mobile station is placed under the supreme authority of the person responsible for the aircraft or other vehicle carrying the mobile station.

36.2 § 2 The person holding this authority shall require that each operator comply with these Regulations and that the mobile station for which the operator is responsible is used, at all times, in accordance with these Regulations.

36.3 § 3 Except as otherwise provided for in these Regulations, the person responsible, as well as all the persons who may have knowledge of any information whatever obtained by means of the radiocommunication service, are placed under the obligation of observing and ensuring the secrecy of correspondence.

36.4 § 4 The provisions of Nos. **36.1**, **36.2** and **36.3** shall also apply to personnel of aircraft earth stations.

ARTICLE 37

Operator's certificates

Section I – General provisions

37.1 § 1 1) The service of every aircraft station and every aircraft earth station shall be controlled by an operator holding a certificate issued or recognized by the government to which the station is subject. Provided the station is so controlled, other persons besides the holder of the certificate may use the radiotelephone equipment.

37.2 2) In order to meet special needs, special agreements between administrations may fix the conditions to be fulfilled in order to obtain a radiotelephone operator's certificate intended to be used in aircraft radiotelephone stations and aircraft earth stations complying with certain technical conditions and certain operating conditions. These agreements, if made, shall be on the condition that harmful interference to international services shall not result therefrom. These conditions and agreements shall be mentioned in the certificates issued to such operators.

37.3 3) The service of automatic communication devices[1] installed in an aircraft station or aircraft earth station shall be controlled by an operator holding a certificate issued or recognized by the government to which the station is subject. Provided the devices are so controlled, they may be used by other persons.

37.4 4) Nevertheless, in the service of aircraft stations and aircraft earth stations operating radiotelephony solely on frequencies above 30 MHz, each government shall decide for itself whether a certificate is necessary and, if so, shall define the conditions for obtaining it.

37.5 5) The provisions of No. **37.4** shall not, however, apply to any aircraft station or aircraft earth station working on frequencies assigned for international use.

37.6 § 2 1) In the case of complete unavailability of the operator in the course of a flight, and solely as a temporary measure, the person responsible for the station may authorize an operator holding a certificate issued by the government of another Member State to perform the radiocommunication service.

37.7 2) When it is necessary to employ a person without a certificate or an operator not holding an adequate certificate as a temporary operator, his performance as such must be limited solely to signals of distress, urgency and safety, messages relating thereto, messages relating directly to the safety of life and essential messages relating to the navigation and safe movement of the aircraft.

37.8 3) In all cases, such temporary operators must be replaced as soon as possible by operators holding the certificate prescribed in § 1 of this Article.

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[1] **37.3.1** The term "automatic communication devices" is intended to include such equipment as teleprinters, data transfer systems, etc.

37.9 § 3 1) Each administration shall take the necessary steps to prevent, to the maximum extent possible, the fraudulent use of certificates. For this purpose, such certificates shall bear the holder's signature and shall be authenticated by the issuing administration. Administrations may employ, if they wish, other means of identification such as photographs, fingerprints, etc.

37.10 2) To facilitate verification of certificates, these may carry, if necessary, in addition to the text in the national language, a translation of this text in a working language of the Union.

37.11 § 4 Each administration shall take the necessary steps to place operators under the obligation to preserve the secrecy of correspondence as provided for in No. **18.4**.

Section II − Classes and categories of certificates

37.12 § 5 1) There are two categories of radiotelephone operators' certificates, general and restricted.

37.13 2) The holder of a radiotelephone operator's general certificate may carry out the radiotelephone service of any aircraft station or of any aircraft earth station.

37.14 3) The holder of a radiotelephone operator's restricted certificate may carry out the radiotelephone service of any aircraft station or aircraft earth station operating on frequencies allocated exclusively to the aeronautical mobile service or the aeronautical mobile-satellite service, provided that the operation of the transmitter requires only the use of simple external switching devices.

Section III − Conditions for the issue of operators' certificates

37.15 *A − General*

37.16 § 6 1) The conditions to be imposed for obtaining the various certificates are contained in the following paragraphs and represent the minimum requirements.

37.17 2) Each administration is free to fix the number of examinations necessary to obtain each certificate.

37.18 § 7 1) The administration which issues a certificate may, before authorizing an operator to carry out the service on board aircraft, require the fulfilment of other conditions (for example: experience with automatic communication devices; further technical and professional knowledge relating particularly to navigation; physical fitness; the completion as an operator of a certain number of flying hours; etc.).

37.19 2) Administrations should take whatever steps they consider necessary to ensure the continued proficiency of operators after prolonged absences from operational duties.

37.20 *B – Radiotelephone operators' certificates*

37.21 § 8 The radiotelephone operator's general certificate is issued to candidates who have given proof of the knowledge and professional qualifications enumerated below (see also No. **37.13**):

37.22 *a)* a knowledge of the elementary principles of radiotelephony;

37.23 *b)* detailed knowledge of the practical operation and adjustment of radiotelephone apparatus;

37.24 *c)* ability to send correctly and to receive correctly by radiotelephone in one of the working languages of the Union;

37.25 *d)* detailed knowledge of the Regulations applying to radiotelephone communications and specifically of that part of those Regulations relating to the safety of life.

37.26 § 9 1) The radiotelephone operator's restricted certificate is issued to candidates who have given proof of the knowledge and professional qualifications enumerated below:

37.27 *a)* practical knowledge of radiotelephone operation and procedure;

37.28 *b)* ability to send correctly and to receive correctly by radiotelephone in one of the working languages of the Union;

37.29 *c)* general knowledge of the Regulations applying to radiotelephone communications and specifically of that part of those Regulations relating to the safety of life.

37.30 2) For aircraft radiotelephone stations and aircraft earth stations operating on frequencies allocated exclusively to the aeronautical mobile service or the aeronautical mobile-satellite service, each administration may itself fix the conditions for obtaining a radiotelephone operator's restricted certificate, provided that the operation of the transmitter requires only the use of simple external switching devices. The administration shall ensure that the operator has an adequate knowledge of radiotelephone operation and procedure particularly as far as distress, urgency and safety are concerned. This in no way contravenes the provisions of No. **37.2**.

37.31 § 10 A radiotelephone operator's certificate shall show whether it is a general certificate or a restricted certificate and, in the latter case, if it has been issued in conformity with the provisions of No. **37.30**.

ARTICLE 38

Personnel

38.1 Administrations shall ensure that the staff on duty in aeronautical stations and in aeronautical earth stations shall be adequately qualified to operate the stations efficiently.

ARTICLE 39

Inspection of stations

39.1 § 1 1) The inspectors of governments or appropriate administrations of countries who visit an aircraft station or aircraft earth station may require the production of the licence for examination. The operator of the station, or the person responsible for the station, shall facilitate this examination. The licence shall be kept in such a way that it can be produced upon request.

39.2 2) The inspectors shall have in their possession an identity card or badge, issued by the competent authority, which they shall show on request of the person responsible for the aircraft.

39.3 3) When the licence cannot be produced or when manifest irregularities are observed, governments or administrations may inspect the radio installations in order to satisfy themselves that these conform to the conditions imposed by these Regulations.

39.4 4) In addition, inspectors have the right to require the production of the operators' certificates, but proof of professional knowledge may not be demanded.

39.5 § 2 1) When a government or administration has found it necessary to adopt the course indicated in No. **39.3**, or when the operator's certificates cannot be produced, the government or administration to which the aircraft station or aircraft earth station is subject shall be so informed without delay. In addition, the procedure specified in Section V of Article **15** is followed when necessary.

39.6 2) Before leaving, the inspector shall report the result of his inspection to the person responsible for the aircraft. If any breach of the conditions imposed by these Regulations is observed, the inspector shall make this report in writing.

39.7 § 3 Member States undertake not to impose upon foreign aircraft stations or aircraft earth stations which are temporarily within their territorial limits or which make a temporary stay in their territory, technical and operating conditions more severe than those contemplated in these Regulations. This undertaking in no way affects arrangements which are made under international agreements relating to air navigation, and which are therefore not covered by these Regulations.

39.8 § 4 The frequencies of emissions of aircraft stations shall be checked by the inspection service to which these stations are subject.

ARTICLE 40

Working hours of stations

40.1 § 1 Every station of the aeronautical mobile service and the aeronautical mobile-satellite service shall have an accurate clock correctly regulated to Coordinated Universal Time (UTC).

40.2 § 2 The service of an aeronautical station or an aeronautical earth station shall be continuous throughout the period during which it bears responsibility for the radiocommunication service to aircraft in flight.

40.3 § 3 Aircraft stations and aircraft earth stations in flight shall maintain service to meet the essential communications needs of the aircraft with respect to safety and regularity of flight and shall maintain watch as required by the competent authority and shall not cease watch, except for reasons of safety, without informing the aeronautical station or aeronautical earth station concerned.

ARTICLE 41

Communications with stations in the maritime services

41.1 Stations on board aircraft may communicate, for purposes of distress, and for public correspondence[1], with stations of the maritime mobile or maritime mobile-satellite services. For these purposes, they shall conform to the relevant provisions of Chapter **VII** and Chapter **IX**, Articles **51** (Section III), **53**, **54**, **55**, **57** and **58** (see also Nos. **4.19**, **4.20** and **43.4**). (WRC-07)

[1] **41.1.1** Stations on board aircraft may communicate, for public correspondence purposes as long as watch is maintained on the frequencies provided for safety and regularity of flight.

ARTICLE 42

Conditions to be observed by stations

42.1 § 1 The energy radiated by receiving apparatus shall be reduced to the lowest practical value and shall not cause harmful interference to other stations.

42.2 § 2 Administrations shall take all practicable steps necessary to ensure that the operation of any electrical or electronic apparatus installed in mobile stations and mobile earth stations does not cause harmful interference to the essential radio services of stations which are operating in accordance with the provisions of these Regulations.

42.3 § 3 Mobile stations and mobile earth stations other than survival craft stations shall be provided with the documents enumerated in the appropriate section of Appendix **16** (Section IV, "Stations on board aircraft").

42.4 § 4 The operation of a broadcasting service (see No. **1.38**) by an aircraft station at sea and over the sea is prohibited (see also No. **23.2**).

ARTICLE 43

Special rules relating to the use of frequencies

43.1 § 1 Frequencies in any band allocated to the aeronautical mobile (R) service and the aeronautical mobile-satellite (R) service are reserved for communications relating to safety and regularity of flight between any aircraft and those aeronautical stations and aeronautical earth stations primarily concerned with flight along national or international civil air routes.

43.2 § 2 Frequencies in any band allocated to the aeronautical mobile (OR) service and the aeronautical mobile-satellite (OR) service are reserved for communications between any aircraft and aeronautical stations and aeronautical earth stations other than those primarily concerned with flight along national or international civil air routes.

43.3 § 3 Frequencies in the bands allocated to the aeronautical mobile service between 2 850 kHz and 22 000 kHz (see Article **5**) shall be assigned in conformity with the provisions of Appendices **26** and **27** and the other relevant provisions of these Regulations.

43.4 § 4 Administrations shall not permit public correspondence in the frequency bands allocated exclusively to the aeronautical mobile service or to the aeronautical mobile-satellite service.

43.5 § 5 In order to reduce interference, aircraft stations shall, within the means at their disposal, endeavour to select for calling the band with the most favourable propagational characteristics for effecting reliable communication. In the absence of more precise data, an aircraft station shall, before making a call, listen for the signals of the station with which it desires to communicate. The strength and intelligibility of such signals are useful as a guide to propagational conditions and indicate which is the preferable band for calling.

43.6 § 6 Governments may, by agreement, decide the frequencies to be used for call and reply in the aeronautical mobile service and the aeronautical mobile-satellite service.

ARTICLE 44

Order of priority of communications

44.1 § 1 The order of priority for communications[1] in the aeronautical mobile service and the aeronautical mobile-satellite service shall be as follows, except where impracticable in a fully automated system in which, nevertheless, Category 1 shall receive priority:

1 Distress calls, distress messages and distress traffic.

2 Communications preceded by the urgency signal.

3 Communications relating to radio direction-finding.

4 Flight safety messages.

5 Meteorological messages.

6 Flight regularity messages.

7 Messages relating to the application of the United Nations Charter.

8 Government messages for which priority has been expressly requested.

9 Service communications relating to the working of the telecommunication service or to communications previously exchanged.

10 Other aeronautical communications.

44.2 § 2 Categories 1 and 2 shall receive priority over all other communications irrespective of any agreement under the provisions of No. **35.1**.

[1] **44.1.1** The term *communications* as used in this Article includes radiotelegrams, radiotelephone calls and radiotelex calls.

ARTICLE 45

General communication procedure

45.1 § 1 As a general rule, it rests with the aircraft station to establish communication with the aeronautical station. For this purpose, the aircraft station may call the aeronautical station only when it comes within the designated operational coverage[1] area of the latter.

45.2 § 2 An aeronautical station having traffic for an aircraft station may call this station if it has reason to believe that the aircraft station is keeping watch and is within the designated operational coverage area (see No. **45.1.1**) of the aeronautical station.

45.3 § 3 When an aeronautical station receives calls in close succession from several aircraft stations, it decides on the order in which these stations may transmit their traffic. Its decision shall be based on the priority in Article **44**.

45.4 § 4 If an aeronautical station finds it necessary to intervene in communications between aircraft stations, these stations shall comply with the instructions given by the aeronautical station.

45.5 § 5 Before transmitting, a station shall take precautions to ensure that it will not interfere with a communication already in progress and that the station called is not in communication with another station.

45.6 § 6 When a radiotelephone call has been made to an aeronautical station, but no answer has been received, a period of at least ten seconds should elapse before a subsequent call is made to that station.

45.7 § 7 Aircraft stations shall not radiate carrier waves between calls.

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[1] **45.1.1** Designated operational coverage is that volume of airspace needed operationally in order to provide a particular service and within which the facility is afforded frequency protection.

CHAPTER IX

Maritime services

ARTICLE 46

Authority of the master

46.1 § 1 The service of a ship station is placed under the supreme authority of the master or of the person responsible for the ship or other vessel carrying the station.

46.2 § 2 The person holding this authority shall require that each operator comply with these Regulations and that the ship station for which the operator is responsible is used, at all times, in accordance with these Regulations.

46.3 § 3 The master or the person responsible, as well as all persons who may have knowledge of the text or even of the existence of a radiotelegram, or of any information whatever obtained by means of the radiocommunication service, are placed under the obligation of observing and ensuring the secrecy of correspondence.

46.4 § 4 The provisions of Nos. **46.1**, **46.2** and **46.3** shall also apply to personnel of ship earth stations.

ARTICLE 47

Operator's certificates

Section I – General provisions

47.1 (SUP - WRC-03)

47.2 § 1 1) The service of every ship radiotelephone station, ship earth station and ship station using the frequencies and techniques for GMDSS, as prescribed in Chapter **VII**, shall be controlled by an operator holding a certificate issued or recognized by the government to which the station is subject. Provided the station is so controlled, other persons besides the holder of the certificate may use the equipment. (WRC-07)

47.3 (SUP - WRC-03)

47.4 2) Nevertheless, in the service of radiotelephone stations operating solely on frequencies above 30 MHz, each government shall decide for itself whether a certificate is necessary and, if so, shall define the conditions for obtaining it.

47.5 3) The provisions of No. **47.4** shall not, however, apply to any ship station working on frequencies assigned for international use.

47.6 (SUP - WRC-07)

47.7 (SUP - WRC-07)

47.8 (SUP - WRC-07)

47.9 § 3 1) Each administration shall take the necessary steps to prevent, to the maximum extent possible, the fraudulent use of certificates. For this purpose, such certificates shall bear the holder's signature and shall be authenticated by the issuing administration. Administrations may employ, if they wish, other means of identification such as photographs, fingerprints, etc.

47.10 2) In the maritime mobile service the certificates issued after 1 January 1978 shall bear the photograph of the holder and the holder's date of birth.

47.11 3) To facilitate verification of certificates, these may carry, if necessary, in addition to the text in the national language, a translation of this text in a working language of the Union.

47.12 4) In the maritime mobile service all certificates not in one of the working languages of the Union and issued after 1 January 1978 shall carry at least the following information in one of these working languages:

47.13 *a)* the name and date of birth of the holder;

47.14 *b)* the title of the certificate and its date of issue;

47.15 *c)* if applicable, the number and period of validity of the certificate;

47.16 *d)* the issuing administration.

47.17 § 4 Each administration shall take the necessary steps to place operators under the obligation to preserve the secrecy of correspondence as provided for in No. **18.4**.

47.18 (SUP - WRC-12)

47.18A (SUP - WRC-12)

Section II – Categories of operator's certificates

A – GMDSS (SOLAS Convention) certificates (WRC-12)

47.19 § 6 1) There are four categories of certificates, shown in descending order of requirements, for personnel of ship stations and ship earth stations using the frequencies and techniques prescribed in Chapter **VII**. An operator meeting the requirements of a certificate automatically meets all of the requirements of lower order certificates. (WRC-12)

47.20 *a)* First-class radio electronic certificate.

47.21 *b)* Second-class radio electronic certificate.

47.22 *c)* General operator's certificate.

47.23 *d)* Restricted operator's certificate.

47.23A (SUP - WRC-12)

47.23B (SUP - WRC-12)

47.24 2) The holder of one of the certificates specified in Nos. **47.20** to **47.23** may carry out the service of ship stations or ship earth stations using the frequencies and techniques prescribed in Chapter **VII**.

B – GMDSS (non-SOLAS Convention) certificates (WRC-12)

47.24A There are two categories of certificates, shown in descending order of requirements. An operator meeting the requirements of a certificate automatically meets all of the requirements of the lower order certificate. (WRC-12)

47.24B *a)* Long-range certificate (WRC-12)

47.24C *b)* Short-range certificate (WRC-12)

C – Other maritime radio operator certificates (WRC-12)

47.25 § 7 1) There are six categories of certificates. Maritime radio operator certificates of the categories listed in Nos. **47.26A to 47.26F** may continue to be used for the purposes they were issued for. (WRC-12)

47.26 § 8 The following maritime radio operator's certificates are still valid: (WRC-12)

47.26A *a)* Radiocommunication operator's general certificate. (WRC-12)

47.26B *b)* First-class radio telegraph operator's certificate. (WRC-12)

47.26C *c)* Second-class radio telegraph operator's certificate. (WRC-12)

47.26D *d)* Radiotelegraph operator's special certificate. (WRC-12)

47.26E *e)* Radiotelephone operator's general certificate. (WRC-12)

47.26F *f)* Restricted radiotelephone operator's certificate. (WRC-12)

Section III − Conditions for the issuing of certificates

47.27 § 9 1) The requirements for the certificates listed in Nos. **47.20** to **47.23**, for which candidates must show proof of technical and professional knowledge and qualification, are shown in Table **47-1**. (WRC-12)

47.27A 2) The conditions for the issuing of long-range and short-range certificates listed in Nos. **47.24B** and **47.24C** are contained in Resolution **343 (Rev.WRC-12)**. (WRC-12)

47.27B 3) Each administration may determine the conditions, in addition to those identified in No. **47.27**, under which GMDSS (SOLAS Convention) certificates specified in Nos. **47.20** to **47.23** may be granted. (WRC-12)

47.27C § 10 Each administration may determine the conditions, in addition to those identified in No. **47.27A**, under which GMDSS (non-SOLAS Convention) certificates specified in Nos. **47.24B** to **47.24C** may be granted. (WRC-12)

47.27D Each administration may determine the conditions under which other maritime radio operator certificates specified in Nos. **47.26A** to **47.26F** may be granted. (WRC-12)

47.28 (SUP - WRC-07)

47.29 (SUP - WRC-07)

TABLE **47-1** (WRC-23)

Requirements for radio electronic and operator's certificates

The relevant certificate is issued to a candidate who has given proof of the technical and professional knowledge and qualifications enumerated below, as indicated by an asterisk in the appropriate box	**1st-class radio electronic certificate**	**2nd-class radio electronic certificate**	**General operator's certificate**	**Restricted operator's certificate**
Knowledge of the principles of electricity and the theory of radio and of electronics sufficient to meet the requirements specified below:	*	*		
Theoretical knowledge of GMDSS radiocommunication equipment, including narrow-band direct-printing telegraph and radiotelephone transmitters and receivers, digital selective-calling equipment, ship earth stations, satellite emergency position-indicating radiobeacons, marine antenna systems, radio equipment for survival craft together with all auxiliary items, including power supplies, as well as general knowledge of the principles of other equipment generally used for radionavigation, with particular reference to maintaining equipment in service.	*			
General theoretical knowledge of GMDSS radiocommunication equipment, including narrow-band direct-printing telegraph and radiotelephone transmitters and receivers, digital selective-calling equipment, ship earth stations (including telegraphy), satellite emergency position-indicating radio beacons, marine antenna systems, radio equipment for survival craft together with all auxiliary items, including power supplies, as well as general knowledge of the principles of other equipment generally used for radionavigation, with particular reference to maintaining equipment in service.		*		
Practical knowledge of the operation and knowledge of the preventive maintenance of the equipment indicated above.	*	*		
Practical knowledge necessary for the location and repair (using appropriate testing equipment and tools) of faults in the equipment mentioned above which may occur during a voyage.	*			
Practical knowledge necessary for effecting repairs in the case of faults in the equipment indicated above, using the means available on board and, if necessary, replacing modular units.		*		

TABLE **47-1** (*end*) (WRC-23)

The relevant certificate is issued to a candidate who has given proof of the technical and professional knowledge and qualifications enumerated below, as indicated by an asterisk in the appropriate box	**1st-class radio electronic certificate**	**2nd-class radio electronic certificate**	**General operator's certificate**	**Restricted operator's certificate**
Detailed practical knowledge of the operation of all the GMDSS sub-systems and equipment.	*	*	*	
Practical knowledge of the operation of all the GMDSS sub-systems and equipment which is required while the ship is within the range of VHF coast stations (see NOTE 1).				*
Ability to send and to receive correctly by radiotelephony and telegraphy to and from ship earth stations.	*	*	*	
Ability to send and to receive correctly by radiotelephony.	*	*	*	*
Detailed knowledge of the regulations applying to radiocommunications, knowledge of the documents relating to charges for radiocommunications and knowledge of those provisions of the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended which relate to radio.	*	*	*	
Knowledge of the regulations applying to radiotelephone communications and specifically of that part of those regulations relating to the safety of life.				*
Sufficient knowledge of one of the working languages of the Union. Candidates should be able to express themselves satisfactorily in that language, both orally and in writing.	*	*	*	
An elementary knowledge of one of the working languages of the Union. Candidates should be able to express themselves satisfactorily in that language, both orally and in writing. Administrations may waive the above language requirements for holders of a restricted operator's certificate when the ship station is confined to a limited area specified by the administration concerned. In such cases the certificate shall be suitably endorsed.				*

NOTE 1 – A restricted operator's certificate covers only the operation of GMDSS equipment required for GMDSS sea areas A1, and does not cover the operation of GMDSS A2/A3/A4 equipment fitted on a ship over and above the basic A1 requirements, even if the ship is in a sea area A1. GMDSS sea areas A1, A2, A3 and A4 are identified in the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended.

NOTE 2 – (SUP - WRC-12)

ARTICLE 48

Personnel

Section I − Personnel of coast stations and coast earth stations

48.1 § 1 Administrations shall ensure that the staff on duty in coast stations and in coast earth stations are adequately qualified to operate the stations efficiently.

Section II − Class and minimum number of personnel for ship stations and ship earth stations

48.2 § 2 Administrations shall ensure that the personnel of ship stations and ship earth stations are adequately qualified to enable efficient operation of the station, and shall take steps to ensure the operational availability and maintenance of equipment for distress and safety communications in accordance with the relevant international agreements.

48.3 § 3 An adequately qualified person shall be available to act as a dedicated communications operator in cases of distress.

48.4 § 4 The personnel of ship stations and ship earth stations for which a radio installation is compulsory under international agreements and which use the frequencies and techniques prescribed in Chapter **VII** shall, with respect to the provisions of Article **47**, include:

48.5 *a)* for stations on board ships which sail beyond the range of VHF coast stations, taking into account the provisions of the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended: a holder of a first- or second-class radio electronic certificate or a general operator's certificate;

48.6 *b)* for stations on board ships which sail solely within the range of VHF coast stations, taking into account the provisions of the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended: a holder of a first- or second-class radio electronic certificate or a general operator's certificate or a restricted operator's certificate.

48.7 § 5 The personnel of ship stations and ship earth stations for which a radio installation is not compulsory either under international agreements or national regulations and which use the frequencies and techniques prescribed in Chapter **VII** shall be adequately qualified and certificated in accordance with the administration's requirements. Guidance concerning appropriate qualifications and certification is provided in Resolution **343 (Rev.WRC-12)**. That Resolution describes two appropriate certificates for use by personnel of ship stations and ship earth stations for which a radio installation is not compulsory. (WRC-23)

ARTICLE 49

Inspection of stations

49.1 § 1 1) The governments or appropriate administrations of countries which a ship station or ship earth station visits may require the production of the licence for examination. The operator of the station, or the person responsible for the station, shall facilitate this examination. The licence shall be kept in such a way that it can be produced upon request. As far as possible, the licence, or a copy certified by the authority which has issued it, should be permanently exhibited in the station.

49.2 2) The inspectors shall have in their possession an identity card or badge, issued by the competent authority, which they shall show on request of the master or person responsible for the ship or other vessel carrying the ship station or the ship earth station.

49.3 3) When the licence cannot be produced or when manifest irregularities are observed, governments or administrations may inspect the radio installations in order to satisfy themselves that these conform to the conditions imposed by these Regulations.

49.4 4) In addition, inspectors have the right to require the production of the operators' certificates, but proof of professional knowledge may not be demanded.

49.5 § 2 1) When a government or an administration has found it necessary to adopt the course indicated in No. **49.3**, or when the operators' certificates cannot be produced, the government or administration to which the ship station or ship earth station is subject shall be so informed without delay. In addition, the procedure specified in Article **15** is followed when necessary.

49.6 2) Before leaving, the inspector shall report the result of his inspection to the master, or the person responsible for the ship or other vessel carrying the ship station or ship earth station. If any breach of the conditions imposed by these Regulations is observed, the inspector shall make this report in writing.

49.7 § 3 Member States undertake not to impose upon foreign ship stations or upon foreign ship earth stations, which are temporarily within their territorial waters or which make a temporary stay in their territory, technical and operating conditions more severe than those contemplated in these Regulations. This undertaking in no way affects arrangements which are made under international agreements relating to maritime navigation, and which are therefore not covered by these Regulations.

49.8 § 4 The frequencies of emissions of ship stations shall be checked by the inspection service to which these stations are subject.

ARTICLE 50

Working hours of stations

50.1 § 1 In order to permit the application of the following rules on the subject of hours of watch, every station of the maritime mobile service and the maritime mobile-satellite service shall have an accurate clock correctly regulated to Coordinated Universal Time (UTC).

50.2 § 2 Coordinated Universal Time (UTC), reckoned from 0000 to 2359 h beginning at midnight, shall be used for all entries in the radiocommunication service log and in all similar documents of ships compulsorily equipped with radiocommunication apparatus in compliance with an international agreement; this same provision will apply, as far as possible, to other ships.

50.3 § 3 1) The services of coast stations and coast earth stations are, as far as possible, continuous (day and night). Certain coast stations, however, may have a service of limited duration. Each administration or recognized private operating agency duly authorized to that effect fixes the hours of service for coast stations under its jurisdiction.

50.4 2) These hours of service shall be notified to the Radiocommunication Bureau, who shall publish them in the List of Coast Stations and Special Service Stations (List IV). (WRC-07)

50.5 § 4 Coast stations whose service is not continuous shall not close before finishing all operations resulting from a distress call or from an urgency or safety signal. (WRC-07)

50.6 (SUP - WRC-07)

50.7 (SUP - WRC-07)

50.8 (SUP - WRC-07)

50.9 (SUP - WRC-07)

ARTICLE 51

Conditions to be observed in the maritime services

Section I − Maritime mobile service

51.1 *A − General*

51.2 § 1 The energy radiated by receiving apparatus shall be reduced to the lowest practical value and shall not cause harmful interference to other stations.

51.3 § 2 Administrations shall take all practicable steps necessary to ensure that the operation of any electrical or electronic apparatus installed in ship stations does not cause harmful interference to the essential radio services of stations which are operating in accordance with the provisions of these Regulations.

51.4 § 3 1) Changes of frequency in the sending and receiving apparatus of any ship station shall be capable of being made as rapidly as possible.

51.5 2) Installations of any ship station shall be capable, once communication is established, of changing from transmission to reception and vice versa in as short a time as possible.

51.5A 3) The operation of a broadcasting service (see No. **1.38**) by a ship station at sea is prohibited (see also No. **23.2**).

51.6 § 4 Ship stations and ship earth stations other than survival craft stations shall be provided with the documents enumerated in the appropriate section of Appendix **16**.

51.7 § 5 When any ship station transmitter itself cannot be controlled in such a way that its frequency satisfies the tolerance specified in Appendix **2**, the ship station shall be provided with a device, having a precision equal to at least one-half of this tolerance, for measuring the frequency of the emission.

51.8 to **51.23** (SUP - WRC-07)

51.24 *C − Ship stations using digital selective calling*

51.25 § 12 The characteristics of the digital selective calling equipment should be in accordance with the most recent version of Recommendation ITU-R M.493. (WRC-12)

51.26 C1 − Bands between 415 kHz and 535 kHz

51.27 § 13 All ship stations equipped with apparatus for digital selective calling to work in the authorized bands between 415 kHz and 535 kHz shall be able to send and receive class F1B or J2B emissions on at least two digital selective calling channels necessary for their service.

51.28 C2 − Bands between 1 606.5 kHz and 4 000 kHz (WRC-03)

51.29 § 14 All ship stations equipped with digital selective calling apparatus to work in the authorized bands between 1 606.5 kHz and 4 000 kHz shall be able to: (WRC-03)

51.30 *a)* send and receive class F1B or J2B emissions on the frequency 2 187.5 kHz;

51.31 *b)* in addition, send and receive class F1B or J2B emissions on other digital selective calling frequencies in this band necessary to carry out their service.

51.32 C3 − Bands between 4 000 kHz and 27 500 kHz

51.33 § 15 All ship stations equipped with digital selective calling apparatus to work in the authorized bands between 4 000 kHz and 27 500 kHz shall be able to:

51.34 *a)* send and receive class F1B or J2B emissions on the frequencies designated for digital selective distress calling in each of the maritime HF bands in which they are operating (see also No. **32.9**);

51.35 *b)* send and receive class F1B or J2B emissions on an international calling channel (specified in Recommendation ITU-R M.541-11) in each of the HF maritime mobile bands necessary for their service; (WRC-23)

51.36 *c)* send and receive class F1B or J2B emissions on other digital selective calling channels in each of the HF maritime mobile bands necessary for their service.

51.37 C4 − Bands between 156 MHz and 174 MHz

51.38 § 16 All ship stations equipped with apparatus for digital selective calling to work in the authorized bands between 156 MHz and 174 MHz shall be able to send and receive class G2B emissions on the frequency 156.525 MHz.

51.39 *CA − Ship stations using narrow-band direct-printing telegraphy*

51.40 § 17 1) All ship stations using narrow-band direct-printing telegraphy equipment for general traffic should be able to send and receive on frequencies designated for narrow-band direct-printing telegraphy in the frequency bands in which they are operating. (WRC-23)

51.41 2) The characteristics of the narrow-band direct-printing equipment should be in accordance with the most recent versions of Recommendations ITU-R M.476, ITU-R M.625 and ITU-R M.627. (WRC-23)

51.42 CA1 − Bands between 415 kHz and 535 kHz

51.43 § 18 All ship stations equipped with narrow-band direct-printing telegraphy apparatus to work in the authorized bands between 415 kHz and 535 kHz shall be able to:

51.44 *a)* send and receive class F1B or J2B emissions for general traffic on the working frequencies necessary to carry out their service; (WRC-23)

51.45 *b)* receive class F1B emissions on 518 kHz, if complying with the provisions of Chapter **VII**.

51.46 CA2 − Bands between 1 606.5 kHz and 4 000 kHz (WRC-03)

51.47 § 19 All ship stations equipped with narrow-band direct-printing telegraphy apparatus to work in the authorized bands between 1 606.5 kHz and 4 000 kHz shall be able to send and receive class F1B or J2B emissions on working frequencies necessary to carry out their service. (WRC-03)

51.48 CA3 − Bands between 4 000 kHz and 27 500 kHz

51.49 § 20 All ship stations equipped with narrow-band direct-printing telegraphy apparatus for general traffic to work in the authorized bands between 4 000 kHz and 27 500 kHz should be able to send and receive class F1B or J2B emissions on working frequencies in each of the HF maritime mobile bands necessary to carry out their service.

All ship stations equipped with narrow-band direct-printing telegraphy apparatus for receiving maritime safety information (MSI) to work in the authorized bands between 4 000 kHz and 27 500 kHz shall be able to receive class F1B or J2B emissions on working frequencies in each of the HF maritime mobile bands necessary to carry out their service. (WRC-23)

51.49A *Cbis – Ship stations using the automatic connection system* (WRC-23)

51.49B The characteristics of the automatic connection system should be in accordance with the most recent versions of Recommendations ITU-R M.493 and ITU-R M.541. (WRC-23)

51.50 *D − Ship stations using radiotelephony*

51.51 D1 − Bands between 1 606.5 kHz and 4 000 kHz (WRC-03)

51.52 § 21 All ship stations equipped with radiotelephony apparatus to work in the authorized bands between 1 606.5 kHz and 2 850 kHz shall be able to: (WRC-03)

51.53 *a)* send class J3E emissions on a carrier frequency of 2 182 kHz and receive class J3E emissions on a carrier frequency of 2 182 kHz, except for such apparatus as is referred to in No. **51.56**; (WRC-07)

51.54 *b)* send, in addition, J3E emissions on at least two working frequencies[1];

51.55 *c)* receive, in addition, J3E emissions on all other frequencies necessary for their service.

51.56 § 22 The provisions of Nos. **51.54** and **51.55** do not apply to apparatus provided solely for distress, urgency and safety purposes.

51.57 D2 − Bands between 4 000 kHz and 27 500 kHz

51.58 § 23 All ship stations equipped with radiotelephony to work in the authorized bands between 4 000 kHz and 27 500 kHz and which do not comply with the provisions of Chapter **VII** should be able to send and receive on the carrier frequencies 4 125 kHz and 6 215 kHz. However, all ship stations which comply with the provisions of Chapter **VII** shall be able to send and receive on the carrier frequencies designated in Article **31** for distress and safety traffic by radiotelephony for the frequency bands in which they are operating. (WRC-07)

51.59 D3 − Bands between 156 MHz and 174 MHz

51.60 § 24 All ship stations equipped with radiotelephony to work in the authorized bands between 156 MHz and 174 MHz (see No. **5.226** and Appendix **18**) shall be able to send and receive class G3E emissions on:

51.61 *a)* the distress, safety and calling frequency 156.8 MHz;

51.62 *b)* the primary intership frequency 156.3 MHz;

51.63 *c)* the intership navigation safety frequency 156.65 MHz;

51.64 *d)* all the frequencies necessary for their service.

51.64A *E − Ship stations receiving data transmissions* (WRC-23)

51.64B E1 − Bands between 415 kHz and 535 kHz (WRC-23)

51.64C § 24A All ship stations equipped with NAVDAT apparatus for receiving digital data transmissions in the authorized bands between 415 kHz and 535 kHz shall be capable of receiving class W7D emissions on 500 kHz, if complying with the provisions of Chapter **VII**. (WRC-23)

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[1] **51.54.1** In certain areas, administrations may reduce this requirement to one working frequency.

51.64D E2 − Bands between 4 000 kHz and 27 500 kHz (WRC-23)

51.64E § 24B All ship stations equipped with NAVDAT apparatus for receiving digital data transmissions in the authorized bands between 4 000 kHz and 27 500 kHz shall be capable of receiving class W7D emissions, if complying with the provisions of Chapter **VII**. (WRC-23)

Section II − Maritime mobile-satellite service

51.65 § 25 The energy radiated by receiving apparatus shall be reduced to the lowest practical value and shall not cause harmful interference to other stations.

51.66 § 26 Administrations shall take all practicable steps necessary to ensure that the operation of any electrical or electronic apparatus installed in ship earth stations does not cause harmful interference to the essential radio services of stations which are operating in accordance with the provisions of these Regulations.

Section III − Stations on board aircraft communicating with stations of the maritime mobile service and the maritime mobile-satellite service

51.67 *A − General provisions*

51.68 § 27 1) Stations on board aircraft may communicate with stations of the maritime mobile or maritime mobile-satellite services. They shall conform to those provisions of these Regulations which relate to these services.

51.69 2) For this purpose stations on board aircraft should use the frequencies allocated to the maritime mobile or maritime mobile-satellite services.

51.70 3) Stations on board aircraft, when handling public correspondence with stations of the maritime mobile service or of the maritime mobile-satellite service, shall comply with all the provisions applicable to the handling of public correspondence in the maritime mobile or maritime mobile-satellite services (see particularly Articles **53**, **54**, **55**, **57** and **58**).

51.71 § 28 In the case of communication between stations on board aircraft and stations of the maritime mobile service, radiotelephone calling may be renewed as specified in the most recent version of Recommendation ITU-R M.1171 and radiotelegraph calling may be renewed after an interval of five minutes, notwithstanding the procedure contained in the most recent version of Recommendation ITU-R M.1170. (WRC-07)

51.72 *B − Provisions relating to the use of frequencies between 156 MHz and 174 MHz*

51.73 § 29 1) Having regard to interference which may be caused by aircraft stations at high altitudes, frequencies in the maritime mobile bands above 30 MHz shall not be used by aircraft stations, with the exception of those frequencies between 156 MHz and 174 MHz specified in Appendix **18** which may be used provided that the following conditions are observed:

51.74 *a)* the altitude of aircraft stations shall not exceed 300 m (1 000 feet), except for reconnaissance aircraft participating in ice-breaking operations, where an altitude of 450 m (1 500 feet) is allowed;

51.75 *b)* the mean power of aircraft station transmitters shall not exceed 5 W; however, a power of 1 W or less shall be used to the maximum extent possible;

51.76 *c)* aircraft stations shall use the channels designated for this purpose in Appendix **18**;

51.77 *d)* except as provided in No. **51.75**, aircraft station transmitters shall comply with the technical characteristics given in Recommendation ITU-R M.489-2;

51.78 *e)* the communications of an aircraft station shall be brief and limited to operations in which stations of the maritime mobile service are primarily involved and where direct communication between the aircraft and the ship or coast station is required.

51.79 2) The frequency 156.3 MHz may be used by stations on board aircraft for safety purposes. It may also be used for communication between ship stations and stations on board aircraft engaged in coordinated search and rescue operations (see Appendix **15**). (WRC-07)

51.80 3) The frequency 156.8 MHz may be used by stations on board aircraft for safety purposes only (see Appendix **15**). (WRC-07)

ARTICLE 52

Special rules relating to the use of frequencies

Section I − General provisions

52.1 *A − Single-sideband radiotelegraph transmissions*

52.2 § 1 1) Where these provisions specify A1A emission, class A1B or J2A emissions shall be considered equivalent.

52.3 2) Where these provisions specify class F1B emission, class J2B and J2D emissions shall be considered equivalent. However, class J2D emission shall not be used with the HF distress and safety frequencies listed in Appendix **15**.

52.4 *B − Bands between 415 kHz and 535 kHz*

52.5 (SUP - WRC-07)

52.6 § 3 1) In the maritime mobile service, no assignments shall be made on the frequency 518 kHz other than for transmission by coast stations of meteorological and navigational warnings and urgent information to ships by means of automatic narrow-band direct-printing telegraphy (international NAVTEX system). In the maritime mobile service, no assignments shall be made on the frequency 500 kHz other than for transmission by coast stations of meteorological and navigational warnings and urgent information to ships by means of the international NAVDAT system. (WRC-23)

52.7 2) In the maritime mobile service, the frequency 490 kHz is used exclusively for the transmission by coast stations of meteorological and navigational warnings and urgent information to ships by means of narrow-band direct-printing telegraphy. (WRC-03)

52.8 *C − Bands between 1 606.5 kHz and 4 000 kHz* (WRC-03)

52.9 § 4 1) In Region 1, frequencies assigned to stations operating in the bands between 1 850 kHz and 3 800 kHz (see Article **5**) should, whenever possible, be in accordance with the following subdivision:

–	1 850-1 950 kHz:	Coast stations, single-sideband radiotelephony.
–	1 950-2 045 kHz:	Ship stations, single-sideband radiotelephony.
–	2 194-2 262.5 kHz:	Ship stations, single-sideband radiotelephony.
–	2 262.5-2 498 kHz:	Intership, single-sideband radiotelephony.
–	2 502-2 578 kHz:	Ship stations, narrow-band direct-printing telegraphy.

– 2 578-2 850 kHz: Coast stations, narrow-band direct-printing telegraphy and single-sideband radiotelephony.

– 3 155-3 200 kHz: Ship stations, narrow-band direct-printing telegraphy.

– 3 200-3 340 kHz: Ship stations, single-sideband radiotelephony.

– 3 340-3 400 kHz: Intership, single-sideband radiotelephony.

– 3 500-3 600 kHz: Intership, single-sideband radiotelephony.

– 3 600-3 800 kHz: Coast stations, single-sideband radiotelephony.

52.10 2) In Region 1, frequencies assigned to stations operating in the bands listed below shall be in accordance with the following subdivision:

– 1 606.5-1 625 kHz: Coast stations, narrow-band direct-printing telegraphy, digital selective calling.

– 1 635-1 800 kHz: Coast stations, single-sideband radiotelephony.

– 2 045-2 141.5 kHz: Ship stations, single-sideband radiotelephony.

– 2 141.5-2 160 kHz: Ship stations, narrow-band direct-printing telegraphy, digital selective calling.

52.11 § 5 In Regions 2 and 3, the carrier frequencies 2 635 kHz (assigned frequency 2 636.4 kHz) and 2 638 kHz (assigned frequency 2 639.4 kHz) are used as single-sideband intership radiotelephony working frequencies in addition to the frequencies prescribed for common use in certain services. The carrier frequencies 2 635 kHz and 2 638 kHz should be used with class J3E emissions only. In Region 3 these frequencies are protected by a guardband between 2 634 kHz and 2 642 kHz.

52.12 *D − Bands between 4 000 kHz and 27 500 kHz*

52.13 § 6 Bands exclusively allocated to the maritime mobile service between 4 000 kHz and 27 500 kHz (see Article **5**) are subdivided into categories and sub-bands as indicated in Appendix **17**.

52.13A § 6A In the maritime mobile service, no assignments shall be made on the frequency 4 226 kHz other than for transmission by coast stations of meteorological and navigational warnings and urgent information to ships by means of the international NAVDAT system. (WRC-23)

52.14 *E − Bands between 156 MHz and 174 MHz*

52.15 § 7 The ship movement service should be operated only on frequencies allocated to the maritime mobile service in the band 156-174 MHz.

Section II − (Number not used)

52.16 to **52.93** (SUP - WRC-07)

Section III − Use of frequencies for narrow-band direct-printing telegraphy

52.94 *A − General*

52.95 § 44 Frequencies assigned to coast stations for narrow-band direct-printing telegraphy shall be indicated in the List of Coast Stations and Special Service Stations (List IV). This List shall also indicate any other useful information concerning the service performed by each coast station. (WRC-07)

52.96 *B − Bands between 415 kHz and 535 kHz*

52.97 § 45 All ship stations equipped with narrow-band direct-printing apparatus for general traffic to work in the authorized bands between 415 kHz and 535 kHz should be able to send and receive class F1B or J2B emissions as specified in No. **51.44**. Additionally, ship stations complying with the provisions of Chapter **VII** shall be able to receive class F1B emissions on 518 kHz (see No. **51.45**). (WRC-23)

52.98 (SUP - WRC-03)

52.99 *C − Bands between 1 606.5 kHz and 4 000 kHz* (WRC-03)

52.100 § 46 1) All ship stations equipped with narrow-band direct-printing telegraph apparatus to work in the authorized bands between 1 606.5 kHz and 4 000 kHz shall be able to send and receive class F1B or J2B emissions on at least two working frequencies. (WRC-03)

52.101 2) Narrow-band direct-printing telegraphy is forbidden in the frequency band 2 170-2 194 kHz. (WRC-23)

52.102 *D − Bands between 4 000 kHz and 27 500 kHz*

52.103 § 47 All ship stations equipped with narrow-band direct-printing telegraph apparatus for general traffic to work in the authorized bands between 4 000 kHz and 27 500 kHz should be able to send and receive class F1B or J2B emissions as specified in No. **51.49**. All ship stations equipped with narrow-band direct-printing telegraph apparatus for receiving MSI to work in the authorized frequency bands between 4 000 kHz and 27 500 kHz shall be able to receive class F1B or J2B emissions as specified in No. **51.49**. The assignable frequencies are indicated in Appendices **15** and **17**. (WRC-23)

52.104 § 48 Coast stations employing class F1B emissions and operating in the bands exclusively allocated to the maritime mobile service between 4 000 kHz and 27 500 kHz shall at no time use mean powers in excess of the following:

Band	*Maximum mean power*
4 MHz	5 kW
6 MHz	5 kW
8 MHz	10 kW
12 MHz	15 kW
16 MHz	15 kW
18/19 MHz	15 kW
22 MHz	15 kW
25/26 MHz	15 kW

52.105 1) In all bands, the working frequencies for ship stations using narrow-band direct-printing telegraphy at speeds not exceeding 100 Bd for FSK and 200 Bd for PSK, including those paired with the working frequencies assignable to coast stations (see Appendix **17**), are spaced 0.5 kHz apart. The frequencies assignable to ship stations which are paired with those used by coast stations are shown in Appendix **17**. The frequencies assignable to ship stations which are not paired with those used by coast stations are shown in Appendix **17**.

52.106 (SUP - WRC-03)

52.107 2) Each administration shall, if necessary, assign to each ship station under its jurisdiction and employing non-paired narrow-band direct-printing telegraphy one or more frequencies reserved for this purpose and shown in Appendix **17**.

52.108 *E − Bands between 156 MHz and 174 MHz*

52.109 § 49 All ship stations equipped with direct-printing telegraph apparatus may work in the authorized bands between 156 MHz and 174 MHz and shall conform to the provisions of Appendix **18**.

Section IV − Use of frequencies for digital selective-calling

52.110 *A − General*

52.111 § 50 The provisions described in this Section are applicable to calling and acknowledgement, when digital selective-calling techniques are used, except in cases of distress, urgency and safety, to which the provisions of Chapter **VII** apply. When an automatic connection system (ACS) is used, the provisions of Section IVA should apply. (WRC-23)

52.112 § 51 The characteristics of the digital selective-calling equipment shall be in accordance with Recommendation ITU-R M.541-11 and should be in accordance with the most recent version of Recommendation ITU-R M.493. (WRC-23)

52.113 § 52 The frequencies on which coast stations provide services using digital selective-calling techniques shall be indicated in the List of Coast Stations and Special Service Stations (List IV), which shall also supply any other useful information concerning such services. (WRC-07)

52.114 *B − Bands between 415 kHz and 526.5 kHz*

B1 − Mode of operation

52.115 § 53 1) The class of emission to be used for digital selective-calling and acknowledgement in the authorized bands between 415 kHz and 526.5 kHz shall be F1B.

52.116 2) When transmitting digital selective calls and acknowledgements in the bands between 415 kHz and 526.5 kHz, coast stations should use the minimum power necessary to cover their service area.

52.117 § 54 Transmissions of digital selective calls and acknowledgements by ship stations shall be limited to a mean power of 400 W.

B2 − Call and acknowledgement

52.118 § 55 For call and acknowledgement by digital selective-calling techniques, an appropriate channel shall be used.

52.119 § 56 The international digital selective-calling frequency 455.5 kHz may be assigned to any coast station. In order to reduce interference on this frequency, it may be used as a general rule by coast stations to call ships of another nationality, or in cases where it is not known on which digital selective-calling frequencies within these bands the ship station is maintaining watch.

52.120 § 57 The international digital selective-calling frequency 458.5 kHz may be used by any ship station. In order to reduce interference on this frequency, it shall only be used when calling cannot be made on national frequencies assigned to the coast station.

52.121 § 58 The frequency to be used for transmission of an acknowledgement shall normally be the frequency paired with the calling frequency used.

B3 − Watch

52.122 § 59 1) A coast station providing international public correspondence service using digital selective-calling techniques within the bands between 415 kHz and 526.5 kHz should, during its hours of service, maintain automatic digital selective-calling watch on appropriate national or international calling frequencies. The hours and frequencies shall be indicated in the List of Coast Stations and Special Service Stations (List IV). (WRC-07)

52.123 2) Ship stations equipped with apparatus for digital selective-calling to work in the authorized bands between 415 kHz and 526.5 kHz should, when within the coverage area of coast stations providing services using digital selective-calling techniques in these bands, maintain an automatic digital selective-calling watch on one or more appropriate digital selective-calling frequencies within these bands, taking into account the digital selective-calling frequencies operated by the coast stations.

52.124 *C − Bands between 1 606.5 kHz and 4 000 kHz* (WRC-03)

C1 − Mode of operation

52.125 § 60 1) The class of emission to be used for digital selective-calling and acknowledgement in the bands between 1 606.5 kHz and 4 000 kHz shall be F1B. (WRC-03)

52.126 2) Coast stations should, when transmitting digital selective calls and acknowledgements in the bands between 1 606.5 kHz and 4 000 kHz, use the minimum power necessary to cover their service area. (WRC-03)

52.127 3) In Region 1, transmissions of digital selective calls and acknowledgements by ship stations shall be limited to a mean power of 400 W.

C2 − Call and acknowledgement

52.128 § 61 1) When calling a coast station by digital selective-calling techniques, ship stations should use for the call, in order of preference:

52.129 *a)* a national digital selective-calling channel on which the coast station is maintaining watch;

52.130 *b)* subject to the provisions of No. **52.131**, the international digital selective-calling frequency 2 189.5 kHz.

52.131 2) The international digital selective-calling frequency 2 189.5 kHz may be assigned to any ship station. In order to reduce interference on this frequency, it may be used as a general rule by ship stations to call coast stations of another nationality.

52.132 3) A ship station calling another ship station by digital selective-calling techniques should use the frequency 2 177 kHz for the call. Acknowledgements of such calls should also be made on this frequency.

52.133 § 62 1) When calling ship stations by digital selective-calling techniques, coast stations should use for the call, in the order of preference:

52.134 *a)* a national digital selective-calling channel on which the coast station is maintaining watch;

52.135 *b)* subject to the provisions of No. **52.136**, the international digital selective-calling frequency 2 177 kHz.

52.136 2) The international digital selective-calling frequency 2 177 kHz may be assigned to any coast station. In order to reduce interference on this frequency, it may be used as a general rule by coast stations to call ships of another nationality, or in cases where it is not known on which digital selective-calling frequencies within the bands between 1 606.5 kHz and 4 000 kHz the ship station is maintaining watch. (WRC-03)

52.137 § 63 The frequency to be used for transmission of an acknowledgement shall normally be the frequency paired with the frequency used for the call received, as indicated in the List of Coast Stations and Special Service Stations (List IV) (see also No. **52.113**). (WRC-07)

C3 − Watch

52.138 § 64 1) The provisions detailed in this Sub-section are applicable to watch-keeping by digital selective-calling, except for distress, urgency and safety purposes, to which the provisions of Section III of Article **31** apply.

52.139 2) A coast station providing international public correspondence service using digital selective-calling techniques within the bands between 1 606.5 kHz and 4 000 kHz should, during its hours of service, maintain automatic digital selective-calling watch on appropriate national or international calling frequencies. The hours and frequencies shall be indicated in the List of Coast Stations and Special Service Stations (List IV). (WRC-07)

52.140 3) Ship stations equipped with apparatus for digital selective-calling to work in the authorized bands between 1 606.5 kHz and 4 000 kHz should, when within the coverage area of coast stations providing services using digital selective-calling techniques in these bands, maintain an automatic digital selective-calling watch on one or more appropriate digital selective-calling frequencies within these bands, taking into account the digital selective-calling frequencies operated by the coast stations. (WRC-03)

52.141 *D − Bands between 4 000 kHz and 27 500 kHz*

D1 − Mode of operation

52.142 § 65 1) The class of emission to be used for digital selective-calling and acknowledgement in the authorized bands between 4 000 kHz and 27 500 kHz shall be F1B.

52.143 2) When transmitting digital selective calls and acknowledgements in the bands between 4 000 kHz and 27 500 kHz, coast stations shall at no time use a mean power in excess of the following values:

Band	*Maximum mean power*
4 MHz	5 kW
6 MHz	5 kW
8 MHz	10 kW
12 MHz	15 kW
16 MHz	15 kW
18/19 MHz	15 kW
22 MHz	15 kW
25/26 MHz	15 kW

52.144 3) Transmissions of digital selective calls and acknowledgements by ship stations in the bands between 4 000 kHz and 27 500 kHz shall be limited to a mean power of 1.5 kW.

D2 − Call and acknowledgement

52.145 § 66 A station calling another station by digital selective-calling techniques within the authorized bands between 4 000 kHz and 27 500 kHz should choose an appropriate digital selective-calling frequency, taking into account propagation characteristics.

52.146 § 67 1) When calling a coast station by digital selective-calling techniques on frequencies within the authorized bands between 4 000 kHz and 27 500 kHz, ship stations should use for the call, in order of preference:

52.147 *a)* a national digital selective-calling channel on which the coast station is maintaining watch;

52.148 *b)* subject to the provisions of No. **52.149**, one of the international digital selective-calling frequencies. (WRC-07)

52.149 2) The international digital selective-calling frequencies shall be as indicated in Recommendation ITU-R M.541-11 and may be used by any ship station. In order to reduce interference on these frequencies, they shall only be used when calling cannot be made on nationally assigned frequencies. (WRC-23)

52.150 § 68 1) When calling ship stations by digital selective-calling techniques on frequencies within the bands between 4 000 kHz and 27 500 kHz coast stations should use for the call, in order of preference:

52.151 *a)* a national digital selective-calling channel on which the coast station is maintaining watch;

52.152 *b)* subject to the provisions of No. **52.153**, one of the international digital selective-calling frequencies. (WRC-07)

52.153 2) The international digital selective-calling frequencies shall be as indicated in Recommendation ITU-R M.541-11 and may be assigned to any coast station. In order to reduce interference on these frequencies, they may be used as a general rule by coast stations to call ships of another nationality, or in cases where it is not known on which digital selective-calling frequencies within the frequency bands concerned the ship station is maintaining watch. (WRC-23)

D3 − Watch

52.154 § 69 1) The provisions detailed in this Sub-section are applicable to watch-keeping by digital selective-calling, except for distress, urgency and safety purposes, to which the provisions of Section III of Article **31** apply.

52.155 2) A coast station providing international public correspondence service using digital selective-calling techniques within the bands between 4 000 kHz and 27 500 kHz should, during its hours of service, maintain automatic digital selective-calling watch on the appropriate digital selective-calling frequencies as indicated in the List of Coast Stations and Special Service Stations (List IV). (WRC-07)

52.156 3) Ship stations equipped with apparatus for digital selective-calling to work in the authorized bands between 4 000 kHz and 27 500 kHz should maintain automatic digital selective-calling watch on appropriate digital selective-calling frequencies within these bands, taking into account propagation characteristics and the calling frequencies for coast stations providing service using digital selective-calling techniques.

52.157 *E − Bands between 156 MHz and 174 MHz*

E1 − Mode of operation

52.158 § 70 The class of emission to be used for digital selective-calling and acknowledgement in the authorized bands between 156 MHz and 174 MHz shall be G2B.

E2 − Call and acknowledgement

52.159 § 71 1) The frequency 156.525 MHz is an international frequency in the maritime mobile service used for distress, urgency, safety and calling by digital selective-calling techniques (see Nos. **33.8** and **33.31** and Appendix **15**). (WRC-07)

52.160 2) Calling by digital selective-calling techniques within the authorized bands between 156 MHz and 174 MHz, from ship to coast station, from coast station to ship and from ship to ship should, as a general rule, be made on the digital selective-calling frequency 156.525 MHz.

E3 − Watch

52.161 § 72 Information concerning watch-keeping by automatic digital selective-calling on the frequency 156.525 MHz by coast stations shall be given in the List of Coast Stations and Special Service Stations (List IV) (see also No. **31.13**). (WRC-07)

52.162 § 73 Ship stations equipped with apparatus for digital selective-calling to work in the authorized bands between 156 MHz and 174 MHz should, while at sea, maintain an automatic digital selective-calling watch on the frequency 156.525 MHz (see also No. **31.17**).

Section IVA − Use of frequencies for the automatic connection system (WRC-23)

52.162A *A – General* (WRC-23)

52.162B § 73A An automatic connection system (ACS) is an automatic connection function using digital selective calling (DSC) for shore-to-ship, ship-to-shore or ship-to-ship communication with the most appropriate working frequency (or channel) in the MF and HF bands of the maritime mobile service.

The procedure for ACS shall not interrupt a reliable watch on a 24-hour basis on appropriate DSC distress alerting frequencies unless the equipment is transmitting.

When an ACS is utilized, it should be in accordance with the most recent versions of Recommendations ITU-R M.493 and ITU-R M.541. (WRC-23)

52.162C *B – Bands between 1 606.5 kHz and 4 000 kHz* (WRC-23)

52.162D § 73B The automatic connection system (ACS) frequency used for transmitting and receiving for both ship stations and coast stations is 2 174.5 kHz. (WRC-23)

52.162E *C – Bands between 4 000 kHz and 27 500 kHz* (WRC-23)

52.162F § 73C The automatic connection system (ACS) frequencies used for transmitting and receiving for both ship stations and coast stations are 4 177.5 kHz, 6 268 kHz, 8 376.5 kHz, 12 520 kHz and 16 695 kHz. (WRC-23)

Section V − Use of frequencies for wide-band telegraphy, facsimile, special transmission systems and oceanographic data transmissions

52.163 *A − Wide-band telegraphy, facsimile and special transmission systems*

52.164 A1 − Bands between 1 606.5 kHz and 4 000 kHz (WRC-03)

52.165 § 74 In Region 2, the frequencies in the band 2 068.5-2 078.5 kHz are assigned to ship stations using wide-band telegraphy, facsimile and special transmission systems. The provisions of No. **52.171** apply.

52.166 A2 − Bands between 4 000 kHz and 27 500 kHz

52.167 § 75 In all bands, the working frequencies for ship stations equipped to use wide-band telegraphy, facsimile and special transmission systems are spaced 4 kHz apart. The assignable frequencies are shown in Appendix **17**.

52.168 § 76 1) Each administration shall assign to each ship station under its jurisdiction and employing wide-band telegraphy, facsimile and special transmission systems one or more series of the working frequencies reserved for this purpose shown in Appendix **17**. The total number of series assigned to each ship station shall be determined by traffic requirements.

52.169 2) When ship stations employing wide-band telegraphy, facsimile and special transmission systems are assigned less than the total number of working frequencies in a band, the administration concerned shall assign working frequencies to such ships in accordance with an orderly system of rotation that will ensure approximately the same number of assignments on any one working frequency.

52.170 3) However, within the limits of the bands given in Appendix **17**, administrations may, to meet the needs of specific systems, assign frequencies in a different manner from that shown in Appendix **17**. Nevertheless administrations shall take into account, as far as possible, the provisions of Appendix **17**, concerning channelling and the 4 kHz spacing.

52.171 § 77 Ship stations equipped for wide-band telegraphy, facsimile and special transmission systems may, in the frequency bands reserved for such use, employ any class of emission provided that such emissions can be contained within the wide-band channels indicated in Appendix **17**. However, the use of A1A Morse telegraphy and telephony is excluded except for circuit alignment purposes.

52.172 § 78 Coast radiotelegraph stations employing multichannel telegraph emissions and operating in the bands allocated exclusively to the maritime mobile service between 4 000 kHz and 27 500 kHz shall at no time use a mean power in excess of 2.5 kW per 500 Hz bandwidth.

52.173 *B − Oceanographic data transmission systems*

52.174 § 79 In all bands, the assignable frequencies for oceanographic data transmissions are spaced 0.3 kHz apart. The assignable frequencies are shown in Appendix **17**.

52.175 § 80 The frequency bands for oceanographic data transmission systems (see Appendix **17**) may also be used by buoy stations for oceanographic data transmission and by stations interrogating these buoys.

Section VI − Use of frequencies for radiotelephony

52.176 *A − General*

52.177 § 81 Except with regard to the provisions of Article **11** concerning notification and recording of frequencies, when designating frequencies for single-sideband radiotelephony the carrier frequency is always to be designated. The assigned frequency shall be 1 400 Hz higher than the carrier frequency.

52.178 § 82 Coast stations shall not occupy idle radiotelephone channels by emitting identification signals, such as those generated by call slips or tapes. Exceptionally, a coast station, when requested by a ship station for the purpose of establishing a radiotelephone call, may emit a receiver tuning signal of not more than 10 s duration.

52.179 § 83 However, coast stations in automatic service in the UHF band may emit marking signals. The emission power of the signals shall however be limited to the minimum value necessary for effective operation of the signalling. Such emissions shall not cause harmful interference to the maritime mobile service in other countries.

52.180 § 84 The frequencies of transmission (and reception when these frequencies are in pairs as in the case of duplex radiotelephony) assigned to each coast station shall be indicated in the List of Coast Stations and Special Service Stations (List IV). This List shall also indicate any other useful information concerning the service performed by each coast station. (WRC-07)

52.181 § 85 Single-sideband apparatus in radiotelephone stations of the maritime mobile service operating in the frequency bands allocated to this service between 1 606.5 kHz and 4 000 kHz and in the frequency bands allocated exclusively to this service between 4 000 kHz and 27 500 kHz shall satisfy the technical and operational conditions specified in Recommendation ITU-R M.1173-1. (WRC-15)

52.182 *B − Bands between 1 606.5 kHz and 4 000 kHz* (WRC-03)

B1 − Mode of operation of stations

52.183 § 86 1) Unless otherwise specified in the Radio Regulations (see Nos. **51.53**, **52.188**, **52.189** and **52.199**), the class of emission to be used in the bands between 1 606.5 kHz and 4 000 kHz shall be J3E. (WRC-07)

52.184 2) The peak envelope power of coast radiotelephone stations operating in the authorized bands allocated between 1 606.5 kHz and 4 000 kHz shall not exceed: (WRC-03)

52.185 – 5 kW for coast stations located north of latitude 32° N;

52.186 – 10 kW for coast stations located south of latitude 32° N.

52.187 3) The normal mode of operation for each coast station shall be indicated in the List of Coast Stations and Special Service Stations (List IV). (WRC-07)

52.188 4) Transmissions in the bands 2 170-2 173.5 kHz and 2 190.5-2 194 kHz with the carrier frequency 2 170.5 kHz and the carrier frequency 2 191 kHz, respectively, are limited to class J3E emissions and are limited to a peak envelope power of 400 W. (WRC-07)

B2 − Call and reply

52.189 § 87 1) The frequency 2 182 kHz[1] is an international distress frequency for radiotelephony (see Appendix **15** and Resolution **354 (Rev.WRC-23)**). (WRC-23)

52.190 2) The frequency 2 182 kHz may also be used:

52.191 *a)* for call and reply in accordance with the provisions of Article **57**;

52.192 *b)* by coast stations to announce the transmission, on another frequency, of traffic lists as specified in Recommendation ITU-R M.1171-1. (WRC-23)

52.193 3) In addition, an administration may assign to its stations other frequencies for call and reply.

[1] **52.189.1** Where administrations provide at their coast stations a watch on 2 182 kHz for receiving class J3E emissions as well as class A3E and H3E emissions, ship stations may call those coast stations for safety purposes using class H3E or J3E emissions.

52.194 § 88 To facilitate use of the frequency 2 182 kHz for distress purposes, all transmissions on 2 182 kHz shall be kept to a minimum.

52.195 § 89 1) Before transmitting on the carrier frequency 2 182 kHz, a station shall, in accordance with Recommendation ITU-R M.1171-1, listen on this frequency for a reasonable period to make sure that no distress traffic is being sent. (WRC-23)

52.196 2) The provisions of No. **52.195** do not apply to stations in distress.

B3 − Traffic

52.197 § 90 1) Coast stations which use 2 182 kHz for calling shall be able to use at least one other frequency in the authorized bands between 1 606.5 kHz and 2 850 kHz. (WRC-03)

52.198 2) Coast stations authorized to use radiotelephony on one or more frequencies other than 2 182 kHz in the authorized bands between 1 606.5 kHz and 2 850 kHz shall use class J3E emissions on those frequencies (see also No. **52.188**). (WRC-03)

52.199 3) Coast stations open to the public correspondence service on one or more frequencies between 1 606.5 kHz and 2 850 kHz shall also be capable of transmitting class H3E and J3E emissions with a carrier frequency of 2 182 kHz, and of receiving class A3E, H3E and J3E emissions with a carrier frequency of 2 182 kHz. (WRC-03)

52.200 (SUP - WRC-23)

52.201 5) Working frequencies of coast stations shall be chosen in such a manner as to avoid interference with other stations.

B4 − Additional provisions applying to Region 1

52.202 § 91 The peak envelope power of ship radiotelephone stations operating in the authorized bands between 1 606.5 kHz and 2 850 kHz shall not exceed 400 W. (WRC-03)

52.203 § 92 1) All stations on ships making international voyages should be able to use:

52.204 *a)* the following ship-to-shore working frequency, if required by their service:

52.205 – carrier frequency 2 045 kHz (assigned frequency 2 046.4 kHz) for class J3E emissions;

52.206 *b)* the following intership frequency, if required by their service:

52.207 – carrier frequency 2 048 kHz (assigned frequency 2 049.4 kHz) for class J3E emissions;

52.208 This frequency may be used as an additional ship-to-shore frequency.

52.209 (SUP - WRC-07)

52.210 § 93 1) Ships frequently exchanging correspondence with a coast station of a nationality other than their own may use the same frequencies as ships of the nationality of the coast station:

52.211 – where mutually agreed by the administrations concerned; or

52.212 – where the facility is open to ships of all nationalities by virtue of a note against each of the frequencies concerned in the List of Coast Stations and Special Service Stations (List IV). (WRC-07)

52.213 2) In exceptional circumstances, if frequency usage according to Nos. **52.203** to **52.208** or No. **52.210** is not possible, a ship station may use one of its own assigned national ship-to-shore frequencies for communication with a coast station of another nationality, under the express condition that the coast station as well as the ship station shall take precautions, in accordance with Recommendation ITU-R M.1171-1, to ensure that the use of such a frequency will not cause harmful interference to the service for which the frequency in question is authorized. (WRC-23)

52.214 § 94 The following ship-to-shore frequencies:

– carrier frequency 2 051 kHz (assigned frequency 2 052.4 kHz),

– carrier frequency 2 054 kHz (assigned frequency 2 055.4 kHz), and

– carrier frequency 2 057 kHz (assigned frequency 2 058.4 kHz),

may be assigned to coast stations as receiving frequencies.

B5 − Additional provisions applying to Regions 2 and 3

52.215 § 95 All stations on ships making international voyages should, if required by their service, be able to use the intership carrier frequencies:

2 635 kHz (assigned frequency 2 636.4 kHz) or

2 638 kHz (assigned frequency 2 639.4 kHz).

The conditions of use of these frequencies are specified in No. **52.11**.

52.216 *C − Bands between 4 000 kHz and 27 500 kHz*

C1 − Mode of operation of stations

52.217 § 96 1) The class of emission to be used for analogue radiotelephony in the bands between 4 000 kHz and 26 175 kHz shall be J3E; for digital telecommunications in those bands, the class of emission shall be J2D. (WRC-03)

52.218 2) The normal mode of operation of each coast station is indicated in the List of Coast Stations and Special Service Stations (List IV). (WRC-07)

52.219 3) Coast stations employing class J3E or J2D emissions in accordance with No. **52.217** in the bands between 4 000 kHz and 27 500 kHz shall use the minimum power necessary to cover their service area and shall at no time use a peak envelope power in excess of 10 kW per channel.

52.220 4) Ship stations employing class J3E or J2D emissions in accordance with No. **52.217** in the bands between 4 000 kHz and 27 500 kHz shall at no time use a peak envelope power in excess of 1.5 kW per channel.

C2 − Call and reply

52.220A 5) Administrations should encourage the coast stations and ship stations under their jurisdiction to use digital selective calling techniques for call and reply. (WRC-2000)

52.220B § 96A When calling by radiotelephony is necessary, it should be done (in order of preference): (WRC-2000)

52.220C 1) on the working frequencies assigned to the coast stations; or (WRC-2000)

52.220D 2) when this is not possible, on the calling frequencies listed under No. **52.221** or **52.221A** below. (WRC-2000)

52.221 § 97 1) Ship stations may use the following carrier frequencies for calling in radiotelephony:

4 125 kHz[2, 3, 4]

6 215 kHz[3, 4]

8 255 kHz

8 291 kHz[4] (see also No. **52.221A**)

12 290 kHz[4] (see also No. **52.221A**)

16 420 kHz[4] (see also No. **52.221A**)

18 795 kHz

22 060 kHz

25 097 kHz (WRC-15)

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[2] **52.221.1** In the United States, the carrier frequency 4 125 kHz is also authorized for common use by coast and ship stations for single-sideband radiotelephony on a simplex basis, provided the peak envelope power of such stations does not exceed 1 kW (see also No. **52.222.2**).

[3] **52.221.2** The carrier frequencies 4 125 kHz and 6 215 kHz are also authorized for common use by coast and ship stations for single-sideband radiotelephony on a simplex basis for call and reply purposes, provided that the peak envelope power of such stations does not exceed 1 kW. The use of these frequencies for working purposes is not permitted (see also No. **52.221.1**). (WRC-07)

[4] **52.221.3** The carrier frequencies 4 125 kHz, 6 215 kHz, 8 291 kHz, 12 290 kHz and 16 420 kHz are also authorized for common use by coast and ship stations for single-sideband radiotelephony on a simplex basis for distress and safety traffic.

52.221A 2) The carrier frequency 8 291 kHz is authorized on a simplex basis for distress and safety traffic only (see also Appendix **15**). Calling on the carrier frequencies 12 290 kHz and 16 420 kHz shall be permitted only to and from rescue coordination centres (see No. **30.6.1**), subject to the safeguards of Resolution **352 (WRC-03)**. The alternative carrier frequencies 12 359 kHz and 16 537 kHz may be used by ship stations and coast stations for calling on a simplex basis, provided that the peak envelope power does not exceed 1 kW. (WRC-15)

52.222 3) Coast stations may use the following carrier frequencies for calling in radiotelephony:

4 417 kHz[5]

6 516 kHz[5]

8 779 kHz

13 137 kHz (see No. **52.222A**)

17 302 kHz (see No. **52.222A**)

19 770 kHz

22 756 kHz

26 172 kHz (WRC-2000)

52.222A 4) The carrier frequencies 13 137 kHz and 17 302 kHz shall not be used as calling frequencies after 31 December 2003. The alternative carrier frequencies 12 359 kHz and 16 537 kHz may be used by ship stations and coast stations for calling on a simplex basis, provided that the peak envelope power does not exceed 1 kW. (WRC-2000)

52.223 § 98 The hours of service of coast stations open to public correspondence and the frequency or frequencies on which watch is maintained shall be indicated in the List of Coast Stations and Special Service Stations (List IV). (WRC-07)

52.224 § 99 1) Before transmitting on the carrier frequencies 4 125 kHz, 6 215 kHz, 8 291 kHz, 12 290 kHz or 16 420 kHz, a station shall, in accordance with Recommendation ITU-R M.1171-1, listen on the frequency for a reasonable period to make sure that no distress traffic is being sent (see No. **52.221A**). (WRC-23)

52.225 2) The provisions of No. **52.224** do not apply to stations in distress.

52.222.1 (SUP - WRC-07)

[5] **52.222.2** The carrier frequencies 4 417 kHz and 6 516 kHz are also authorized for common use by coast and ship stations for single-sideband radiotelephony on a simplex basis, provided that the peak envelope power of such stations does not exceed 1 kW. The use of 6 516 kHz for this purpose should be limited to daytime operation (see also No. **52.221.1**).

C3 − Traffic

52.226 § 100 1) For the conduct of duplex telephony, the transmitting frequencies of the coast stations and of the corresponding ship stations shall be associated in pairs, as indicated in Appendix **17**, except temporarily in cases where working conditions prohibit the use of paired frequencies in order to meet operational needs.

52.227 2) The frequencies to be used for the conduct of simplex radiotelephony are shown in Appendix **17**, Section B. In these cases, the peak envelope power of the coast station transmitter shall not exceed 1 kW.

52.228 3) The frequencies indicated in Appendix **17** for ship station transmissions may be used by ships of any category according to traffic requirements.

52.229 4) Transmitters used for radiotelephony in the frequency bands between 4 000 kHz and 27 500 kHz shall comply with technical characteristics specified in Recommendation ITU-R M.1173-1. (WRC-15)

52.230 *D − Bands between 156 MHz and 174 MHz*

D1 − Call and reply

52.231 § 101 1) The frequency 156.8 MHz is the international frequency for distress traffic and for calling by radiotelephony when using frequencies in the authorized bands between 156 MHz and 174 MHz. The class of emission to be used for radiotelephony on the frequency 156.8 MHz shall be G3E (as specified in Recommendation ITU-R M.489-2). (WRC-07)

52.232 2) The frequency 156.8 MHz may also be used:

52.233 *a)* by coast and ship stations for call and reply in accordance with the provisions of Articles **54** and **57**;

52.234 *b)* by coast stations to announce the transmission on another frequency of traffic lists, in accordance with Recommendation ITU-R M.1171-1, and important maritime information. (WRC-23)

52.235 (SUP - WRC-07)

52.236 3) Any one of the channels designated in Appendix **18** for public correspondence may be used as a calling channel if an administration so desires. Such use shall be indicated in the List of Coast Stations and Special Service Stations (List IV). (WRC-07)

52.237 5) Ship and coast stations in the public correspondence service may use a working frequency, for calling purposes, as provided in Articles **54** and **57**.

52.238 6) All emissions in the band 156.7625-156.8375 MHz capable of causing harmful interference to the authorized transmissions of stations of the maritime mobile service on 156.8 MHz are forbidden.

52.239 7) To facilitate the reception of distress calls and distress traffic, all transmissions on 156.8 MHz shall be kept to a minimum and shall not exceed one minute.

52.240 8) Before transmitting on the frequency 156.8 MHz, a station shall, in accordance with Recommendation ITU-R M.1171-1, listen on this frequency for a reasonable period to make sure that no distress traffic is being sent. (WRC-23)

52.241 9) The provisions of No. **52.240** do not apply to stations in distress.

52.241A 10) The frequency 156.525 MHz is the international distress, safety and calling frequency for the maritime mobile VHF radiotelephone service using digital selective calling (DSC) when using frequencies in the authorized bands between 156 MHz and 174 MHz. (WRC-07)

52.241B 11) All emissions in the band 156.4875-156.5625 MHz capable of causing harmful interference to the authorized transmissions of stations of the maritime mobile service on 156.525 MHz are forbidden. (WRC-07)

52.241C 12) To facilitate the reception of distress calls and distress traffic, all transmissions on 156.525 MHz shall be kept to a minimum. (WRC-07)

D2 − Watch

52.242 § 102 1) A coast station open to the international public correspondence service should, during its hours of service, maintain watch on its receiving frequency or frequencies indicated in the List of Coast Stations and Special Service Stations (List IV). (WRC-07)

52.243 2) The method of watch on a working frequency shall be no less efficient than watch by an operator.

52.244 3) Ship stations should, where practicable, maintain watch on 156.8 MHz when within the service area of a coast station providing international maritime mobile radiotelephone service in the band 156-174 MHz. Ship stations fitted only with VHF radiotelephone equipment operating in the authorized bands between 156 MHz and 174 MHz should maintain watch on 156.8 MHz when at sea.

52.245 4) Ship stations, when in communication with a port station, may, on an exceptional basis and subject to the agreement of the administration concerned, continue to maintain watch on the appropriate port operations frequency only, provided that watch on 156.8 MHz is being maintained by the port station.

52.246 5) Ship stations, when in communication with a coast station in the ship movement service and subject to the agreement of the administration concerned, may continue to maintain watch on the appropriate ship movement service frequency only, provided that watch on 156.8 MHz is being maintained by that coast station.

52.247 § 103 A coast station in the port operations service in an area where 156.8 MHz is being used for distress, urgency or safety shall, during its working hours, keep an additional watch on 156.6 MHz or another port operations frequency indicated in the List of Coast Stations and Special Service Stations (List IV). (WRC-23)

52.248 § 104 A coast station in the ship movement service in an area where 156.8 MHz is being used for distress, urgency and safety shall, during its working hours, keep an additional watch on the ship movement frequencies indicated in the List of Coast Stations and Special Service Stations (List IV). (WRC-23)

D3 − Traffic

52.249 § 105 1) Where practicable, coast stations open to the international public correspondence service shall be capable of working with ship stations equipped for duplex or semi-duplex operation.

52.250 2) The method of working (single-frequency or two-frequency) specified in Appendix **18** for each channel should be used in the international services.

52.251 § 106 Communications in the port operations service shall be restricted to those relating to operational handling, the movement and the safety of ships and, in emergency, to the safety of persons. Messages of a public correspondence nature shall be excluded from this service.

52.252 § 107 Communications in the ship movement service shall be restricted to those relating to the movement of ships. Messages of a public correspondence nature shall be excluded from this service.

52.253 § 108 1) Coast stations which use 156.8 MHz for calling shall be able to use at least one other authorized channel in the international maritime mobile radiotelephone service in the band 156-174 MHz.

52.254 2) In the band 156-174 MHz administrations shall, where practicable, assign frequencies to coast and ship stations in accordance with the Table of transmitting frequencies given in Appendix **18** for such international services as administrations consider necessary.

52.255 (SUP - WRC-03)

52.256 3) In assigning frequencies to their coast stations, administrations should collaborate in cases where harmful interference might occur.

52.257 4) Channels are designated by numbers in the Table of transmitting frequencies given in Appendix **18**.

52.258 § 109 1) In assigning frequencies to stations of authorized services, other than maritime mobile, administrations shall avoid the possibility of interference to international maritime services in the bands between 156 MHz and 174 MHz.

52.259 2) The use of channels for maritime mobile purposes other than those indicated in the Table of transmitting frequencies given in Appendix **18** shall not cause harmful interference to services which operate in accordance with that table and shall not prejudice the future development of such services.

52.260 § 110 The carrier power of ship station transmitters shall not exceed 25 W.

Section VII – Use of frequencies for data transmissions (WRC-12)

52.261 *A – General* (WRC-12)

52.262 Frequencies assigned to coast stations for data transmissions shall be indicated in the List of Coast Stations and Special Service Stations (List IV). This List shall also indicate any other useful information concerning the service performed by each coast station. (WRC-12)

52.262A *B – Bands between 415 kHz and 526.5 kHz* (WRC-23)

B1 – Mode of operation of stations (WRC-23)

52.262B The class of emission to be used for data transmissions in the frequency bands between 415 kHz and 526.5 kHz should be in accordance with the most recent version of Recommendation ITU-R M.2010. Coast stations and ship stations should use radio systems specified in the most recent version of Recommendation ITU-R M.2010. (WRC-23)

52.263 *C – Bands between 4 000 kHz and 27 500 kHz* (WRC-23)

C1 – Mode of operation of stations (WRC-23)

52.264 The class of emission to be used for data transmissions in the frequency bands between 4 000 kHz and 27 500 kHz should be in accordance with the most recent versions of Recommendations ITU-R M.1798 or ITU-R M.2058. Coast stations and ship stations should use radio systems specified in the most recent versions of Recommendations ITU-R M.1798 or ITU-R M.2058. (WRC-23)

52.265 Coast stations employing the class of emissions in accordance with No. **52.264** in the frequency bands between 4 000 kHz and 27 500 kHz shall not exceed a peak envelope power of 10 kW. (WRC-12)

52.265A Coast stations employing the class of emission in accordance with the most recent version of Recommendation ITU-R M.2058 in the frequency bands between 4 000 kHz and 27 500 kHz shall not exceed a mean power in the following values:

Band	*Maximum mean power*
4 MHz	5 kW
6 MHz	5 kW
8 MHz	10 kW
12 MHz	10 kW
16 MHz	10 kW
18/19 MHz	10 kW
22 MHz	10 kW

(WRC-23)

52.266 Ship stations employing the class of emissions in accordance with No. **52.264** in the frequency bands between 4 000 kHz and 27 500 kHz shall not exceed a peak envelope power of 1.5 kW. (WRC-12)

ARTICLE 53

Order of priority of communications

53.1 § 1 All stations in the maritime mobile service and the maritime mobile-satellite service shall be capable of offering four levels of priority in the following order:

1) Distress calls, distress messages, and distress traffic.

2) Urgency communications.

3) Safety communications.

4) Other communications.

53.2 § 2 In a fully automated system, where it is impracticable to offer all four levels of priority, category 1 shall receive priority until such time as intergovernmental agreements[1] remove exemptions granted for such systems from offering the complete order of priority.

[1] **53.2.1** Requirements and performance standards for radio systems and equipment for maritime distress and safety radiocommunications are developed and adopted by the International Maritime Organization (IMO).

ARTICLE 54

Selective calling

54.1 § 1 1) Selective calling is designed for automatic station calling and distress alerting or the transmission of information for the organization of traffic.

54.2 2) Selective calling is carried out using a digital selective-calling system which shall be in accordance with Recommendation ITU-R M.541-11, and may be in accordance with the most recent version of Recommendation ITU-R M.493. (WRC-23)

ARTICLE 54A

Automatic connection system

54A.1 § 1 1) An automatic connection system (ACS) using digital selective calling in MF and HF bands is designed to ensure reliable access to required radio links for mariners. (WRC-23)

54A.2 2) Automatic connection system (ACS) should be in accordance with the most recent versions of Recommendations ITU-R M.541 and ITU-R M.493. (WRC-23)

ARTICLE 55

Morse radiotelegraphy

55.1 The recommended procedure for conducting Morse radiotelegraph communications is detailed in the most recent version of Recommendation ITU-R M.1170. (WRC-07)

ARTICLE 56

Narrow-band direct-printing telegraphy

56.1 § 1 Stations using narrow-band direct-printing telegraphy shall comply with the provisions of Articles **51** and **52**.

56.2 § 2 The procedures specified in Recommendation ITU-R M.492-6 shall be employed except in cases of distress, urgency, or safety, in which case alternate or non-standard procedures may be used. (WRC-07)

56.3 § 3 Before transmitting, a station shall take precautions to ensure that its emissions will not interfere with transmissions already in progress; if such interference is likely, the station shall await an appropriate break in the communications in progress. This obligation does not apply to stations where unattended operation is possible through automatic means.

56.4 § 4 1) For communication between two stations the ARQ mode should be used when available.

56.5 2) For transmissions from one coast or ship station to two or more other stations the forward-error-correcting mode should be used when available.

56.6 § 5 The services provided by each station open to public correspondence shall be indicated in the List of Coast Stations and Special Service Stations (List IV) and in the List of Ship Stations and Maritime Mobile Service Identity Assignments (List V), together with information on charging. (WRC-07)

56.7 § 6 Where transmission over the telecommunication channels open to public correspondence (excluding the telecommunication channels of the mobile service and of the mobile-satellite service and its feeder links) is involved, the provisions of the International Telecommunication Regulations and the relevant ITU-T Recommendations should be taken into account.

ARTICLE 57

Radiotelephony

57.1 § 1 The procedure detailed in Recommendation ITU-R M.1171-1 shall be applicable to radiotelephone stations, except in cases of distress, urgency or safety. (WRC-23)

57.2 § 2 The radiotelephone public correspondence service provided on ships should, if possible, be operated on a duplex basis.

57.3 § 3 1) Devices providing for the emission of a signal to indicate that a call is in progress on a channel may be used in this service on a non-interference basis to the service provided by coast stations.

57.4 2) The use of devices for continuous or repetitive calling or identification in a manually operated radiotelephony service is not permitted.

57.5 3) A station may not transmit identical information simultaneously on two or more frequencies when communicating with only one other station.

57.6 4) A station shall not emit any carrier wave between calls. However, stations in an automatically operated radiotelephone system may emit marking signals under the conditions provided for in No. **52.179**.

57.7 5) When it is necessary to spell out certain expressions, difficult words, service abbreviations, figures, etc., the phonetic spelling tables in Appendix **14** shall be used.

57.8 § 4 Calling, and signals preparatory to traffic, shall not exceed one minute when made on the carrier frequency 2 182 kHz or on 156.8 MHz, except in cases of distress, urgency or safety. (WRC-07)

57.9 § 5 When it is necessary for a ship station to send signals for testing or adjustments which are liable to interfere with the working of neighbouring coast stations, the consent of these stations shall be obtained before such signals are sent.

57.10 § 6 When it is necessary for a station to make test signals, either for the adjustment of a transmitter before making a call or for the adjustment of a receiver, such signals shall be kept to a minimum but in any event, shall not exceed ten seconds, and shall include the call sign or other identification of the station emitting the test signals. This call sign or other identification shall be spoken slowly and distinctly.

ARTICLE 58

Charging and accounting for maritime radiocommunications

58.1 The provisions of the International Telecommunications Regulations, taking into account ITU-T Recommendations, shall apply. (WRC-23)

CHAPTER X

Provisions for entry into force of the Radio Regulations (WRC-12)

ARTICLE 59

Entry into force and provisional application of the Radio Regulations (WRC-12)

59.1 These Regulations, which complement the provisions of the Constitution and Convention of the International Telecommunication Union, and as revised and contained in the Final Acts of WRC-95, WRC-97, WRC-2000, WRC-03, WRC-07, WRC-12, WRC-15, WRC-19 and WRC-23, shall be applied, pursuant to Article 54 of the Constitution, on the following basis. (WRC-23)

59.2 The provisions of these Regulations, as revised by WRC-95, concerning new or modified frequency allocations (including any new or modified conditions applying to existing allocations) and the related provisions of Articles **S21**[1] and **S22**[1], and Appendix **S4**[1], apply provisionally as of 1 January 1997.

59.3 The other provisions of these Regulations, as revised by WRC-95 and WRC-97, apply provisionally as of 1 January 1999, with the following exceptions: (WRC-2000)

59.4 – the revised provisions for which other effective dates of application are stipulated in Resolutions:

49 (WRC-97)[2], **51 (WRC-97)**[3], **52 (WRC-97)**[4], **54 (WRC-97)**[4], **130 (WRC-97)**[4], **533 (WRC-97)**[5], **534 (WRC-97)**[4] and **538 (WRC-97)** [4].

59.5 The other provisions of these Regulations, as revised by WRC-2000, shall enter into force on 1 January 2002, with the following exceptions: (WRC-2000)

59.6 – the revised provisions for which other effective dates of application are stipulated in Resolutions:

49 (Rev.WRC-2000)[2], **51 (Rev.WRC-2000)**[3], **53 (Rev.WRC-2000)**[6] **55 (WRC-2000)**[7], **56 (WRC-2000)**[8], **58 (WRC-2000)**[3], **59 (WRC-2000)**[6], **77 (WRC-2000)**[6], **84 (WRC-2000)**[6], **122 (Rev.WRC-2000)**[9], **128 (Rev.WRC-2000)**[6], **533 (Rev.WRC-2000)**[5], **539 (WRC-2000)**[10], **540 (WRC-2000)**[6], **541 (WRC-2000)**[6], **542 (WRC-2000)**[6], **604 (WRC-2000)**[6] and **605 (WRC-2000)**[6]. (WRC-2000)

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[1] *Note by the Secretariat:* In view of the changes in the numbering scheme, these references correspond now to Articles **21** and **22**, and to Appendix **4**, as appropriate.

[2] *Note by the Secretariat*: This Resolution was revised by WRC-2000, WRC-03, WRC-12, WRC-15, WRC-19 and WRC-23.

[3] *Note by the Secretariat:* This Resolution was abrogated by WRC-15.

[4] *Note by the Secretariat:* This Resolution was abrogated by WRC-2000.

[5] *Note by the Secretariat:* This Resolution was abrogated by WRC-12.

[6] *Note by the Secretariat:* This Resolution was abrogated by WRC-03.

[7] *Note by the Secretariat:* This Resolution was revised by WRC-07, WRC-12, WRC-15, WRC-19 and WRC-23.

[8] *Note by the Secretariat:* This Resolution was abrogated by WRC-07.

[9] *Note by the Secretariat:* This Resolution was revised by WRC-03, WRC-07 and WRC-19.

[10] *Note by the Secretariat:* This Resolution was revised by WRC-03, WRC-15 and WRC-19.

59.7 The other provisions of these Regulations, as revised by WRC-03, shall enter into force on 1 January 2005, with the following exceptions: (WRC-03)

59.8 – the revised provisions for which other effective dates of application are stipulated in Resolutions:

56 (Rev.WRC-03)[8], **85 (WRC-03)**[17], **87 (WRC-03)**[8], **96 (WRC-03)**[8], **122 (Rev.WRC-03)**[9], **142 (WRC-03)**[3], **145 (WRC-03)**[11], **146 (WRC-03)**[8], **221 (Rev.WRC-03)**[12], **413 (WRC-03)**[13], **539 (Rev.WRC-03)**[10], **546 (WRC-03)**[5], **743 (WRC-03)** and **902 (WRC-03)**[17]. (WRC-23)

59.9 The other provisions of these Regulations, as revised by WRC-07, shall enter into force on 1 January 2009, with the following exceptions: (WRC-07)

59.10 – the revised provisions for which other effective dates of application are stipulated in Resolutions:

55 (Rev.WRC-07)[7], **97 (WRC-07)**[5], **149 (WRC-07)**[14], **355 (WRC-07)**[5] and **905 (WRC-07)**[5]. (WRC-12)

59.11 The other provisions of these Regulations, as revised by WRC-12, shall enter into force on 1 January 2013, with the following exceptions: (WRC-12)

59.12 – the revised provisions for which other effective dates of application are stipulated in Resolution:

98 (WRC-12)[3] (WRC-15)

59.13 The other provisions of these Regulations, as revised by WRC-15, shall enter into force on 1 January 2017, with the following exceptions: (WRC-15)

59.14 – the revised provisions for which other effective dates of application are stipulated in Resolutions:

31 (WRC-15)[15] and **99 (WRC-15)**[16] (WRC-19)

59.15 The other provisions of these Regulations, as revised by WRC-19, shall enter into force on 1 January 2021, with the following exceptions: (WRC-19)

59.16 – the revised provisions for which other effective dates of application are stipulated in Resolution:

99 (Rev.WRC-19)[16] (WRC-23)

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[11] *Note by the Secretariat:* This Resolution was revised by WRC-07, WRC-12 and WRC-19.

[12] *Note by the Secretariat:* This Resolution was revised by WRC-07 and WRC-23.

[13] *Note by the Secretariat:* This Resolution was revised by WRC-07, WRC-12 and WRC-23.

[14] *Note by the Secretariat*: This Resolution was revised by WRC-12.

[15] *Note by the Secretariat*: This Resolution was abrogated by WRC-19.

[16] *Note by the Secretariat*: This Resolution was revised by WRC-19 and WRC-23.

[17] *Note by the Secretariat*: This Resolution was revised by WRC-23.

59.17 The other provisions of these Regulations, as revised by WRC-23, shall enter into force on 1 January 2025, with the following exceptions: (WRC-23)

59.18 – the revised provisions for which other effective dates of application are stipulated in Resolution:

99 (Rev.WRC-23) (WRC-23)

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Note by the Secretariat

This revision of the Radio Regulations, complementing the Constitution and the Convention of the International Telecommunication Union, incorporates the decisions of the World Radiocommunication Conferences of 1995 (WRC-95), 1997 (WRC-97), 2000 (WRC-2000), 2003 (WRC-03), 2007 (WRC-07), 2012 (WRC-12), 2015 (WRC-15), 2019 (WRC-19) and 2023 (WRC-23). The majority of the provisions of these Regulations shall enter into force as from 1 January 2025; the remaining provisions shall apply as from the special dates of application indicated in Article **59** of the revised Radio Regulations.

In preparing the Radio Regulations, Edition of 2024, the Secretariat corrected the typographical errors that were drawn to the attention of WRC-23 and which were approved by WRC-23.

This edition uses the same numbering scheme as the 2001 edition of the Radio Regulations, notably:

With respect to *Article numbers*, this edition follows the standard sequential numbering. The Article numbers are not followed by any abbreviation (such as "(WRC-97)", "(WRC-2000)", "(WRC-03)", "(WRC-07)", "(WRC-12)", "(WRC-15)", "(WRC-19)" or "(WRC-23)"). Consequently, any reference to an Article, in any of the provisions of these Radio Regulations (e.g. in No. **13.1** of Article **13**), in the texts of the Appendices as contained in Volume 2 of this edition (e.g. in § 1 of Appendix **2**), in the texts of the Resolutions included in Volume 3 of this edition (e.g. in Resolution **1 (Rev.WRC-97)**), and in the texts of the Recommendations included in Volume 3 of this edition (e.g. in Recommendation **8**), is considered as a reference to the text of the concerned Article which appears in this edition, unless otherwise specified.

With respect to *provision numbers in Articles*, this edition continues to use composite numbers indicating the number of the Article and the provision number within that Article (e.g. No. 9.2B means provision No. 2B of Article **9**). The abbreviation "(WRC-23)", "(WRC-19)", "(WRC-15)", "(WRC-12)", "(WRC-07)", "(WRC-03)", "(WRC-2000)" or "(WRC-97)" at the end of such a provision means that the relevant provision was modified or added by WRC-23, by WRC-19, by WRC-15, by WRC-12, by WRC-07, by WRC-03, by WRC-2000 or by WRC-97, as applicable. The absence of an abbreviation at the end of the provision means that the provision is identical with the provision of the simplified Radio Regulations as approved by WRC-95, and whose complete text was contained in Document 2 of WRC-97.

With respect to *Appendix numbers*, this edition follows the standard sequential numbering, with the addition of the appropriate abbreviation after the Appendix number (such as "(WRC-97)", "(WRC-2000)", "(WRC-03)", "(WRC-07)", "(WRC-12)", "(WRC-15)", "(WRC-19)" or "(WRC-23)"), where applicable. As a rule, any reference to an Appendix, in any of the provisions of these Radio Regulations, in the texts of the Appendices as contained in Volume 2 of this edition, in the texts of the Resolutions and of the Recommendations included in Volume 3 of this edition, is presented in the standard manner (e.g. "Appendix **30 (Rev.WRC-23)**") if not explicitly described in the text (e.g. Appendix **4** as modified by WRC-23). In the texts of Appendices that were partially modified by WRC-23, the provisions that were modified by WRC-23 are indicated with the abbreviation "(WRC-23)" at the end of the concerned text. If an Appendix is referenced without any abbreviation after the Appendix number, in the texts of this edition (e.g. in No. **13.1**), or without other description, such reference is considered as a reference to the text of the concerned Appendix which appears in this edition.

Within the text of the Radio Regulations, the symbol, ↑, has been used to represent quantities associated with an uplink. Similarly, the symbol, ↓, has been used to represent quantities associated with a downlink.

Abbreviations have generally been used for the names of world administrative radio conferences and world radiocommunication conferences. These abbreviations are shown below.

Abbreviation	Conference
WARC Mar	World Administrative Radio Conference to Deal with Matters Relating to the Maritime Mobile Service (Geneva, 1967)
WARC-71	World Administrative Radio Conference for Space Telecommunications (Geneva, 1971)
WMARC-74	World Maritime Administrative Radio Conference (Geneva, 1974)
WARC SAT-77	World Broadcasting-Satellite Administrative Radio Conference (Geneva, 1977)
WARC-Aer2	World Administrative Radio Conference on the Aeronautical Mobile (R) Service (Geneva, 1978)
WARC-79	World Administrative Radio Conference (Geneva, 1979)
WARC Mob-83	World Administrative Radio Conference for the Mobile Services (Geneva, 1983)
WARC HFBC-84	World Administrative Radio Conference for the Planning of the HF Bands Allocated to the Broadcasting Service (Geneva, 1984)
WARC Orb-85	World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilising It (First Session – Geneva, 1985)
WARC HFBC-87	World Administrative Radio Conference for the Planning of the HF Bands Allocated to the Broadcasting Service (Geneva, 1987)
WARC Mob-87	World Administrative Radio Conference for the Mobile Services (Geneva, 1987)
WARC Orb-88	World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilising It (Second Session – Geneva, 1988)
WARC-92	World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (Malaga-Torremolinos, 1992)
WRC-95	World Radiocommunication Conference (Geneva, 1995)
WRC-97	World Radiocommunication Conference (Geneva, 1997)
WRC-2000	World Radiocommunication Conference (Istanbul, 2000)
WRC-03	World Radiocommunication Conference (Geneva, 2003)
WRC-07	World Radiocommunication Conference (Geneva, 2007)
WRC-12	World Radiocommunication Conference (Geneva, 2012)
WRC-15	World Radiocommunication Conference (Geneva, 2015)
WRC-19	World Radiocommunication Conference (Sharm El-Sheikh, 2019)
WRC-23	World Radiocommunication Conference (Dubai, 2023)
WRC-27	World Radiocommunication Conference, 2027[1]

[1] The date of this conference has not been finalized.

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APPENDIX 1 (REV.WRC-19)

Classification of emissions and necessary bandwidths

(See Article **2**)

§ 1 1) Emissions shall be designated according to their necessary bandwidth and their classification as explained in this Appendix.

2) Formulae and examples of emissions designated in accordance with this Appendix are given in Recommendation ITU-R SM.1138-3. Further examples may be provided in other ITU-R Recommendations. These examples may also be published in the Preface to the International Frequency Information Circular (BR IFIC). (WRC-19)

Section I – Necessary bandwidth

§ 2 1) The necessary bandwidth, as defined in No. **1.152** and determined in accordance with the formulae and examples, shall be expressed by three numerals and one letter. The letter occupies the position of the decimal point and represents the unit of bandwidth. The first character shall be neither zero nor K, M or G.

2) Necessary bandwidths[1]:

between 0.001 and 999 Hz shall be expressed in Hz (letter H);

between 1.00 and 999 kHz shall be expressed in kHz (letter K);

between 1.00 and 999 MHz shall be expressed in MHz (letter M);

between 1.00 and 999 GHz shall be expressed in GHz (letter G).

3) For the full designation of an emission, the necessary bandwidth, indicated in four characters, shall be added just before the classification symbols. When used, the necessary bandwidth shall be determined by one of the following methods:

3.1) use of the formulae and examples of necessary bandwidths and designation of corresponding emissions given in Recommendation ITU-R SM.1138-3; (WRC-19)

3.2) computation, in accordance with other ITU-R Recommendations;

3.3) measurement, in cases not covered by § 3.1) or 3.2) above.

---

[1] Examples:

0.002	Hz	=	H002	6	kHz	=	6K00	1.25	MHz	=	1M25
0.1	Hz	=	H100	12.5	kHz	=	12K5	2	MHz	=	2M00
25.3	Hz	=	25H3	180.4	kHz	=	180K	10	MHz	=	10M0
400	Hz	=	400H	180.5	kHz	=	181K	202	MHz	=	202M
2.4	kHz	=	2K40	180.7	kHz	=	181K	5.65	GHz	=	5G65

Section II – Classification

§ 3 The class of emission is a set of characteristics conforming to § 4 below.

§ 4 Emissions shall be classified and symbolized according to their basic characteristics as given in Sub-Section IIA and any optional additional characteristics as provided for in Sub-Section IIB.

§ 5 The basic characteristics (see Sub-Section IIA) are:

1) first symbol – type of modulation of the main carrier;

2) second symbol – nature of signal(s) modulating the main carrier;

3) third symbol – type of information to be transmitted.

Modulation used only for short periods and for incidental purposes (such as, in many cases, for identification or calling) may be ignored provided that the necessary bandwidth as indicated is not thereby increased.

Sub-Section IIA – Basic characteristics

§ 6 1) *First symbol* – Type of modulation of the main carrier

1.1)	Emission of an unmodulated carrier	N
1.2)	Emission in which the main carrier is amplitude-modulated (including cases where sub-carriers are angle-modulated)	
	1.2.1) Double-sideband	A
	1.2.2) Single-sideband, full carrier	H
	1.2.3) Single-sideband, reduced or variable level carrier	R
	1.2.4) Single-sideband, suppressed carrier	J
	1.2.5) Independent sidebands	B
	1.2.6) Vestigial sideband	C
1.3)	Emission in which the main carrier is angle-modulated	
	1.3.1) Frequency modulation	F
	1.3.2) Phase modulation	G
1.4)	Emission in which the main carrier is amplitude-and angle-modulated either simultaneously or in a pre-established sequence	D
1.5)	Emission of pulses[2]	
	1.5.1) Sequence of unmodulated pulses	P
	1.5.2) A sequence of pulses	
	1.5.2.1) modulated in amplitude	K
	1.5.2.2) modulated in width/duration	L

[2] Emissions where the main carrier is directly modulated by a signal which has been coded into quantized form (e.g. pulse code modulation) should be designated under § 1.2) or 1.3).

1.5.2.3)	modulated in position/phase	M
1.5.2.4)	in which the carrier is angle-modulated during the angle-period of the pulse	Q
1.5.2.5)	which is a combination of the foregoing or is produced by other means	V
1.6)	Cases not covered above, in which an emission consists of the main carrier modulated, either simultaneously or in a pre-established sequence, in a combination of two or more of the following modes: amplitude, angle, pulse	W
1.7)	Cases not otherwise covered	X
	2) *Second symbol* – Nature of signal(s) modulating the main carrier	
2.1)	No modulating signal	0
2.2)	A single channel containing quantized or digital information without the use of a modulating sub-carrier[3]	1
2.3)	A single channel containing quantized or digital information with the use of a modulating sub-carrier[3]	2
2.4)	A single channel containing analogue information	3
2.5)	Two or more channels containing quantized or digital information	7
2.6)	Two or more channels containing analogue information	8
2.7)	Composite system with one or more channels containing quantized or digital information, together with one or more channels containing analogue information	9
2.8)	Cases not otherwise covered	X
	3) *Third symbol* – Type of information to be transmitted[4]	
3.1)	No information transmitted	N
3.2)	Telegraphy – for aural reception	A
3.3)	Telegraphy – for automatic reception	B
3.4)	Facsimile	C
3.5)	Data transmission, telemetry, telecommand	D
3.6)	Telephony (including sound broadcasting)	E
3.7)	Television (video)	F
3.8)	Combination of the above	W
3.9)	Cases not otherwise covered	X

[3] This excludes time-division multiplex.

[4] In this context the word "information" does not include information of a constant, unvarying nature such as is provided by standard frequency emissions, continuous wave and pulse radars, etc.

Sub-Section IIB – Optional characteristics for the classification of emissions

§ 7 Two optional characteristics should be added for a more complete description of an emission. These are:

Fourth symbol – Details of signal(s)

Fifth symbol – Nature of multiplexing

Where the fourth or fifth symbol is used it shall be as indicated below.

Where the fourth or the fifth symbol is not used this should be indicated by a dash where each symbol would otherwise appear.

1) *Fourth symbol* – Details of signal(s)

1.1)	Two-condition code with elements of differing numbers and/or durations	A
1.2)	Two-condition code with elements of the same number and duration without error-correction	B
1.3)	Two-condition code with elements of the same number and duration with error-correction	C
1.4)	Four-condition code in which each condition represents a signal element (or one or more bits)	D
1.5)	Multi-condition code in which each condition represents a signal element (of one or more bits)	E
1.6)	Multi-condition code in which each condition or combination of conditions represents a character	F
1.7)	Sound of broadcasting quality (monophonic)	G
1.8)	Sound of broadcasting quality (stereophonic or quadraphonic)	H
1.9)	Sound of commercial quality (excluding categories given in § 1.10) and 1.11))	J
1.10)	Sound of commercial quality with the use of frequency inversion or band-splitting	K
1.11)	Sound of commercial quality with separate frequency-modulated signals to control the level of demodulated signal	L
1.12)	Monochrome	M
1.13)	Colour	N
1.14)	Combination of the above	W
1.15)	Cases not otherwise covered	X

2) *Fifth symbol* – Nature of multiplexing

2.1)	None	N
2.2)	Code-division multiplex[5]	C
2.3)	Frequency-division multiplex	F
2.4)	Time-division multiplex	T
2.5)	Combination of frequency-division multiplex and time-division multiplex	W
2.6)	Other types of multiplexing	X

[5] This includes bandwidth expansion techniques.

APPENDIX 2 (REV.WRC-03)

Table of transmitter frequency tolerances

(See Article **3**)

1 Frequency tolerance is defined in Article **1** and is expressed in parts in 10^6, unless otherwise indicated.

2 The power shown for the various categories of stations is the peak envelope power for single-sideband transmitters and the mean power for all other transmitters, unless otherwise indicated. The term "power of a radio transmitter" is defined in Article **1**.

3 For technical and operational reasons, certain categories of stations may need more stringent tolerances than those shown in the table.

Frequency bands (lower limit exclusive, upper limit inclusive) and categories of stations	**Tolerances applicable to transmitters**
Band: **9 kHz to 535 kHz**	
1 *Fixed stations*:	
– 9 kHz to 50 kHz	100
– 50 kHz to 535 kHz	50
2 *Land stations*:	
a) Coast stations	100 [1, 2]
b) Aeronautical stations	100
3 *Mobile stations*:	
a) Ship stations	200 [3, 4]
b) Ship's emergency transmitters	500 [5]
c) Survival craft stations	500
d) Aircraft stations	100
4 *Radiodetermination stations*	100
5 *Broadcasting stations*	10 Hz
Band: **535 kHz to 1 606.5 kHz (1 605 kHz in Region 2)**	
Broadcasting stations	10 Hz (WRC-03)
Band: **1 606.5 kHz (1 605 kHz in Region 2) to 4 000 kHz**	
1 *Fixed stations*:	
– power 200 W or less	100 [7, 8]
– power above 200 W	50 [7, 8]
2 *Land stations*:	
– power 200 W or less	100 [1, 2, 7, 9, 10]
– power above 200 W	50 [1, 2, 7, 9, 10]

Frequency bands (lower limit exclusive, upper limit inclusive) and categories of stations	Tolerances applicable to transmitters
Band: **1 606.5 kHz (1 605 kHz in Region 2) to 4 000 kHz** (*cont.*)	
3 *Mobile stations*:	
a) Ship stations	40 Hz [3, 4, 12]
b) Survival craft stations	100
c) Emergency position-indicating radiobeacons	100
d) Aircraft stations	100 [10]
e) Land mobile stations	50 [13]
4 *Radiodetermination stations*:	
– power 200 W or less	20 [14]
– power above 200 W	10 [14]
5 *Broadcasting stations*	10 Hz [15]
Band: **4 MHz to 29.7 MHz**	
1 *Fixed stations*:	
a) Single-sideband and independent-sideband emissions:	
– power 500 W or less	50 Hz
– power above 500 W	20 Hz
b) Class F1B emissions	10 Hz
c) Other classes of emission:	
– power 500 W or less	20
– power above 500 W	10
2 *Land stations*:	
a) Coast stations	20 Hz [1, 2, 16]
b) Aeronautical stations:	
– power 500 W or less	100 [10]
– power above 500 W	50 [10]
c) Base stations	20 [7]
3 *Mobile stations*:	
a) Ship stations:	
1) Class A1A emissions	10
2) Emissions other than Class A1A	50 Hz [3, 4, 19]
b) Survival craft stations	50
c) Aircraft stations	100 [10]
d) Land mobile stations	40 [20]
4 *Broadcasting stations*	10 Hz [15, 21]
5 *Space stations*	20
6 *Earth stations*	20

Frequency bands (lower limit exclusive, upper limit inclusive) and categories of stations	Tolerances applicable to transmitters
Band: **29.7 MHz to 100 MHz**	
1 *Fixed stations*:	
– power 50 W or less	30
– power above 50 W	20
2 *Land stations*	20
3 *Mobile stations*	20 [22]
4 *Radiodetermination stations*	50
5 *Broadcasting stations (other than television)*	2 000 Hz [23]
6 *Broadcasting stations (television sound and vision)*	500 Hz [24, 25]
7 *Space stations*	20
8 *Earth stations*	20
Band: **100 MHz to 470 MHz**	
1 *Fixed stations*:	
– power 50 W or less	20 [26]
– power above 50 W	10
2 *Land stations*:	
a) Coast stations	10
b) Aeronautical stations	20 [28]
c) Base stations:	
– in the band 100-235 MHz	15 [29]
– in the band 235-401 MHz	7 [29]
– in the band 401-470 MHz	5 [29]
3 *Mobile stations*:	
a) Ship stations and survival craft stations:	
– in the band 156-174 MHz	10
– outside the band 156-174 MHz	50 [31]
b) Aircraft stations	30 [28]
c) Land mobile stations:	
– in the band 100-235 MHz	15 [29]
– in the band 235-401 MHz	7 [29, 32]
– in the band 401-470 MHz	5 [29, 32]
4 *Radiodetermination stations*	50 [33]
5 *Broadcasting stations (other than television)*	2 000 Hz [23]
6 *Broadcasting stations (television sound and vision)*	500 Hz [24, 25]
7 *Space stations*	20
8 *Earth stations*	20

Frequency bands (lower limit exclusive, upper limit inclusive) and categories of stations	Tolerances applicable to transmitters
Band: **470 MHz to 2 450 MHz**	
1 *Fixed stations*:	
– power 100 W or less	100
– power above 100 W	50
2 *Land stations*	20 [36]
3 *Mobile stations*	20 [36]
4 *Radiodetermination stations*	500 [33]
5 *Broadcasting stations (other than television)*	100
6 *Broadcasting stations (television sound and vision)* in the band 470 MHz to 960 MHz	500 Hz [24, 25]
7 *Space stations*	20
8 *Earth stations*	20
Band: **2 450 MHz to 10 500 MHz**	
1 *Fixed stations*:	
– power 100 W or less	200
– power above 100 W	50
2 *Land stations*	100
3 *Mobile stations*	100
4 *Radiodetermination stations*	1 250 [33]
5 *Space stations*	50
6 *Earth stations*	50
Band: **10.5 GHz to 40 GHz**	
1 *Fixed station*	300
2 *Radiodetermination stations*	5 000 [33]
3 *Broadcasting stations*	100
4 *Space stations*	100
5 *Earth stations*	100

Notes in the table of transmitter frequency tolerances

1 For coast station transmitters used for direct-printing telegraphy or for data transmission, the tolerance is:

– 5 Hz for narrow-band phase-shift keying;

– 15 Hz for frequency-shift keying for transmitters in use or installed before 2 January 1992;

– 10 Hz for frequency-shift keying for transmitters installed after 1 January 1992.

2 For coast station transmitters used for digital selective calling, the tolerance is 10 Hz. (WRC-03)

3 For ship station transmitters used for direct-printing telegraphy or for data transmission, the tolerance is:

– 5 Hz for narrow-band phase-shift keying;

– 40 Hz for frequency-shift keying for transmitters in use or installed before 2 January 1992;

– 10 Hz for frequency-shift keying for transmitters installed after 1 January 1992.

4 For ship station transmitters used for digital selective calling, the tolerance is 10 Hz. (WRC-03)

5 If the emergency transmitter is used as the reserve transmitter for the main transmitter, the tolerance for ship station transmitters applies.

6 (SUP - WRC-03)

7 For single-sideband radiotelephone transmitters except at coast stations, the tolerance is:

– 50 Hz in the bands 1 606.5 (1 605 Region 2)-4 000 kHz and 4-29.7 MHz, for peak envelope powers of 200 W or less and 500 W or less, respectively;

– 20 Hz in the bands 1 606.5 (1 605 Region 2)-4 000 kHz and 4-29.7 MHz, for peak envelope powers above 200 W and 500 W, respectively.

8 For radiotelegraphy transmitters with frequency-shift keying the tolerance is 10 Hz.

9 For coast station single-sideband radiotelephone transmitters the tolerance is 20 Hz.

10 For single-sideband transmitters operating in the frequency bands 1 606.5 (1 605 Region 2)-4 000 kHz and 4-29.7 MHz which are allocated exclusively to the aeronautical mobile (R) service, the tolerance on the carrier (reference) frequency is:

a) for all aeronautical stations, 10 Hz;

b) for all aircraft stations operating on international services, 20 Hz;

c) for aircraft stations operating exclusively on national services, 50 Hz*.

11 Not used.

12 For A1A emissions the tolerance is 50×10^{-6}.

13 For transmitters used for single-sideband radiotelephony or for frequency-shift keying radiotelegraphy the tolerance is 40 Hz.

14 For radiobeacon transmitters in the band 1 606.5 (1 605 Region 2)-1 800 kHz the tolerance is 50×10^{-6}.

---

* NOTE – In order to achieve maximum intelligibility, it is suggested that administrations encourage the reduction of this tolerance to 20 Hz.

15 For A3E emissions with carrier power of 10 kW or less the tolerance is 20×10^{-6}, 15×10^{-6} and 10×10^{-6} in the bands 1 606.5 (1 605 Region 2)-4 000 kHz, 4-5.95 MHz and 5.95-29.7 MHz respectively.

16 For A1A emissions the tolerance is 10×10^{-6}.

17 Not used.

18 Not used.

19 For ship station transmitters in the band 26 175-27 500 kHz, on board small craft, with a carrier power not exceeding 5 W in or near coastal waters and utilizing F3E and G3E emissions, the frequency tolerance is 40×10^{-6}. (WRC-03)

20 The tolerance is 50 Hz for single-sideband radiotelephone transmitters, except for those transmitters operating in the band 26 175-27 500 kHz, and not exceeding a peak envelope power of 15 W, for which the basic tolerance of 40×10^{-6} applies.

21 It is suggested that administrations avoid carrier frequency differences of a few hertz, which cause degradations similar to periodic fading. This could be avoided if the frequency tolerance were 0.1 Hz, a tolerance which would be suitable for single-sideband emissions*.

22 For non-vehicular mounted portable equipment with a transmitter mean power not exceeding 5 W, the tolerance is 40×10^{-6}.

23 For transmitters of a mean power of 50 W or less operating at frequencies below 108 MHz a tolerance of 3 000 Hz applies.

24 In the case of television stations of:

– 50 W (vision peak envelope power) or less in the band 29.7-100 MHz;

– 100 W (vision peak envelope power) or less in the band 100-960 MHz;

and which receive their input from other television stations or which serve small isolated communities, it may not, for operational reasons, be possible to maintain this tolerance. For such stations, the tolerance is 2 000 Hz.

For stations of 1 W (vision peak envelope power) or less, this tolerance may be relaxed further to:

– 5 kHz in the band 100-470 MHz;

– 10 kHz in the band 470-960 MHz.

25 For transmitters for system M (NTSC) the tolerance is 1 000 Hz. However, for low power transmitters using this system Note 24 applies.

26 For multi-hop radio-relay systems employing direct frequency conversion the tolerance is 30×10^{-6}.

27 Not used.

28 For a channel spacing of 50 kHz the tolerance is 50×10^{-6}.

29 These tolerances apply to channel spacings equal to or greater than 20 kHz.

---

* NOTE – The single-sideband system adopted for the bands exclusively allocated to HF broadcasting does not require a frequency tolerance less than 10 Hz. The above-mentioned degradation occurs when the ratio of wanted-to-interfering signal is well below the required protection ratio. This remark is equally valid for both double- and single-sideband emissions.

[30] Not used.

[31] For transmitters used by on-board communication stations a tolerance of 5×10^{-6} shall apply.

[32] For non-vehicular mounted portable equipment with a transmitter mean power not exceeding 5 W the tolerance is 15×10^{-6}.

[33] Where specific frequencies are not assigned to radar stations, the bandwidth occupied by the emissions of such stations shall be maintained wholly within the band allocated to the service and the indicated tolerance does not apply.

[34] Not used.

[35] Not used.

[36] In applying this tolerance administrations should be guided by the latest relevant ITU-R Recommendations.

APPENDIX 3 (REV.WRC-12)

Maximum permitted power levels for unwanted emissions in the spurious domain (WRC-12)

(See Article **3**)

1 This Appendix derived indicates the maximum permitted power levels of unwanted emissions in the spurious domain using the values indicated in Table I. The provisions of No. **4.5** apply to unwanted emissions not covered in this Appendix. (WRC-12)

2 Spurious domain emissions[1] from any part of the installation, other than the antenna and its transmission line, shall not have an effect greater than would occur if this antenna system were supplied with the maximum permitted power at the frequency of that emission. (WRC-12)

3 These levels shall not, however, apply to emergency position-indicating radiobeacon (EPIRB) stations, emergency locator transmitters, ships' emergency transmitters, lifeboat transmitters, survival craft stations or maritime transmitters when used in emergency situations.

4 For technical or operational reasons, more stringent levels than those specified may be applied to protect specific services in certain frequency bands. The levels applied to protect these services, such as safety and passive services, shall be those agreed upon by the appropriate world radiocommunication conference. More stringent levels may also be fixed by specific agreement between the administrations concerned. Additionally, special consideration of transmitter spurious domain emissions may be required for the protection of safety services, radio astronomy and space services using passive sensors. Information on the levels of interference detrimental to radio astronomy, Earth exploration satellites and meteorological passive sensing is given in the most recent version of Recommendation ITU-R SM.329. (WRC-12)

5 Spurious domain emission limits for combined radiocommunication and information technology equipment are those for the radiocommunication transmitters. (WRC-12)

6 The frequency range of the measurement of spurious domain emissions is from 9 kHz to 110 GHz or the second harmonic if higher. (WRC-03)

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[1] Spurious domain emissions are unwanted emissions at frequencies within the spurious domain.

7 Except as provided in § 8 and 9 of this Appendix, the spurious domain emission levels are specified in the following reference bandwidths:

– 1 kHz between 9 kHz and 150 kHz

– 10 kHz between 150 kHz and 30 MHz

– 100 kHz between 30 MHz and 1 GHz

– 1 MHz above 1 GHz. (WRC-03)

8 The reference bandwidth of all space service spurious domain emissions should be 4 kHz. (WRC-03)

9 For radar systems, the reference bandwidths for specifying spurious domain emission levels should be calculated for each particular system. Thus, for the four general types of radar pulse modulation utilized for radionavigation, radiolocation, acquisition, tracking and other radiodetermination functions, the reference bandwidth values are determined using the following:

– for a fixed-frequency, non-pulse-coded radar, the reciprocal of the radar pulse length, in seconds (e.g. if the radar pulse length is 1 μs, then the reference bandwidth is 1/(1 μs) = 1 MHz);

– for a fixed-frequency, phase-coded pulsed radar, the reciprocal of the phase chip length, in seconds (e.g. if the phase-coded chip is 2 μs long, then the reference bandwidth is 1/(2 μs) = 500 kHz);

– for a frequency modulated (FM) or chirped radar, the square root of the quantity obtained by dividing the chirp bandwidth in MHz by the pulse length, in μs (e.g. if the FM is from 1 250 MHz to 1 280 MHz, i.e. 30 MHz, during the pulse length of 10 μs, then the reference bandwidth is $(30\ \text{MHz}/10\ \mu\text{s})^{1/2} = 1.73$ MHz);

– for radars operating with multiple waveforms, the reference bandwidth for specifying spurious domain emission levels is determined empirically from observations of the radar emission and is obtained following the guidance given in the most recent version of Recommendation ITU-R M.1177.

In the case of radars, for which the bandwidth, as determined using the method above, is greater than 1 MHz, a reference bandwidth of 1 MHz should be used. (WRC-03)

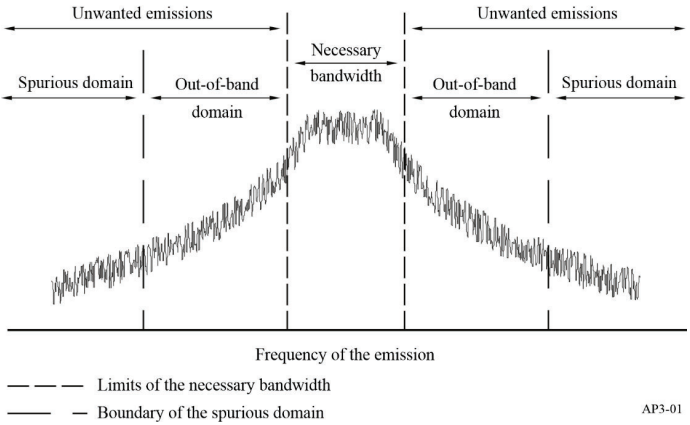
10 Guidance regarding the methods of measuring spurious domain emissions is given in the most recent version of Recommendation ITU-R SM.329. The e.i.r.p. method specified in this Recommendation should be used when it is not possible to accurately measure the power supplied to the antenna transmission line, or for specific applications where the antenna is designed to provide significant attenuation in the spurious domain. Additionally, the e.i.r.p. method may need some modification for special cases. Specific guidance regarding the methods of measuring spurious domain emissions from radar systems is given in the most recent version of Recommendation ITU-R M.1177.

To improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth in which spurious domain emissions are measured can be different from the reference bandwidth used for specifying spurious domain emission levels. (WRC-03)

11 The emission limits of this Appendix apply to all emissions, including harmonic emissions, intermodulation products, frequency conversion products and parasitic emissions, at frequencies in the spurious domain (see Fig. 1). The upper and lower parts of the spurious domain extend outward from a boundary determined using Annex 1. (WRC-03)

FIGURE 1 (WRC-03)

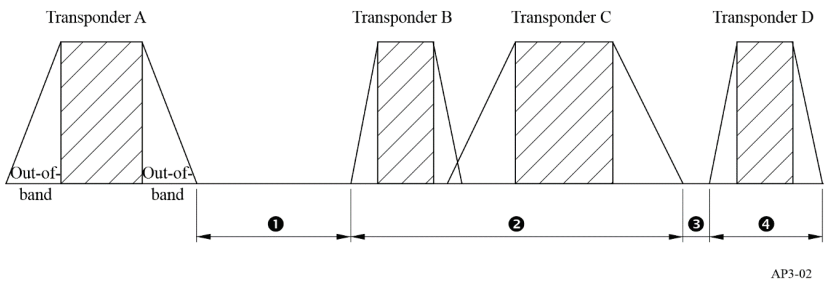
Out-of-band and spurious domains



12 For the case of a single satellite operating with more than one transponder in the same service area, and when considering the limits for spurious domain emissions as indicated in § 11 of this Appendix, spurious domain emissions from one transponder may fall on a frequency at which a second, companion transponder is transmitting. In these situations, the level of spurious domain emissions from the first transponder is well exceeded by the fundamental or out-of-band domain emissions of the second transponder. Therefore, the limits of this Appendix should not apply to those emissions of a satellite that fall within either the necessary bandwidth or the out-of-band domain of another transponder on the same satellite, in the same service area (see Fig. 2). (WRC-03)

FIGURE 2

Example of the applicability of spurious domain emission limits to a satellite transponder



Transponders A, B, C and D are operating on the same satellite in the same service area. Transponder A is not required to meet spurious domain emission limits in frequency ranges ❷ and ❹, but is required to meet them in frequency ranges ❶ and ❸. (WRC-03)

13 Examples of applying 43 + 10 log (*P*) to calculate attenuation requirements

Where specified in relation to mean power, spurious domain emissions are to be at least *x* dB below the total mean power *P*, i.e. −*x* dBc. The power *P* (W) is to be measured in a bandwidth wide enough to include the total mean power. The spurious domain emissions are to be measured in the reference bandwidths given in the relevant ITU-R Recommendations. The measurement of the spurious domain emission power is independent of the value of necessary bandwidth. Because the absolute emission power limit, derived from 43 + 10 log (*P*), can become too stringent for high-power transmitters, alternative relative powers are also provided in Table I.

Example 1

A land mobile transmitter, with any value of necessary bandwidth, must meet a spurious domain emission attenuation of 43 + 10 log (*P*), or 70 dBc, whichever is less stringent. The reference bandwidths used for specifying spurious domain emission levels are provided in § 8 to 10 of this Appendix. Applying this in the frequency range between 30 MHz and 1 GHz gives a reference bandwidth of 100 kHz.

With a measured total mean power of 10 W:

– Attenuation relative to total mean power = 43 + 10 log (10) = 53 dBc.

– The 53 dBc value is less stringent than the 70 dBc, so the 53 dBc value is used.

– Therefore: Spurious domain emissions must not exceed 53 dBc in a 100 kHz bandwidth, or converting to an absolute level, they must not exceed 10 dBW − 53 dBc = −43 dBW in a 100 kHz reference bandwidth.

With a measured total mean power of 1 000 W:

– Attenuation relative to total mean power = 43 + 10 log (1 000) = 73 dBc.

– The 73 dBc value is more stringent than the 70 dBc limit, so the 70 dBc value is used.

– Therefore: Spurious domain emissions must not exceed 70 dBc in a 100 kHz bandwidth, or converting to an absolute level, they must not exceed 30 dBW − 70 dBc = −40 dBW in a 100 kHz reference bandwidth. (WRC-03)

Example 2

A space service transmitter with any value of necessary bandwidth must meet a spurious domain emission attenuation of 43 + 10 log (*P*), or 60 dBc, whichever is less stringent. To measure spurious domain emissions at any frequency, Note 10 to Table I indicates using a reference bandwidth of 4 kHz.

With a measured total mean power of 20 W:

– Attenuation relative to total mean power = 43 + 10 log (20) = 56 dBc.

– The 56 dBc value is less stringent than the 60 dBc limit, so the 56 dBc value is used.

– Therefore: Spurious domain emissions must not exceed 56 dBc in a 4 kHz reference bandwidth, or converting to an absolute level, they must not exceed 13 dBW − 56 dBc = −43 dBW in a 4 kHz reference bandwidth. (WRC-03)

TABLE I (WRC-12)

Attenuation values used to calculate maximum permitted spurious domain emission power levels for use with radio equipment

Service category in accordance with Article 1, or equipment type[15]	**Attenuation (dB) below the power supplied to the antenna transmission line**
All services except those services quoted below:	43 + 10 log (*P*), or 70 dBc, whichever is less stringent
Space services (earth stations)[10, 16]	43 + 10 log (*P*), or 60 dBc, whichever is less stringent
Space services (space stations)[10, 17]	43 + 10 log (*P*), or 60 dBc, whichever is less stringent
Radiodetermination[14]	43 + 10 log (*PEP*), or 60 dB, whichever is less stringent
Broadcast television[11]	46 + 10 log (*P*), or 60 dBc, whichever is less stringent, without exceeding the absolute mean power level of 1 mW for VHF stations or 12 mW for UHF stations. However, greater attenuation may be necessary on a case by case basis
Broadcast FM	46 + 10 log (*P*), or 70 dBc, whichever is less stringent; the absolute mean power level of 1 mW should not be exceeded
Broadcasting at MF/HF	50 dBc; the absolute mean power level of 50 mW should not be exceeded
SSB from mobile stations[12]	43 dB below *PEP*
Amateur services operating below 30 MHz (including those using SSB)[16]	43 + 10 log (*PEP*), or 50 dB, whichever is less stringent

TABLE I *(end)* (WRC-12)

Service category in accordance with Article 1, or equipment type[15]	**Attenuation (dB) below the power supplied to the antenna transmission line**
Services operating below 30 MHz, except space, radiodetermination, broadcast, those using SSB from mobile stations, and amateur[12]	43 + 10 log (X), or 60 dBc, whichever is less stringent, where $X = PEP$ for SSB modulation, and $X = P$ for other modulation
Low-power device radio equipment[13]	56 + 10 log (P), or 40 dBc, whichever is less stringent
Emergency transmitters[18]	No limit

P: mean power in watts supplied to the antenna transmission line, in accordance with No. **1.158**. When burst transmission is used, the mean power *P* and the mean power of any spurious domain emissions are measured using power averaging over the burst duration.

PEP: peak envelope power in watts supplied to the antenna transmission line, in accordance with No. **1.157**.

dBc: decibels relative to the unmodulated carrier power of the emission. In the cases which do not have a carrier, for example in some digital modulation schemes where the carrier is not accessible for measurement, the reference level equivalent to dBc is decibels relative to the mean power *P*.

10 Spurious domain emission limits for all space services are stated in a 4 kHz reference bandwidth.

11 For analogue television transmissions, the mean power level is defined with a specified video signal modulation. This video signal has to be chosen in such a way that the maximum mean power level (e.g. at the video signal blanking level for negatively modulated television systems) is supplied to the antenna transmission line.

12 All classes of emission using SSB are included in the category “SSB”.

13 Low-power radio devices having a maximum output power of less than 100 mW and intended for short-range communication or control purposes; such equipment is in general exempt from individual licensing.

14 For radiodetermination systems (radar as defined by No. **1.100**), spurious domain emission attenuation (dB) shall be determined for radiated emission levels, and not at the antenna transmission line. The measurement methods for determining the radiated spurious domain emission levels from radar systems should be guided by the most recent version of Recommendation ITU-R M.1177. (WRC-03)

15 In some cases of digital modulation (including digital broadcasting), broadband systems, pulsed modulation and narrow-band high-power transmitters for all categories of services, there may be difficulties in meeting limits close to ±250% of the necessary bandwidth.

16 Earth stations in the amateur-satellite service operating below 30 MHz are in the service category “Amateur services operating below 30 MHz (including those using SSB)”. (WRC-2000)

17 Space stations in the space research service intended for operation in deep space as defined by No. **1.177** are exempt from spurious domain emission limits. (WRC-03)

18 Emergency position-indicating radio beacon, emergency locator transmitters, personal location beacons, search and rescue transponders, ship emergency, lifeboat and survival craft transmitters and emergency land, aeronautical or maritime transmitters. (WRC-2000)

ANNEX 1 (WRC-03)

Determination of the boundary between the out-of-band and spurious domains

1 Except as provided below, the boundary between the out-of-band and spurious domains occurs at frequencies that are separated from the centre frequency of the emission by the values shown in Table 1. In general, the boundary, on either side of the centre frequency, occurs at a separation of 250% of the necessary bandwidth, or at 2.5 B_N, as shown in Table 1. For most systems, the centre frequency of the emission is the centre of the necessary bandwidth. For multichannel or multicarrier transmitters/transponders, where several carriers may be transmitted simultaneously from a final output amplifier or an active antenna, the centre frequency of the emission is taken to be the centre of the −3 dB bandwidth of the transmitter or transponder, and the transmitter or transponder bandwidth is used in place of the necessary bandwidth for determining the boundary. For multicarrier satellite systems, guidance on the boundary between the out-of-band and spurious domains is provided in the most recent version of Recommendation ITU-R SM.1541. Some systems specify unwanted emissions relative to channel bandwidth, or channel spacing. These may be used as a substitute for the necessary bandwidth in Table 1, provided they are found in ITU-R Recommendations.

TABLE 1

Values for frequency separation between the centre frequency and the boundary of the spurious domain

Frequency range	Narrow-band case		Normal separation	Wideband case	
	for B_N <	Separation		for B_N>	Separation
9 kHz < f_c ≤ 150 kHz	250 Hz	625 Hz	2.5 B_N	10 kHz	1.5 B_N + 10 kHz
150 kHz < f_c ≤ 30 MHz	4 kHz	10 kHz	2.5 B_N	100 kHz	1.5 B_N + 100 kHz
30 MHz < f_c ≤ 1 GHz	25 kHz	62.5 kHz	2.5 B_N	10 MHz	1.5 B_N + 10 MHz
1 GHz < f_c ≤ 3 GHz	100 kHz	250 kHz	2.5 B_N	50 MHz	1.5 B_N + 50 MHz
3 GHz < f_c ≤ 10 GHz	100 kHz	250 kHz	2.5 B_N	100 MHz	1.5 B_N + 100 MHz
10 GHz < f_c ≤ 15 GHz	300 kHz	750 kHz	2.5 B_N	250 MHz	1.5 B_N + 250 MHz
15 GHz < f_c ≤ 26 GHz	500 kHz	1.25 MHz	2.5 B_N	500 MHz	1.5 B_N + 500 MHz
f_c > 26 GHz	1 MHz	2.5 MHz	2.5 B_N	500 MHz	1.5 B_N + 500 MHz

NOTE – In Table 1, f_c is the centre frequency of the emission and B_N is the necessary bandwidth. If the assigned frequency band of the emissions extends across two frequency ranges, then the values corresponding to the higher frequency range shall be used for determining the boundary.

Example 1: The necessary bandwidth of an emission at 26 MHz is 1.8 kHz. Since B_N is less than 4 kHz, the minimum separation of 10 kHz applies. The spurious domain begins 10 kHz each side of the centre of the necessary bandwidth.

Example 2: The necessary bandwidth of an emission at 8 GHz is 200 MHz. Since the wideband case applies for B_N > 100 MHz at that frequency, the spurious domain begins 1.5 × 200 MHz + 100 MHz = 400 MHz each side of the centre of the necessary bandwidth. Using the general separation formula, the out-of-band domain would have extended to 2.5 × 200 MHz = 500 MHz either side of the centre frequency.

2 Tables 2 and 3 show exceptions to Table 1 for narrow-band and wideband cases, respectively, applicable to particular systems or services and frequency bands.

TABLE 2

Narrow-band variations for particular systems or services and frequency bands

System or service	Frequency range		Narrow-band case	
			for B_N < (kHz)	Separation (kHz)
Fixed service	14 kHz-1.5 MHz		20	50[(1)]
	1.5-30 MHz	$P_T \leq 50$ W	30	75[(2)]
		$P_T > 50$ W	80	200[(2)]

(1) The separation value is based on an assumption that the maximum value of the necessary bandwidth is about 3 kHz for the frequency range 14 kHz-1.5 MHz. The separation value of 50 kHz is extremely large as compared with the necessary bandwidth. This is because unwanted emissions of high power transmitters under modulated conditions have to be below the spurious limit (70 dBc) at the boundary between the out-of-band and spurious domains.

(2) P_T is the transmitter power. The separation values are based on an assumption that the maximum value of the necessary bandwidth is about 12 kHz for the frequency range 1.5-30 MHz. The separation value of 200 kHz for $P_T > 50$ W is extremely large as compared with the necessary bandwidth. This is because unwanted emissions of high power transmitters under modulated conditions have to be below the spurious limit, 70 dBc, at the boundary between the out-of-band and spurious domains. Also, if future systems in the fixed service operating in this frequency range require a necessary bandwidth larger than 12 kHz, it may become necessary to review the 200 kHz separation.

TABLE 3

Wideband variations for particular systems or services and frequency bands

System or service	Frequency range	Wideband case	
		For B_N >	Separation
Fixed service	14-150 kHz	20 kHz	1.5 B_N + 20 kHz
Fixed-satellite service (FSS)	3.4-4.2 GHz	250 MHz	1.5 B_N + 250 MHz
FSS	5.725-6.725 GHz	500 MHz	1.5 B_N + 500 MHz
FSS	7.25-7.75 GHz and 7.9-8.4 GHz	250 MHz	1.5 B_N + 250 MHz
FSS	10.7-12.75 GHz	500 MHz	1.5 B_N + 500 MHz
Broadcasting-satellite service	11.7-12.75 GHz	500 MHz	1.5 B_N + 500 MHz
FSS	12.75-13.25 GHz	500 MHz	1.5 B_N + 500 MHz
FSS	13.75-14.8 GHz	500 MHz	1.5 B_N + 500 MHz

3 For primary radar, the boundary between the out-of-band and spurious domains is the frequency at which the out-of-band domain limits specified in the applicable ITU-R Recommendations are equal to the spurious domain limit defined in Table I of this Appendix. Further guidance on the boundary between the out-of-band and spurious domains for primary radar is provided in the most recent version of Recommendation ITU-R SM.1541.

APPENDIX 4 (REV.WRC-23)

Consolidated list and tables of characteristics for use in the application of the procedures of Chapter III

1 The substance of this Appendix is separated into two parts: one concerning data and their use for terrestrial radiocommunication services and another concerning data and their use for space radiocommunication services or the radio astronomy service. (WRC-12)

2 Both parts contain a list of characteristics and a table indicating the use of each of the characteristics in specific circumstances.

Annex 1: Characteristics of stations in the terrestrial services

Annex 2: Characteristics of satellite networks, earth stations or radio astronomy stations.

ANNEX 1

Characteristics of stations in the terrestrial services[1]

In application of Appendix **4** there are many cases when the data requirements involve the use of standard symbols in submissions to the Radiocommunication Bureau. These standard symbols may be found in the Preface to the BR International Frequency Information Circular (BR IFIC) (Terrestrial Services). In the Tables, this is referred to simply as "the Preface". Also additional information may be found in the guidelines published on the Bureau's website.

Key to the symbols used in Annex 1

X	Mandatory information
+	Mandatory under the conditions specified in Column 3 of Table 1 and Column 2 of Table 2
O	Optional information
C	Mandatory if used as a basis to effect coordination with another administration
	The data item is not applicable to the corresponding notice

[1] The Radiocommunication Bureau shall develop and keep up-to-date forms of notice to meet fully the statutory provisions of this Appendix and related decisions of future conferences. Additional information on the items listed in this Annex together with an explanation of the symbols is to be found in the Preface to the BR IFIC (Terrestrial Services).

Reading Appendix 4 Tables 1 and 2

The rules used to link the sign with the text are based on the Table column headings covering specific procedures, services and frequency bands.

1 If any data item has the indication "+", it shows that the data item is subject to a mandatory requirement under specific conditions. If these conditions are not met, the corresponding item is not applicable unless otherwise specified. These conditions are listed after the data item name and are normally presented as shown below.

2 "Required" without any reference to a column heading is used in the case that the associated condition is valid for every applicable column.

1.5.2	1B	the reference frequency, as defined in Article **1** Required if the modulation envelope is asymmetric	+	+	1B

"In the case of", followed by a reference to the column heading is used, as shown below, when the associated conditions are different for individual columns, or if the indication is not the same across all applicable columns.

7.1	7A	the class of emission In the case of a VHF/UHF broadcasting station, required for assignments subject to § 5.1.3 of the GE06 Regional Agreement	+	**X**	7A

3 A subheading title limits the range of procedures, services or frequency bands to which the data items grouped under that subheading are applicable. Unless further specific conditions apply, the data items grouped under that subheading have an "X" as the conditional nature is shown in the subheading title. (WRC-12)

1.4.3		**For assignments in the bands and services governed by the Geneva 06 Regional Agreement only**				
1.4.3.4	DAC	the digital broadcasting assignment code	**X**			DAC

Footnotes to Tables 1 and 2

[1] The most recent version of Recommendation ITU-R SF.675 should be used to the extent applicable in calculating the maximum power density per Hz.

TABLE 1 (Rev.WRC-23)

Characteristics for terrestrial services

Column No.	Item identifier	Notice related to / Description of data items and requirements
1		**GENERAL INFORMATION AND FREQUENCY CHARACTERISTICS**
1.1	**B**	the symbol of the notifying administration (see the Preface)
1.2	**D**	the provision code of the Radio Regulations under which the notice has been submitted
1.3	**E**	the resubmission indicator In the case of a VHF/UHF broadcasting station, or a typical transmitting station, required for an assignment subject to the GE06 Regional Agreement if the notice is resubmitted in the application of Article **11** In the case of a transmitting station, or a receiving land station, required for an assignment subject to the GE06 Regional Agreement or Nos. **9.16**, **9.18** or **9.19** if the notice is resubmitted in the application of Article **11**
1.4		**Assignment and allotment identification information**
1.4.1	**SYNC**	the identification symbols for the synchronized, or single-frequency, network In the case of a VHF/UHF broadcasting station, required for a digital broadcasting assignment in a synchronized or single frequency network subject to the GE06 Regional Agreement In the case of an LF/MF broadcasting station, required for an assignment in a synchronized or single frequency network
1.4.2	**ID1**	the unique identification code given by the administration to the assignment or allotment Required for assignments subject to the GE06 Regional Agreement, and optional for assignments not subject to this Agreement
1.4.3		**For assignments in the bands and services governed by the GE06 Regional Agreement only:**
1.4.3.1	**ID2**	the unique identification code given by the administration for the associated allotment Required for a digital broadcasting assignment linked to an allotment, or converted from an allotment, within the GE06 Plan
1.4.3.2	**ID3**	the unique identification code given by the administration to the digital broadcasting Plan entry for which § 5.1.3 of the GE06 Agreement is to be applied Required if the notified assignment is to be operated under the mask of a digital broadcasting Plan entry in accordance with § 5.1.3 of the GE06 Regional Agreement
1.4.3.3	**DEC**	the digital broadcasting plan entry code that identifies the category of Plan entry to which the assignment belongs
1.4.3.4	**DAC**	the digital broadcasting assignment code

Broadcasting (sound and television) stations in the VHF/UHF bands up to 960 MHz, for the application of No. 11.2 and No. 9.21	Broadcasting (sound) stations in the LF/MF bands, for the application of No. 11.2	Transmitting stations (except broadcasting stations in the planned LF/MF bands, in the HF bands governed by Article 12, and in the VHF/UHF bands up to 960 MHz), for the application of No. 11.2 and No. 9.21	Receiving land stations, for the application of No. 11.9 and No. 9.21	Typical transmitting stations, for the application of No. 11.17	Maritime mobile frequency allotment, for the application of plan modification under Appendix 25 (Nos. 25/1.1.1, 25/1.1.2, 25/1.25)	Broadcasting stations in the HF bands, for the application of No. 12.16	Item identifier
X	X	X	X	X	X	X	B
X	X	X	X	X	X	X	D
+		+	+	+			E
+	+						SYNC
+	O	+	+	+	O		ID1
+							ID2
+		+	+				ID3
X							DEC
X							DAC

Column No.	Item identifier	Notice related to / Description of data items and requirements
1.5		**Frequency information**
1.5.1	**1A**	the assigned frequency, as defined in Article **1** In the case of a transmitting station, required for all services, except adaptive systems in the fixed or mobile service operating in the bands between 300 kHz and 28 MHz (see also Resolution **729 (Rev.WRC-07)**) In the case of an HF broadcasting station under Article **12**, required if neither the preferred band nor reference frequency is provided
1.5.2	**1B**	the reference frequency, as defined in Article **1** Required if the modulation envelope is asymmetric
1.5.3	**1G**	the alternative frequency
1.5.4	**1X**	the channel number of the proposed or allotted channel Required for submissions in accordance with Nos. **25**/1.1.1, **25**/1.1.2 or **25**/1.25 of Appendix **25** if the assistance of the Bureau is not requested under No. **25**/1.3.1 of Appendix **25**
1.5.5	**1Y**	the channel number of the alternative proposed channel
1.5.6	**1Z**	the channel number of the channel to be replaced Required if the administration needs to replace its existing allotted channel
1.5.7	**1AA**	the lower limit of the usable frequency range within which the carrier and the bandwidth of the emission will be located Required for adaptive systems in the fixed or mobile service operating in the bands between 300 kHz and 28 MHz (see also Resolution **729 (Rev.WRC-07)**)
1.5.8	**1AB**	the upper limit of the usable frequency range within which the carrier and the bandwidth of the emission will be located Required for adaptive systems in the fixed or mobile service operating in the bands between 300 kHz and 28 MHz (see also Resolution **729 (Rev.WRC-07)**)
1.5.9	**1C**	the preferred band, in MHz In the case of maritime mobile frequency allotment, required if the assistance of the Bureau is requested under No. **25**/1.3.1 of Appendix **25** In the case of an HF broadcasting station under Article **12**, required for notices if assistance is requested in accordance with No. **7.6**
1.5.10		**For digital broadcasting (except assignments subject to § 5.1.3 of the GE06 Regional Agreement):**
1.5.10.1	**1EO**	the frequency offset, in kHz Required if the centre frequency of the emission is offset from the assigned frequency

Broadcasting (sound and television) stations in the VHF/UHF bands up to 960 MHz, for the application of No. 11.2 and No. 9.21	Broadcasting (sound) stations in the LF/MF bands, for the application of No. 11.2	Transmitting stations (except broadcasting stations in the planned LF/MF bands, in the HF bands governed by Article 12, and in the VHF/UHF bands up to 960 MHz), for the application of No. 11.2 and No. 9.21	Receiving land stations, for the application of No. 11.9 and No. 9.21	Typical transmitting stations, for the application of No. 11.17	Maritime mobile frequency allotment, for the application of plan modification under Appendix 25 (Nos. 25/1.1.1, 25/1.1.2, 25/1.25)	Broadcasting stations in the HF bands, for the application of No. 12.16	Item identifier
X	X	+	X	X		+	1A
		+	+	+		+	1B
						O	1G
					+		1X
					O		1Y
					+		1Z
		+					1AA
		+					1AB
					+	+	1C
+							1EO

Column No.	Item identifier	Notice related to / Description of data items and requirements
1.5.11		**For analogue television broadcasting:**
1.5.11.1	**1E**	the vision carrier frequency offset, in multiples of 1/12 of the line frequency of the television system concerned, expressed by a number (positive or negative) Required if the vision carrier frequency offset, in kHz, (1E1) is not provided for assignments subject to the ST61, GE89 or GE06 Regional Agreements
1.5.11.2	**1E1**	the vision carrier frequency offset, in kHz, expressed by a number (positive or negative) Required if the vision carrier frequency offset, in multiples of 1/12 of the line frequency (1E) is not provided for assignments subject to the ST61, GE89 or GE06 Regional Agreements
1.5.11.3		**For the case where the sound carrier frequency offset is different from the vision carrier frequency offset:**
1.5.11.3.1	**1EA**	the sound carrier frequency offset, in multiples of 1/12 of the line frequency of the television system concerned, expressed by a number (positive or negative) Required if the sound carrier frequency offset, in kHz, (1E1A) is not provided for assignments subject to the ST61, GE89 or GE06 Regional Agreements
1.5.11.3.2	**1E1A**	the sound carrier frequency offset, in kHz, expressed by a number (positive or negative) Required if the sound carrier frequency offset, in multiples of 1/12 of the line frequency (1EA) is not provided for assignments subject to the ST61, GE89 or GE06 Regional Agreements
2		**DATE OF OPERATION**
2.1	**2C**	the date (actual or foreseen, as appropriate) of bringing the frequency assignment (new or modified) into use
2.2	**2E**	the date for the end of operation of a frequency assignment In the case of a VHF/UHF broadcasting station, required, in the application of Article **11**, when the operation of an assignment is limited to a specific period of time under § 4.1.5.4 of the GE06 Regional Agreement In the case of a transmitting station, a receiving land station, or a typical transmitting station, required, in the application of Article **11**, when the operation of an assignment is limited to a specific period of time under § 4.2.5.5 of the GE06 Regional Agreement
2.3	**2F**	the season of operation code
2.4	**10CA**	the start date for the transmission
2.5	**10CB**	the stop date for the transmission
2.6	**10CC**	the days of operation for the transmission during the HFBC schedule
3		**CALL SIGN AND STATION IDENTIFICATION**
3.1	**3A1**	the call sign used in accordance with Article **19** In the case of a transmitting station, for the fixed service below 28 MHz, mobile service, meteorological aids service, radiolocation service between 3 and 50 MHz (operating in accordance with Resolution **612 (Rev.WRC-12)**), or standard frequency and time signal service, in application of Article **11**, required if the station identification (3A2) is not provided

Broadcasting (sound and television) stations in the VHF/UHF bands up to 960 MHz, for the application of No. 11.2 and No. 9.21	Broadcasting (sound) stations in the LF/MF bands, for the application of No. 11.2	Transmitting stations (except broadcasting stations in the planned LF/MF bands, in the HF bands governed by Article 12, and in the VHF/UHF bands up to 960 MHz), for the application of No. 11.2 and No. 9.21	Receiving land stations, for the application of No. 11.9 and No. 9.21	Typical transmitting stations, for the application of No. 11.17	Maritime mobile frequency allotment, for the application of plan modification under Appendix 25 (Nos. 25/1.1.1, 25/1.1.2, 25/1.25)	Broadcasting stations in the HF bands, for the application of No. 12.16	Item identifier
+							1E
+							1E1
+							1EA
+							1E1A
X	X	X	X	X	X		2C
+		+	+	+			2E
						X	2F
						X	10CA
						X	10CB
						X	10CC
O	O	+				O	3A1

Column No.	Item identifier	Notice related to Description of data items and requirements
3.2	3A2	the station identification used in accordance with Article **19** In the case of a transmitting station, for the fixed service below 28 MHz, mobile service, meteorological aids service, radiolocation service between 3 and 50 MHz (operating in accordance with Resolution **612 (Rev.WRC-12)**), or standard frequency and time signal service, in application of Article **11**, required if the call sign (3A1) is not provided
4		**LOCATION OF THE TRANSMITTING ANTENNA(S)**
4.1	4A	the name of the locality by which the transmitting station is known or in which it is situated
4.2	4AA	the name of the location of the intended coast station Required for submissions in accordance with No. **25**/1.1.1 of Appendix **25**
4.3	4B	the code of the geographical area in which the transmitting station is located (see the Preface)
4.4	4C	the geographical coordinates of the transmitter site Latitude and longitude are provided in degrees, minutes and seconds
4.5	4CA	the geographical coordinates of the intended coast station Latitude and longitude are provided in degrees, minutes and seconds Required for submissions in accordance with No. **25**/1.1.1 of Appendix **25**
4.6	4H	HFBC site code *Note* – The code is assigned by the Bureau prior to commencement of the Article **12** procedure and represents the location of the station, its geographical area and geographical coordinates
4.7		**For an area in which transmitting stations operate:**
4.7.1	4CC	the geographical coordinates of the centre of the circular zone, in which mobile transmitting stations associated with a receiving land station, or a typical transmitting station are operating Latitude and longitude are provided in degrees, minutes and seconds In the case of a receiving land station, required: – for the maritime radionavigation service; and – for other services if the code of a geographical area or standard defined area (4E) is not provided In the case of a typical transmitting station, required if a geographical area or standard defined area (4E) is not provided
4.7.2	4D	the nominal radius, in km, of the circular zone, in which mobile transmitting stations associated with a receiving land station, or a typical transmitting station are operating In the case of a receiving land station, required: – for the maritime radionavigation service; and – for other services if the code of a geographical area or standard defined area (4E) is not provided In the case of a typical transmitting station, required if a geographical area or standard defined area (4E) is not provided

Broadcasting (sound and television) stations in the VHF/UHF bands up to 960 MHz, for the application of No. 11.2 and No. 9.21	Broadcasting (sound) stations in the LF/MF bands, for the application of No. 11.2	Transmitting stations (except broadcasting stations in the planned LF/MF bands, in the HF bands governed by Article 12, and in the VHF/UHF bands up to 960 MHz), for the application of No. 11.2 and No. 9.21	Receiving land stations, for the application of No. 11.9 and No. 9.21	Typical transmitting stations, for the application of No. 11.17	Maritime mobile frequency allotment, for the application of plan modification under Appendix 25 (Nos. 25/1.1.1, 25/1.1.2, 25/1.25)	Broadcasting stations in the HF bands, for the application of No. 12.16	Item identifier
O	O	+				O	3A2
X	X	X					4A
					+		4AA
X	X	X					4B
X	X	X					4C
					+		4CA
						X	4H
			+	+			4CC
			+	+			4D

Column No.	Item identifier	Notice related to Description of data items and requirements
4.7.3	**4E**	the code of the geographical area or standard defined area (see the Preface) *Note* – The standard defined area for a receiving land station in the maritime mobile service may be a maritime zone. The standard defined area for a maritime mobile frequency allotment is the allotment area In the case of a receiving land station, for all services, except the maritime radionavigation service, required if a circular zone (4CC and 4D) is not provided In the case of a typical transmitting station, required if a circular zone (4CC and 4D) is not provided
4.8	**4G**	the ground conductivity Required for an assignment subject to the GE75 Regional Agreement
5		**LOCATION OF THE RECEIVING ANTENNA(S)**
5.1	**5A**	the name of the locality by which the receiving station is known or in which it is situated In the case of a transmitting station, required for an associated receiving station in the fixed service if the geographical coordinates of a given reception zone (5CA) are not provided
5.2	**5B**	the code of the geographical area in which the receiving station(s) is located (see the Preface) In the case of a transmitting station, required for an associated receiving station in the fixed service if the geographical coordinates of a given reception zone (5CA) are not provided
5.3	**5C**	the geographical coordinates of the site of the receiving station Latitude and longitude are provided in degrees, minutes and seconds In the case of a transmitting station, required for an associated receiving station in the fixed service if the geographical coordinates of a given reception zone (5CA) are not provided
5.4		**For an area in which receiving stations operate:**
5.4.1	**5CA**	the geographical coordinates of a given reception zone A minimum of 3 geographical coordinates are to be provided. All geographical coordinates (latitude and longitude) are provided in degrees, minutes and seconds For an associated receiving station in the fixed service, required if the name of the locality (5A), geographical area (5B) and geographical coordinates (5C) are not provided For all other services, except where the assignment is subject to the GE06 Agreement, required if neither a circular area (5E and 5F) nor a geographical area or standard defined area of reception (5D) is provided

Broadcasting (sound and television) stations in the VHF/UHF bands up to 960 MHz, for the application of No. 11.2 and No. 9.21	Broadcasting (sound) stations in the LF/MF bands, for the application of No. 11.2	Transmitting stations (except broadcasting stations in the planned LF/MF bands, in the HF bands governed by Article 12, and in the VHF/UHF bands up to 960 MHz), for the application of No. 11.2 and No. 9.21	Receiving land stations, for the application of No. 11.9 and No. 9.21	Typical transmitting stations, for the application of No. 11.17	Maritime mobile frequency allotment, for the application of plan modification under Appendix 25 (Nos. 25/1.1.1, 25/1.1.2, 25/1.25)	Broadcasting stations in the HF bands, for the application of No. 12.16	Item identifier
			+	+	X		4E
	+						4G
		+	X				5A
		+	X				5B
		+	X				5C
		+					5CA

Column No.	Item identifier	Notice related to / Description of data items and requirements
5.4.2	**5D**	the code of the geographical area or standard defined area of reception (see the Preface) *Note* – The standard defined area of a transmitting station may be represented by a maritime zone or aeronautical zone. The standard defined area of a maritime mobile frequency allotment is a maritime zone. The standard defined area of an HF broadcasting station subject to Article **12** is represented by a CIRAF zone In the case of a transmitting station, except transmitting stations in the fixed service, maritime radionavigation service, aeronautical radionavigation service subject to the GE85-MM-R1 Regional Agreement or the maritime mobile service subject to the GE85-MM-R1 Regional Agreement, required if neither a circular receiving area (5E and 5F) nor geographical coordinates of a given reception zone (5CA) is provided
5.4.3	**5E**	the geographical coordinates of the centre of the circular receiving area Latitude and longitude are provided in degrees, minutes and seconds Required: – for the maritime radionavigation service, aeronautical radionavigation service subject to the GE85-MM-R1 Regional Agreement or the maritime mobile service subject to the GE85-MM-R1 Regional Agreement; and – for all other services, except the fixed service, if neither a geographical area or standard defined area of reception (5D) nor the geographical coordinates of a given reception zone (5CA) is provided
5.4.4	**5F**	the radius, in km, of the circular receiving area Required: – for the maritime radionavigation service, aeronautical radionavigation service subject to the GE85-MM-R1 Regional Agreement or the maritime mobile service subject to the GE85-MM-R1 Regional Agreement; and – for all other services, except the fixed service, if neither the geographical area or standard defined area of reception (5D) nor the geographical coordinates of a given reception zone (5CA) is provided
5.5	**5G**	the maximum length of the circuit, in km, for non-circular receiving areas Stations in the HF bands only
6		**CLASS OF STATION AND NATURE OF SERVICE**
6.1	**6A**	the class of station, using the symbols from the Preface
6.2	**6B**	the nature of service, using the symbols from the Preface In the case of a transmitting station, required for all services, except the broadcasting service
7		**CLASS OF EMISSION AND NECESSARY BANDWIDTH** *(in accordance with Article **2** and Appendix **1**)*
7.1	**7A**	the class of emission In the case of a VHF/UHF broadcasting station, required for digital broadcasting assignments
7.2	**7AB**	the necessary bandwidth In the case of a VHF/UHF broadcasting station, required for analogue sound and digital broadcasting assignments

Broadcasting (sound and television) stations in the VHF/UHF bands up to 960 MHz, for the application of No. 11.2 and No. 9.21	Broadcasting (sound) stations in the LF/MF bands, for the application of No. 11.2	Transmitting stations (except broadcasting stations in the planned LF/MF bands, in the HF bands governed by Article 12, and in the VHF/UHF bands up to 960 MHz), for the application of No. 11.2 and No. 9.21	Receiving land stations, for the application of No. 11.9 and No. 9.21	Typical transmitting stations, for the application of No. 11.17	Maritime mobile frequency allotment, for the application of plan modification under Appendix 25 (Nos. 25/1.1.1, 25/1.1.2, 25/1.25)	Broadcasting stations in the HF bands, for the application of No. 12.16	Item identifier
		+			X	X	5D
		+					5E
		+					5F
		O			O		5G
X	X	X	X	X	X	X	6A
		+	X	X	X		6B
+	X	X	X	X	X		7A
+	X	X	X	X	X	X	7AB

Column No.	Item identifier	Notice related to Description of data items and requirements
7.3		**System characteristics:**
7.3.1	**7A1**	the code describing the frequency stability (RELAXED, NORMAL or PRECISION) Required for analogue television broadcasting
7.3.2	**7AA**	the code for the type of modulation The type of modulation denotes the use of DSB, SSB or any new modulation techniques recommended by ITU-R In the case of an LF/MF broadcasting station, required for a digital assignment subject to the GE75 Regional Agreement
7.3.3	**7B1**	the adjacent channel protection ratio, in dB Required for the GE75 Regional Agreement
7.3.4	**7B2**	the "RJ 81 class" (A, B or C) Required for the RJ81 Regional Agreement
7.3.4.1	**7B3**	the code rate Required for digital assignments subject to the GE75 Regional Agreement
7.3.5	**7G**	the system code *Note* – The code identifies the category of system to which the station belongs and hence its protection requirements In the VHF band two codes are required for protection from T-DAB and DVB-T In the UHF band only one code is required for protection from DVB-T Required for an assignment subject to the GE06 Regional Agreement
7.3.6	**7C1**	the code identifying the television system (see the Preface) Required for television broadcasting assignments, except assignments subject to § 5.1.3 of the GE06 Regional Agreement
7.3.7	**7C2**	the code corresponding to the colour system (see the Preface) Required for analogue television broadcasting
7.3.8	**7D**	the code corresponding to the sound broadcasting transmission system (see the Preface) *Note* – For LF/MF systems, the signal may consist of analogue or digital modulation or data or some combination of them: the latter case is referred to as hybrid modulation In the case of a VHF/UHF broadcasting station, required for sound broadcasting assignments, except assignments subject to the GE06 Regional Agreement In the case of an LF/MF broadcasting station, required for an assignment with digital or hybrid modulation
7.3.9		**For the GE06 Regional Agreement (except notices subject to § 5.1.3 of the GE06 Regional Agreement):**
7.3.9.1	**7H**	the reference planning configuration (see the Preface) Required for digital sound broadcasting
7.3.9.2	**7J**	the type of spectrum mask
7.3.9.3	**7K**	the reception mode (see the Preface) Required for digital television broadcasting

Broadcasting (sound and television) stations in the VHF/UHF bands up to 960 MHz, for the application of No. 11.2 and No. 9.21	Broadcasting (sound) stations in the LF/MF bands, for the application of No. 11.2	Transmitting stations (except broadcasting stations in the planned LF/MF bands, in the HF bands governed by Article 12, and in the VHF/UHF bands up to 960 MHz), for the application of No. 11.2 and No. 9.21	Receiving land stations, for the application of No. 11.9 and No. 9.21	Typical transmitting stations, for the application of No. 11.17	Maritime mobile frequency allotment, for the application of plan modification under Appendix 25 (Nos. 25/1.1.1, 25/1.1.2, 25/1.25)	Broadcasting stations in the HF bands, for the application of No. 12.16	Item identifier
+							7A1
	+					X	7AA
	+						7B1
	+						7B2
	+						7B3
		+	+	+			7G
+							7C1
+							7C2
+	+						7D
+							7H
X							7J
+							7K

Column No.	Item identifier	Notice related to Description of data items and requirements
7.3.10		**For the fixed service in the bands shared with space services and any type of modulation as applicable:**
7.3.10.1	**7E**	the peak to peak frequency deviation, in MHz
7.3.10.2	**7F**	the sweep frequency, in kHz, of the energy dispersal waveform
8		**POWER CHARACTERISTICS**
8.1	**8**	the symbol (X, Y or Z, as appropriate) describing the type of power (see Article **1**) corresponding to the class of emission
8.2	**8A**	the power delivered to the antenna transmission line, in kW
8.3	**8AA**	the power delivered to the antenna, in dBW For stations where the power delivered to the antenna cannot be measured: – the total radiated power (TRP*); or – the calculated TRP (e.i.r.p. minus antenna directivity); or – the calculated power delivered to the antenna (e.i.r.p. minus maximum antenna gain (9G)) * The TRP is to be understood here as the integral of the power transmitted from all antenna elements in different directions over the entire radiation sphere In the case of a transmitting station, required for an assignment: – in the frequency bands below 28 MHz, in all services except the radionavigation service; or – in the frequency bands above 28 MHz shared with space services; or – in the frequency bands above 28 MHz not shared with space services: • in the aeronautical mobile service, meteorological aids service; or • in all other services, if the radiated power is not supplied In the case of a receiving land station, required if the associated transmitting station's radiated power is not supplied In the case of a typical transmitting station, required if the radiated power is not supplied
8.4	**8AB**	the maximum power density[1] (dB(W/Hz)) for each carrier type averaged over the worst 4 kHz band for carriers below 15 GHz, or averaged over the worst 1 MHz band for carriers above 15 GHz, supplied to the antenna transmission line For the fixed service in the bands shared with space services

Broadcasting (sound and television) stations in the VHF/UHF bands up to 960 MHz, for the application of No. 11.2 and No. 9.21	Broadcasting (sound) stations in the LF/MF bands, for the application of No. 11.2	Transmitting stations (except broadcasting stations in the planned LF/MF bands, in the HF bands governed by Article 12, and in the VHF/UHF bands up to 960 MHz), for the application of No. 11.2 and No. 9.21	Receiving land stations, for the application of No. 11.9 and No. 9.21	Typical transmitting stations, for the application of No. 11.17	Maritime mobile frequency allotment, for the application of plan modification under Appendix 25 (Nos. 25/1.1.1, 25/1.1.2, 25/1.25)	Broadcasting stations in the HF bands, for the application of No. 12.16	Item identifier
		C					7E
		C					7F
X	X	X	X	X	X	X	8
	X					X	8A
		+	+	+	X		8AA
		C					8AB

Column No.	Item identifier	Notice related to Description of data items and requirements
8.5	**8AC**	the maximum power density (dB(W/Hz)) averaged over the worst 4 kHz band, calculated for the maximum effective radiated power *Note* – For a receiving land station, the maximum power density refers to the associated transmitting station In the case of a VHF/UHF broadcasting station, required for assignments subject to § 5.1.3 of the GE06 Regional Agreement In the case of a transmitting station, a receiving land station, or a typical transmitting station, required for assignments subject to the GE06 Regional Agreement
8.6	**8B**	the radiated power, in dBW, in one of the forms described in Nos. **1.161** to **1.163** *Note* – Where adaptive systems in the fixed or mobile service operating in the bands between 300 kHz and 28 MHz (see also Resolution **729 (Rev.WRC-07)**) use automatic power control, the radiated power includes the level of power control listed under 8BA For assignments in all services and frequency bands, except assignments subject to the GE06 Regional Agreement, required if the power delivered to the antenna (8AA), or the maximum antenna gain (9G), is not provided For an assignment subject to the GE06 Regional Agreement, required if the power delivered to the antenna (8AA) is not provided
8.7	**8BA**	the range of power control, in dB Required for adaptive systems in the fixed or mobile service operating in the bands between 300 kHz and 28 MHz (see also Resolution **729 (Rev.WRC-07)**), if automatic power control is used
8.8	**8BH**	the maximum effective radiated power, in dBW, of the horizontally polarized component Required for horizontal or mixed polarization
8.9	**8BV**	the maximum effective radiated power, in dBW, of the vertically polarized component Required for vertical or mixed polarization
8.10	**8BT**	the maximum effective radiated power, in dBW, in the plane defined by the beam tilt angle For a digital broadcasting assignment in the UHF band subject to the GE06 Regional Agreement only
8.11	**8D**	the vision-to-sound carrier power ratio, in dB Required for analogue television broadcasting
8.12	**9L**	the maximum effective monopole radiated power, in dB(kW) Required for the GE75 Regional Agreement

Broadcasting (sound and television) stations in the VHF/UHF bands up to 960 MHz, for the application of No. 11.2 and No. 9.21	Broadcasting (sound) stations in the LF/MF bands, for the application of No. 11.2	Transmitting stations (except broadcasting stations in the planned LF/MF bands, in the HF bands governed by Article 12, and in the VHF/UHF bands up to 960 MHz), for the application of No. 11.2 and No. 9.21	Receiving land stations, for the application of No. 11.9 and No. 9.21	Typical transmitting stations, for the application of No. 11.17	Maritime mobile frequency allotment, for the application of plan modification under Appendix 25 (Nos. 25/1.1.1, 25/1.1.2, 25/1.25)	Broadcasting stations in the HF bands, for the application of No. 12.16	Item identifier
+		+	+	+			8AC
		+	+	+			8B
		+					8BA
+							8BH
+							8BV
O							8BT
+							8D
	+						9L

Column No.	Item identifier	Notice related to / Description of data items and requirements
8.13		**For the RJ81 and RJ88 Regional Agreements:**
8.13.1	**9I**	the r.m.s. value of radiation The product of the r.m.s. characteristic field strength in the horizontal plane and the square root of the power
8.13.2	**9IA**	the value of the radiation at the central azimuth of the augmentation, in mV/m at 1 km Required for antenna radiation pattern type "M" (see 9O)
8.13.3	**9P**	the value of the special quadrature factor, in mV/m at 1 km *Note* – A special quadrature factor may be used with antenna pattern type "M" or "E" to replace the normal expanded quadrature factor when special precautions are taken to ensure pattern stability
9		**ANTENNA CHARACTERISTICS**
9.1		**For a transmitting or receiving antenna:**
9.1.1	**9**	the indicator showing whether the antenna is directional (D) or non-directional (ND) In the case of a receiving land station, required for an assignment subject to the GE06 Regional Agreement
9.1.2	**9D**	the code indicating the type of polarization (see the Preface) In the case of a transmitting station, required for an assignment: – in the fixed service in the bands shared with space services; or – subject to the GE06 Regional Agreement In the case of a receiving land station, required for an assignment subject to the GE06 Regional Agreement
9.1.3	**9E**	the height of the antenna above ground level, in metres In the case of a VHF/UHF broadcasting station, required for the ST61, GE84, GE89 or GE06 Regional Agreements, and optional for assignments not subject to these Agreements In the case of a transmitting station, required for an assignment: – in the bands shared with space services; or – subject to the GE06 Regional Agreement In the case of a receiving land station, required for an assignment subject to the GE06 Regional Agreement
9.2		**For a directional transmitting or receiving antenna:**
9.2.1	**9C**	the total angular width of the radiation main lobe (beamwidth) measured horizontally in a plane containing the direction of maximum radiation, in degrees, within which the power radiated in any direction does not fall more than 3 dB below the power radiated in the direction of maximum radiation In the case of a transmitting station, required for all assignments, except assignments subject to GE06 Regional Agreement where it is optional In the case of a receiving land station, for an assignment subject to the GE06 Regional Agreement only

Broadcasting (sound and television) stations in the VHF/UHF bands up to 960 MHz, for the application of No. 11.2 and No. 9.21	Broadcasting (sound) stations in the LF/MF bands, for the application of No. 11.2	Transmitting stations (except broadcasting stations in the planned LF/MF bands, in the HF bands governed by Article 12, and in the VHF/UHF bands up to 960 MHz), for the application of No. 11.2 and No. 9.21	Receiving land stations, for the application of No. 11.9 and No. 9.21	Typical transmitting stations, for the application of No. 11.17	Maritime mobile frequency allotment, for the application of plan modification under Appendix 25 (Nos. 25/1.1.1, 25/1.1.2, 25/1.25)	Broadcasting stations in the HF bands, for the application of No. 12.16	Item identifier
	X						9I
	+						9IA
	O						9P
X		X	+		X	X	9
X		+	+				9D
+		+	+				9E
		+	O		X		9C

Column No.	Item identifier	Notice related to Description of data items and requirements
9.2.2	**9GL**	the antenna gain towards the local horizon For an assignment subject to the GE06 Regional Agreement only
9.2.3	**9K**	the lowest total receiving system noise temperature, in kelvins For an associated receiving antenna in the fixed service operating in the bands shared with space services only
9.3		**For a transmitting antenna:**
9.3.1	**9EA**	the altitude of the site above mean sea level, in metres In the case of a VHF/UHF broadcasting station, required for assignments subject to the ST61, GE84, GE89, or GE06 Regional Agreements, and optional for assignments not subject to these Agreements In the case of a transmitting station, required for an assignment: – in the fixed or mobile service in the bands shared with space services; or – subject to the GE06 Regional Agreement
9.3.2	**9EB**	the maximum effective height of the antenna, in metres, above the mean level of the ground between 3 and 15 km from the transmitting antenna In the case of a transmitting station, required for an assignment subject to the GE06 Regional Agreement
9.3.3	**9EC**	the effective height of the antenna, in metres, above the mean level of the ground between 3 and 15 km from the transmitting antenna, at 36 different azimuths in 10° intervals (i.e. 0°, 10°, ..., 350°), measured in the horizontal plane from True North in a clockwise direction In the case of a transmitting station, required for an assignment subject to the GE06 Regional Agreement
9.3.4	**9G**	the maximum antenna gain (isotropic, relative to a short vertical antenna or relative to a half-wave dipole, as appropriate) of the transmitting antenna (see No. **1.160**) For a directional antenna, the gain is in the direction of maximum radiation In the case of a transmitting station, or a typical transmitting station: – for all frequency bands and services, except assignments subject to the GE06 Regional Agreement, required if the antenna is: – directional, including where the antenna beam is rotating or swept; or – non-directional, and the power to the antenna (8AA) or the radiated power (8B) is not provided – for an assignment subject to the GE06 Regional Agreement required if the radiated power (8B) is not provided In the case of a maritime mobile frequency allotment, required if the antenna is directional, including where the antenna beam is rotating or swept

Broadcasting (sound and television) stations in the VHF/UHF bands up to 960 MHz, for the application of No. 11.2 and No. 9.21	Broadcasting (sound) stations in the LF/MF bands, for the application of No. 11.2	Transmitting stations (except broadcasting stations in the planned LF/MF bands, in the HF bands governed by Article 12, and in the VHF/UHF bands up to 960 MHz), for the application of No. 11.2 and No. 9.21	Receiving land stations, for the application of No. 11.9 and No. 9.21	Typical transmitting stations, for the application of No. 11.17	Maritime mobile frequency allotment, for the application of plan modification under Appendix 25 (Nos. 25/1.1.1, 25/1.1.2, 25/1.25)	Broadcasting stations in the HF bands, for the application of No. 12.16	Item identifier
		O	O				9GL
		C					9K
+		+					9EA
X		+					9EB
X		+					9EC
		+		+	+		9G

Column No.	Item identifier	Notice related to / Description of data items and requirements
9.3.5	**9M**	the transmitting antenna design frequency
9.3.6	**9S**	the beam tilt angle, in degrees The beam tilt angle is measured from the horizontal plane towards ground and the sign of the angle is negative *Note* – In some broadcasting definitions, the angle may have the opposite sign For a digital broadcasting assignment in the UHF band subject to the GE06 Regional Agreement only
9.3.7	**9J**	the measured radiation pattern of the antenna, the reference radiation pattern or the symbols in standard references to be used for coordination
9.4		**For a directional transmitting antenna where the antenna beam is rotating or swept:**
9.4.1	**9AB1**	the start azimuth for the range of operational angles for the antenna's main beam axis, measured in the horizontal plane from True North in a clockwise direction
9.4.2	**9AB2**	the end azimuth for the range of operational angles for the antenna's main beam axis, measured in the horizontal plane from True North in a clockwise direction
9.5		**For a directional transmitting antenna where the antenna beam is not rotating or swept:**
9.5.1	**9A**	the azimuth of maximum radiation of the transmitting antenna, measured in the horizontal plane from True North in a clockwise direction
9.5.2	**9B**	the elevation angle of maximum directivity, in degrees Required for an assignment in the bands shared with space services
9.5.3	**9R**	the slew angle measured between the azimuth of maximum radiation and the direction of unslewed radiation
9.5.4	**9NH**	the value of attenuation of the horizontally polarized component, at 36 different azimuths in 10° intervals (i.e. 0°, 10°, ..., 350°), measured in the horizontal plane from True North in a clockwise direction, with respect to the maximum effective radiated power of this component, in dB For all assignments, except digital broadcasting assignments subject to the GE06 Regional Agreement and broadcasting assignments subject to § 5.1.3 of the GE06 Regional Agreement, required if the polarization is horizontal or mixed
9.5.5	**9NV**	the value of attenuation of the vertically polarized component, at 36 different azimuths in 10° intervals (i.e. 0°, 10°, ..., 350°), measured in the horizontal plane from True North in a clockwise direction, with respect to the maximum effective radiated power of this component, in dB For all assignments, except digital broadcasting assignments subject to the GE06 Regional Agreement and broadcasting assignments subject to § 5.1.3 of the GE06 Regional Agreement, required if the polarization is vertical or mixed

Broadcasting (sound and television) stations in the VHF/UHF bands up to 960 MHz, for the application of No. 11.2 and No. 9.21	Broadcasting (sound) stations in the LF/MF bands, for the application of No. 11.2	Transmitting stations (except broadcasting stations in the planned LF/MF bands, in the HF bands governed by Article 12, and in the VHF/UHF bands up to 960 MHz), for the application of No. 11.2 and No. 9.21	Receiving land stations, for the application of No. 11.9 and No. 9.21	Typical transmitting stations, for the application of No. 11.17	Maritime mobile frequency allotment, for the application of plan modification under Appendix 25 (Nos. 25/1.1.1, 25/1.1.2, 25/1.25)	Broadcasting stations in the HF bands, for the application of No. 12.16	Item identifier
						X	9M
O						X	9S
		O				X	9J
		X			X		9AB1
		X			X		9AB2
		X			X	X	9A
		+					9B
						X	9R
+							9NH
+							9NV

Column No.	Item identifier	Notice related to / Description of data items and requirements
9.5.6	**9UH**	the value of attenuation of the horizontally polarized component in the horizontal plane, normalized to 0 dB, at 36 different azimuths in 10° intervals (i.e. 0°, 10°, ..., 350°), measured in the horizontal plane from True North in a clockwise direction, with respect to the maximum radiated power of this component, in dB In the case of a VHF/UHF broadcasting station, for a digital broadcasting assignment subject to the GE06 Regional Agreement and an assignment subject to § 5.1.3 of the GE06 Regional Agreement, required if the polarization is horizontal or mixed In the case of a transmitting station, for an assignment subject to § 5.1.3 of the GE06 Regional Agreement, required if the polarization is horizontal or mixed
9.5.7	**9UV**	the value of attenuation of the vertically polarized component in the horizontal plane, normalized to 0 dB, at 36 different azimuths in 10° intervals (i.e. 0°, 10°, ..., 350°), measured in the horizontal plane from True North in a clockwise direction, with respect to the maximum radiated power of this component, in dB In the case of a VHF/UHF broadcasting station, for a digital broadcasting assignment subject to the GE06 Regional Agreement and an assignment subject to § 5.1.3 of the GE06 Regional Agreement, required if the polarization is vertical or mixed In the case of a transmitting station, for an assignment subject to § 5.1.3 of the GE06 Regional Agreement, required if the polarization is vertical or mixed
9.6	**9Q**	the symbol identifying the type of antenna Type A – a simple vertical antenna Type B – a directional or omnidirectional antenna of complex construction
9.7		**For a type A antenna (simple vertical antenna):**
9.7.1	**9EP**	the transmitting antenna's physical length in metres Required for the GE75 Regional Agreement
9.7.2	**9F**	the electrical height of the antenna, in degrees Required for the RJ81 or RJ88 Regional Agreements
9.8		**For a station subject to the GE75 Regional Agreement with a type B antenna (a directional antenna, or omnidirectional antenna of complex construction):**
9.8.1	**9GH**	the antenna gain, in dB, in the horizontal plane, at 36 different azimuths in 10° intervals (i.e. 0°, 10°, ..., 350°), measured in the horizontal plane from True North in a clockwise direction
9.8.2	**9GV**	the antenna gain, in dB, in the vertical plane, at 36 different azimuths in 10° intervals (i.e. 0°, 10°, ..., 350°) measured in the horizontal plane from True North in a clockwise direction, and at ten different elevations in 10° intervals (i.e. 0°, 10°, ..., 90°) measured in the vertical plane *Note* – If administrations have difficulty in providing this information, they can provide a reference to any other information that may be of assistance (e.g. ITU-R Recommendation, antenna pattern) Required for an assignment to be used for night-time operation

Broadcasting (sound and television) stations in the VHF/UHF bands up to 960 MHz, for the application of No. 11.2 and No. 9.21	Broadcasting (sound) stations in the LF/MF bands, for the application of No. 11.2	Transmitting stations (except broadcasting stations in the planned LF/MF bands, in the HF bands governed by Article 12, and in the VHF/UHF bands up to 960 MHz), for the application of No. 11.2 and No. 9.21	Receiving land stations, for the application of No. 11.9 and No. 9.21	Typical transmitting stations, for the application of No. 11.17	Maritime mobile frequency allotment, for the application of plan modification under Appendix 25 (Nos. 25/1.1.1, 25/1.1.2, 25/1.25)	Broadcasting stations in the HF bands, for the application of No. 12.16	Item identifier
+		+					9UH
+		+					9UV
	X						9Q
	+						9EP
	+						9F
	X						9GH
	+						9GV

Column No.	Item identifier	Notice related to / Description of data items and requirements
9.9		**For a station subject to the RJ81 or RJ88 Regional Agreements with a type B antenna (a directional antenna, or omnidirectional antenna of complex construction):**
9.9.1	**9O**	the symbol identifying the type of antenna radiation pattern (T, M, or E)
9.9.2		**For antenna radiation pattern type M:**
9.9.2.1	**9NA**	the serial number of the augmentation as described by items 9IA, 9AA and 9CA
9.9.2.2	**9AA**	the central azimuth of the augmentation (centre of the span) in degrees
9.9.2.3	**9CA**	the total span of the augmentation, in degrees
9.9.3		**For each tower of a type B antenna in the RJ81 or RJ88 Regional Agreements:**
9.9.3.1	**9T1**	the serial number of each of the towers whose characteristics are described in items 9T2 to 9T8
9.9.3.2	**9T8**	the symbol corresponding to the tower structure
9.9.3.3	**9T7**	the electrical height, in degrees, of the tower under consideration Required if the tower is not top-loaded nor sectionalized (see 9.9.4)
9.9.3.4	**9T2**	the ratio of the tower field to the field of the reference tower Required if the antenna consists of two or more towers
9.9.3.5	**9T3**	the positive or negative phase difference in the tower field with respect to the field of the reference tower, in degrees Required if the antenna consists of two or more towers
9.9.3.6	**9T4**	the electrical spacing of the tower from the reference point, in degrees Required if the antenna consists of two or more towers
9.9.3.7	**9T5**	the angular orientation of the tower from the reference point, in degrees (clockwise) from True North Required if the antenna consists of two or more towers
9.9.4		**For each tower of a type B antenna that is top-loaded or sectionalized in accordance with the Regional Administrative MF Broadcasting Conference (Region 2) Rio de Janeiro, 1981 or 1988 Agreements:**
9.9.4.1	**9T9A**	the description of a top-loaded or sectionalized tower
9.9.4.2	**9T9B**	the description of a top-loaded or sectionalized tower Required if tower structure symbol (9T8) is 1, 2, 5, 6, 7, 8 or 9
9.9.4.3	**9T9C**	the description of a top-loaded or sectionalized tower Required if the tower structure symbol (9T8) is 2, 5, 7 or 8
9.9.4.4	**9T9D**	the description of a top-loaded or sectionalized tower Required if tower structures symbol (9T8) is 2, 5 or 8

Broadcasting (sound and television) stations in the VHF/UHF bands up to 960 MHz, for the application of No. 11.2 and No. 9.21	Broadcasting (sound) stations in the LF/MF bands, for the application of No. 11.2	Transmitting stations (except broadcasting stations in the planned LF/MF bands, in the HF bands governed by Article 12, and in the VHF/UHF bands up to 960 MHz), for the application of No. 11.2 and No. 9.21	Receiving land stations, for the application of No. 11.9 and No. 9.21	Typical transmitting stations, for the application of No. 11.17	Maritime mobile frequency allotment, for the application of plan modification under Appendix 25 (Nos. 25/1.1.1, 25/1.1.2, 25/1.25)	Broadcasting stations in the HF bands, for the application of No. 12.16	Item identifier
	X						9O
	X						9NA
	X						9AA
	X						9CA
	X						9T1
	X						9T8
	+						9T7
	+						9T2
	+						9T3
	+						9T4
	+						9T5
	X						9T9A
	+						9T9B
	+						9T9C
	+						9T9D

Column No.	Item identifier	Notice related to / Description of data items and requirements
10		**HOURS OF OPERATION**
10.1	**10B**	the regular hours of operation (in hours and minutes from ... to ...) of the frequency assignment, in UTC
10.2	**10BA**	the local operation period code (see the Preface)
10.3	**10D**	the estimated peak hours of traffic
10.4	**10E**	the estimated daily volume of traffic
11		**COORDINATION AND AGREEMENT**
11.1	**11**	the symbol of each administration with which coordination has been successfully effected Required if coordination is necessary and has been obtained pursuant to the relevant provisions of the Radio Regulations
11.2	**11D**	a declaration by the notifying administration that all conditions associated with the remark are fully met for recording the submitted assignment in the Master International Frequency Register Required for a digital broadcasting assignment subject to § 5.1.2 of the GE06 Regional Agreement and for the broadcasting and other primary services assignments notified pursuant to No. 5.1.3 of the Agreement
11.3	**11C**	a signed commitment from the notifying administration that the submitted assignment for recording in the Master International Frequency Register shall not cause unacceptable interference and shall not claim protection Required for an assignment subject to § 5.1.8 of the GE06 Regional Agreement
11.4	**11E**	a signed commitment from the notifying administration that the submitted assignment for recording in the Master International Frequency Register shall not cause unacceptable interference and shall not claim protection Required for an assignment subject to § 5.2.6 of the GE06 Regional Agreement
11.5	**11F**	Recognition by the notifying administration that the registration of assignments in the aeronautical mobile (R) service in the 5 030-5 091 MHz frequency band accords with the purposes of ITU, including No. 7 of Article 1 of the ITU Constitution. Required for an assignment in aeronautical mobile (R) service in the frequency band 5 030-5 091 MHz
11.6	**11G**	a commitment from the notifying administration that the aggregate power flux-density (pfd) received from stations in the aeronautical mobile (OR) service at the location of any radio astronomy station operating in this frequency band shall be in compliance with the protection criteria provided in Recommendations ITU-R RA.769-2 and ITU-R RA.1513-2 Required for an assignment in the aeronautical mobile (OR) service in the frequency bands 15.41-15.7 GHz and 22-22.2 GHz
11.7	**11H**	a commitment from the notifying administration that the unwanted equivalent isotropically radiated power (e.i.r.p.) of stations operating in the aeronautical mobile (OR) service shall not exceed −23 dBW in any 100 MHz band in the frequency band 22.21-22.5 GHz Required for an assignment in the aeronautical mobile (OR) service in the frequency band 22-22.2 GHz

Broadcasting (sound and television) stations in the VHF/UHF bands up to 960 MHz, for the application of No. 11.2 and No. 9.21	Broadcasting (sound) stations in the LF/MF bands, for the application of No. 11.2	Transmitting stations (except broadcasting stations in the planned LF/MF bands, in the HF bands governed by Article 12, and in the VHF/UHF bands up to 960 MHz), for the application of No. 11.2 and No. 9.21	Receiving land stations, for the application of No. 11.9 and No. 9.21	Typical transmitting stations, for the application of No. 11.17	Maritime mobile frequency allotment, for the application of plan modification under Appendix 25 (Nos. 25/1.1.1, 25/1.1.2, 25/1.25)	Broadcasting stations in the HF bands, for the application of No. 12.16	Item identifier
X	O	X	X	X	X	X	10B
	X						10BA
					X		10D
					X		10E
+	O	+	+	O	+		11
+		+	+				11D
+							11C
		+	+	+			11E
		+	+	+			11F
		+	+	+			11G
		+	+	+			11H

Column No.	Item identifier	Notice related to / Description of data items and requirements
12		**OPERATING ADMINISTRATION OR AGENCY**
12.1	**12A**	the symbol for the operating agency
12.2	**12B**	the symbol for the address of the administration responsible for the station and to which communication should be sent on urgent matters regarding interference, quality of emissions and questions referring to the technical operation of the circuit (see Article **15**, also the Preface) In the case of a VHF/UHF broadcasting station, transmitting station, or a receiving land station, required for application of Article **11**
13		**REMARKS**
13.1	**13C**	Remarks for assisting the Bureau in processing the notice

Broadcasting (sound and television) stations in the VHF/UHF bands up to 960 MHz, for the application of No. 11.2 and No. 9.21	Broadcasting (sound) stations in the LF/MF bands, for the application of No. 11.2	Transmitting stations (except broadcasting stations in the planned LF/MF bands, in the HF bands governed by Article 12, and in the VHF/UHF bands up to 960 MHz), for the application of No. 11.2 and No. 9.21	Receiving land stations, for the application of No. 11.9 and No. 9.21	Typical transmitting stations, for the application of No. 11.17	Maritime mobile frequency allotment, for the application of plan modification under Appendix 25 (Nos. 25/1.1.1, 25/1.1.2, 25/1.25)	Broadcasting stations in the HF bands, for the application of No. 12.16	Item identifier
O	O	O	O	O		O	12A
+	X	+	+	X		X	12B
O	O	O	O	O	O	O	13C

TABLE 2 (Rev.WRC-23)

Characteristics for frequency assignments to high-altitude platform stations (HAPS) and high-altitude platform stations as International Mobile Telecommunications base stations (HIBS) in the terrestrial services

Item identifier	*1 – GENERAL CHARACTERISTICS OF THE HAPS/HIBS*	Transmitting station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.9	Transmitting station in the frequency bands listed in Nos. 5.457, 5.537A, 5.530E, 5.532AA, 5.534A, 5.543B, 5.550D and 5.552A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.457, 5.534A, 5.543B, 5.550D and 5.552A for the application of No. 11.9	Item identifier
	GENERAL INFORMATION					
1.B	the symbol of the notifying administration (see the Preface)	X	X	X	X	1.B
1.D	the provision code of the Radio Regulations under which the notice has been submitted	X	X	X	X	1.D
1.ID1	the unique identifier given by the administration to the station	X	X	X	X	1.ID1
	LOCATION OF THE STATION					
1.4.a	the name by which the station is known	X	X	X	X	1.4.a
1.4.b	the code of the geographical area, above which the station is located (see the Preface)	X	X	X	X	1.4.b
1.4.c	the nominal geographical coordinates of the station Latitude and longitude are provided in degrees, minutes and seconds	X	X	X	X	1.4.c
1.4.h	the nominal altitude of the station above mean sea level, in metres	X	X	X	X	1.4.h
1.4.t	**Station location tolerances:**					1.4.t
1.4.t.1.a	the planned latitudinal tolerance northerly limit, using d.m.s units	X	X	X	X	1.4.t.1.a
1.4.t.1.b	the planned latitudinal tolerance southerly limit, using d.m.s units	X	X	X	X	1.4.t.1.b
1.4.t.2.a	the planned longitudinal tolerance easterly limit, using d.m.s units	X	X	X	X	1.4.t.2.a
1.4.t.2.b	the planned longitudinal tolerance westerly limit, using d.m.s units	X	X	X	X	1.4.t.2.b
1.4.t.3	the planned altitudinal tolerance, in metres	X	X	X	X	1.4.t.3
	COMPLIANCE WITH TECHNICAL OR OPERATIONAL LIMITS					
1.14.b	a commitment that, for the purpose of protecting mobile earth stations in the territory of other administrations in the frequency bands 2 160-2 200 MHz in Region 2 and 2 170-2 200 MHz in Regions 1 and 3, the pfd of the unwanted emissions per HIBS does not exceed the limit of −165 dB(W/(m^2 · 4 kHz)) at the Earth's surface in the territory of other administrations in the frequency bands 2 160-2 200 MHz in Region 2 and 2 170-2 200 MHz in Regions 1 and 3 (see Resolution **221 (Rev.WRC-23)**)	X				1.14.b

Item identifier	*1 - GENERAL CHARACTERISTICS OF THE HAPS/HIBS*	Transmitting station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.9	Transmitting station in the frequency bands listed in Nos. 5.457, 5.537A, 5.530E, 5.532AA, 5.534A, 5.543B, 5.550D and 5.552A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.457, 5.534A, 5.543B, 5.550D and 5.552A for the application of No. 11.9	Item identifier
1.14.c	a commitment that, for the purpose of protecting fixed-service systems in Armenia, Azerbaijan, Belarus, the Russian Federation, Kazakhstan, Mongolia, Uzbekistan, Kyrgyzstan, Tajikistan and Turkmenistan, the pfd of the unwanted emissions per HIBS at the Earth's surface of the countries listed above in this item 1.14c in the frequency band 2 025-2 110 MHz does not exceed the out-of-band pfd limits of −165 dB(W/(m^2 · MHz)) for angles of arrival (θ) less than or equal to 5° above the horizontal plane, −165 + 1.75 (θ − 5) dB(W/(m^2 · MHz)) for angles of arrival between 5° and 25° (included) and −130 dB(W/(m^2 · MHz)) for angles of arrival between 25° and 90° (included) (see Resolution **221 (Rev.WRC-23)**)	**X**				1.14.c
1.14.ca	a commitment that, for the purpose of protecting aeronautical radionavigation service systems in the territory of other administrations in the frequency band 2 700-2 900 MHz, the pfd level per HIBS operating in the frequency band 2 500-2 690 MHz produced at the surface of the Earth in the territory of other administrations shall not exceed the following unwanted emissions limits of −156.2 dB(W/(m^2 · MHz)) for angles of arrival (θ) less than or equal to 7° above the horizontal plane, −163 + 15 · $\log_{10}$ (θ − 4) dB(W/(m^2 · MHz)) for angles of arrival between 7° and 30.5°, −141 + 2.7 · $\log_{10}$ (θ − 4) dB(W/(m^2 · MHz)) for angles of arrival (θ) equal to 30.5°, −157 + 14 · $\log_{10}$ (θ − 4) dB(W/(m^2 · MHz)) for angles of arrival between 30.5° and 40.5° (included) and −101.5 dB(W/(m^2 · MHz)) for angles of arrival more than 40.5° (see Resolution **218 (WRC-23)**)	**X**				1.14.ca

Item identifier	*1 - GENERAL CHARACTERISTICS OF THE HAPS/HIBS*	Transmitting station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.9	Transmitting station in the frequency bands listed in Nos. 5.457, 5.537A, 5.530E, 5.532AA, 5.534A, 5.543B, 5.550D and 5.552A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.457, 5.534A, 5.543B, 5.550D and 5.552A for the application of No. 11.9	Item identifier
1.14.cb	a commitment that, for the purpose of protecting radiolocation service systems in the territory of other administrations, in particular those systems operating in accordance with No. **5.423** in the frequency band 2 700-2 900 MHz, the pfd level per HIBS operating in the frequency band 2 500-2 690 MHz produced at the surface of the Earth in the territory of other administrations shall not exceed the following unwanted emissions limits of −165.6 dB(W/(m^2 · MHz)) for angles of arrival (θ) less than or equal to 37° above the horizontal plane, −165.6 + 5.5 (θ − 37) dB(W/(m^2 · MHz)) for angles of arrival between 37° and 45° and −121.6 + (θ − 45) /3 dB(W/(m^2 · MHz)) for angles of arrival (θ) between 45° and 90° (included) (see Resolution **218 (WRC-23)**)	**X**				1.14.cb
1.14.cc	a commitment that, for the purpose of protecting radio astronomy service stations in the frequency band 2 690-2 700 MHz, the pfd level of HIBS operating in the frequency band 2 500-2 690 MHz produced at any radio astronomy observatory site shall not exceed the following unwanted emissions limit of −177 dBm/MHz (see Resolution **218 (WRC-23)**)	**X**				1.14.cc
1.14.cd	a commitment that, for the purpose of protecting MSS (space-to-Earth) and RDSS (space-to-Earth) in the frequency band 2 483.5-2 500 MHz, the use of HIBS in the frequency band 2 500-2 690 MHz shall comply with an unwanted emission limit of −30 dBm/MHz in the frequency band 2 483.5-2 500 MHz (see Resolution **218 (WRC-23)**)	**X**				1.14.cd
1.14.ce	a commitment that, for the purpose of protecting MSS (Earth-to-space) in the frequency band 2 655-2 690 MHz in Region 3, the notifying administrations of HIBS shall ensure that, in case of causing unacceptable interference, it undertakes to immediately cease emission or reduce the interference to an acceptable level (see Resolution **218 (WRC-23)**)	**X**				1.14.ce
1.14.cf	a firm, objective, actionable, measurable and enforceable commitment that HIBS shall immediately eliminate unacceptable interference to existing primary services or reduce it to an acceptable level should such interference occur	**X**				1.14.cf

Item identifier	*1 - GENERAL CHARACTERISTICS OF THE HAPS/HIBS*	Transmitting station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.9	Transmitting station in the frequency bands listed in Nos. 5.457, 5.537A, 5.530E, 5.532AA, 5.534A, 5.543B, 5.550D and 5.552A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.457, 5.534A, 5.543B, 5.550D and 5.552A for the application of No. 11.9	Item identifier
1.14.d	a commitment that the antenna pattern complies with the reference antenna pattern defined in *resolves* 1 of Resolution **150 (WRC-12)** Required in the band 6 560-6 640 MHz				+	1.14.d
1.14.e	a commitment that the aggregate power flux-density (pfd) of HAPS uplinks is limited to a maximum of −183.9 dB(W/(m^2 · 4 kHz)) at any point in the geostationary arc. To meet this aggregate power flux-density (pfd) criterion, the maximum e.i.r.p. density value of a single HAPS gateway link towards the geostationary arc shall not exceed −59.9 dB(W/4 kHz) in any direction within ±5 degrees of the geostationary arc (see Resolution **150 (WRC-12)**) Required in the band 6 560-6 640 MHz				+	1.14.e
1.14.f	a commitment that the e.i.r.p. density per HAPS in the frequency bands 21.2-21.4 GHz and 22.21-22.5 GHz does not exceed −0.76 θ – 9.5 dB(W/100 MHz) for angles of arrival between −4.53° and 35.5° and −36.5 dB(W/100MHz) for angles of arrival between 35.5° and 90° (see Resolution **165 (Rev.WRC-23)**) Required in the frequency band 21.4-22 GHz			+		1.14.f
1.14.g	a commitment that the unwanted emission power flux-density produced by the HAPS does not exceed −176 dB(W/(m² · 290 MHz)) for continuum observations, and −192 dB(W/(m² · 250 kHz)) for spectral line observations in the frequency band 22.21-22.5 GHz at an RAS station location at a height of 50 m (see Resolution **165 (Rev.WRC-23)**) Required in the frequency band 21.4-22 GHz			+		1.14.g
1.14.h	a commitment that, for the purpose of protecting the aeronautical mobile service operating in the frequency band 21.2-21.5 GHz, the e.i.r.p. density per HAPS in the frequency bands 21.4-21.5 GHz does not exceed 17.5 dB(W/100 MHz) (see Resolution **165 (Rev.WRC-23)**) Required in the frequency band 21.4-22 GHz			+		1.14.h

Item identifier	*1 - GENERAL CHARACTERISTICS OF THE HAPS/HIBS*	Transmitting station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.9	Transmitting station in the frequency bands listed in Nos. 5.457, 5.537A, 5.530E, 5.532AA, 5.534A, 5.543B, 5.550D and 5.552A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.457, 5.534A, 5.543B, 5.550D and 5.552A for the application of No. 11.9	Item identifier
1.14.i	a commitment that the e.i.r.p. density per HAPS in the frequency band 23.6-24 GHz does not exceed −0.7714 θ −16.5 dB(W/200 MHz) for angles of arrival between −4.53° and 35° and −43.5 dB(W/200 MHz) for angles of arrival between 35° and 90° (see Resolution **166 (Rev.WRC-23)**) Required in the frequency band 24.25-25.25 GHz			+		1.14.i
1.14.j	a commitment that the power flux-density produced by unwanted emissions from the HAPS does not exceed −177 dB(W/(m² · 400 MHz) for continuum observations and −191 dB(W/(m² · 250 kHz) for spectral line observations in the frequency band 23.6-24 GHz at an RAS station location at the height of 50 m (see Resolution **166 (Rev.WRC-23)**) Required in the frequency band 24.25-25.25 GHz			+		1.14.j
1.14.k	a commitment that the level of unwanted power density into the HAPS ground station antenna in the frequency band 31.3-31.8 GHz does not exceed −83 dB(W/200 MHz) under clear-sky conditions and may be increased under rainy conditions to mitigate fading due to rain, provided that the effective impact on the passive satellite does not exceed the impact under clear-sky conditions (see Resolution **167 (Rev.WRC-23)**) Required in the frequency band 31-31.3 GHz				+	1.14.k
1.14.l	a commitment that the e.i.r.p. density per HAPS in the frequency band 31.3-31.8 GHz does not exceed −θ − 13.1 dB(W/200 MHz) for angles of arrival between −4.53° and 22° and −35.1 dB(W/200 MHz) for angles of arrival between 22° and 90° (see Resolution **167 (Rev.WRC-23)**) Required in the frequency band 31-31.3 GHz			+		1.14.l

Item identifier	*1 – GENERAL CHARACTERISTICS OF THE HAPS/HIBS*	Transmitting station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.9	Transmitting station in the frequency bands listed in Nos. 5.457, 5.537A, 5.530E, 5.532AA, 5.534A, 5.543B, 5.550D and 5.552A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.457, 5.534A, 5.543B, 5.550D and 5.552A for the application of No. 11.9	Item identifier
1.14.m	a commitment that the power flux-density produced by unwanted emissions from the HAPS ground station does not exceed −141 dB(W/(m² · 500 MHz) in the frequency band 31.3-31.8 GHz at an RAS station location at the height of 50 m (see Resolution **167 (Rev.WRC-23)**) Required in the frequency band 31-31.3 GHz				+	1.14.m
1.14.n	a commitment that the power flux-density produced by unwanted emissions from the HAPS does not exceed −171 dB(W/(m² · 500 MHz) in the frequency band 31.3-31.8 GHz at an RAS station location at the height of 50 m (see Resolution **167 (Rev.WRC-23)**) Required in the frequency band 31-31.3 GHz			+		1.14.n
1.14.o	a commitment that the space research service (space-to-Earth) protection level of −217 dB(W/Hz) at the input of SRS receiver in the frequency band 37.0-38.0 GHz band with 0.001% exceedance due to atmospheric and precipitation effects, as referred to in the relevant ITU-R Recommendations, is not exceeded (see Resolution **168 (Rev.WRC-23)**) Required in the frequency band 38-39.5 GHz			+	+	1.14.o
1.14.p	A commitment that the HAPS operation shall be in conformity with the Radio Regulations, including this Resolution (see Resolution **168 (Rev.WRC-23)**) Required in the frequency band 38-39.5 GHz			+	+	1.14.p
1.14.q	a commitment that, upon receiving an unacceptable interference report with relevant justification on the exceedance of the limits set in this Resolution, the notifying administration for the HAPS system shall take the required action to eliminate the interference or reduce it an acceptable level (see Resolution **168 (Rev.WRC-23)**) Required in the frequency band 38-39.5 GHz			+	+	1.14.q
1.14.r	a commitment that the separation distance between the nadir of the HAPS and a radio astronomy station operating in the frequency band 48.94-49.04 GHz within the territory of another administration shall exceed 50 km (see Resolution **122 (Rev.WRC-19)**) Required in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz			+		1.14.r

Item identifier	*1 - GENERAL CHARACTERISTICS OF THE HAPS/HIBS*	Transmitting station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.9	Transmitting station in the frequency bands listed in Nos. 5.457, 5.537A, 5.530E, 5.532AA, 5.534A, 5.543B, 5.550D and 5.552A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.457, 5.534A, 5.543B, 5.550D and 5.552A for the application of No. 11.9	Item identifier
	COORDINATION AND AGREEMENT					
1.11.a	the symbol of each administration with which coordination has been successfully effected, including where the agreement is to exceed the limits prescribed in the Radio Regulations Required if coordination is necessary and has been obtained pursuant to the relevant provisions of the Radio Regulations	+	+	+	+	1.11.a
	OPERATING ADMINISTRATION OR AGENCY					
1.12.a	the symbol for the operating agency	**O**	**O**	**O**	**O**	1.12.a
1.12.b	the symbol for the address of the administration responsible for the station and to which communication should be sent on urgent matters regarding interference, quality of emissions and questions referring to the technical operation of the circuit (see Article **15**)	**X**	**X**	**X**	**X**	1.12.b
	REMARKS					
1.13.c	Remarks for assisting the Bureau in processing the notice	**O**	**O**	**O**	**O**	1.13.c

Item identifier	*2 - CHARACTERISTICS TO BE PROVIDED FOR EACH INDIVIDUAL OR COMPOSITE HAPS ANTENNA BEAM*	Transmitting station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.9	Transmitting station in the frequency bands listed in Nos. 5.457, 5.537A, 5.530E, 5.532AA, 5.534A, 5.543B, 5.550D and 5.552A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.457, 5.534A, 5.543B, 5.550D and 5.552A for the application of No. 11.9	Item identifier
	IDENTIFICATION AND DIRECTION OF THE HAPS ANTENNA BEAM					
2.1.a	the identification of the HAPS antenna beam	X	X	X	X	2.1.a
2.1.b	an indicator showing whether the antenna beam, under 2.1.a, is fixed or whether it is steerable and/or reconfigurable	X	X	X	X	2.1.b
2.1.c	an indicator showing whether the HAPS antenna tracks the service area	X		X		2.1.c
2.1.d	an indicator showing whether the antenna beam is individual or composite beam	X	X	X	X	2.1.d
	ANTENNA CHARACTERISTICS					
2.9.e	the height of the antenna above ground level, in metres, in the case of a HAPS transmitting ground station Required for an assignment in the frequency bands shared with space services (space-to-Earth)				+	2.9.e
2.9.f	antenna diameter, in metres, in the case of a HAPS transmitting ground station Required in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz				+	2.9.f
2.9.g	the maximum co-polar isotropic gain	X	X	X	X	2.9.g
2.9.j	the measured radiation pattern of the antenna, the reference radiation pattern or the symbols in standard references to be used for coordination	X	X	X	X	2.9.j
2.9.gp	the co-polar antenna gain contours plotted on a map of the Earth's surface, preferably in a radial projection from the HAPS onto a plane perpendicular to the axis from the centre of the Earth to the HAPS The HAPS antenna gain contours shall be drawn as isolines of the isotropic gain, relative to the maximum antenna gain, when any of these contours is located either totally or partially outside the territory of the notifying administration The antenna gain contours shall include the effects of the planned longitudinal and latitudinal tolerance, planned altitudinal tolerance and the pointing accuracy of the antenna, taking into consideration the movement of the HAPS antenna boresight around the effective boresight area	X	X	X	X	2.9.gp

Item identifier	*3 - CHARACTERISTICS TO BE PROVIDED FOR EACH FREQUENCY ASSIGNMENT FOR EACH INDIVIDUAL OR COMPOSITE HAPS ANTENNA BEAM*	Transmitting station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.9	Transmitting station in the frequency bands listed in Nos. 5.457, 5.537A, 5.530E, 5.532AA, 5.534A, 5.543B, 5.550D and 5.552A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.457, 5.534A, 5.543B, 5.550DB and 5.552A for the application of No. 11.9	Item identifier
	ASSIGNED FREQUENCY					
3.1.a	the assigned frequency, as defined in No. **1.148**	**X**	**X**	**X**	**X**	3.1.a
3.1.b	the reference frequency, as defined in Article **1** Required if the modulation envelope is asymmetric	+	+	+	+	3.1.b
	DATE OF OPERATION					
3.2.c	the date (actual or foreseen, as appropriate) of bringing the frequency assignment (new or modified) into use	**X**	**X**	**X**	**X**	3.2.c
	LOCATION OF THE ASSOCIATED ANTENNA(S)					
3.5.c	the geographical coordinates of the ground station(s) in the fixed service Required in the frequency bands 6 560-6 640 MHz and 25.25-27 GHz, 31-31.3 GHz, and 38-39.5 GHz; Required in the other frequency bands, if neither the geographical coordinates of a given zone (3.5.c.a) nor a geographical area (3.5.d) nor a circular area (3.5.e and 3.5.f) are provided			+	+	3.5.c
	For an area in which associated transmitting/receiving ground station(s) operate:					
3.5.c.a	the geographical coordinates of a given zone A minimum of six geographical coordinates are required, in degrees, minutes and seconds *Note* – For the fixed service in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz the geographical coordinates are provided for each of the UAC, SAC and if applicable RAC (see the most recent version of Recommendation ITU-R F.1500) Required if neither a circular area (3.5.e and 3.5.f) nor a geographical area (3.5.d) are provided	+	+	+	+	3.5.c.a
3.5.d	the code of the geographical area (see the Preface) *Note* – For the fixed service in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz separate geographical areas are provided for each of the UAC, SAC and if applicable RAC (see the most recent version of Recommendation ITU-R F.1500) Required if neither a circular area (3.5.e and 3.5.f) nor the geographical coordinates of a given zone (3.5.c.a) are provided	+	+	+	+	3.5.d

Item identifier	*3 - CHARACTERISTICS TO BE PROVIDED FOR EACH FREQUENCY ASSIGNMENT FOR EACH INDIVIDUAL OR COMPOSITE HAPS ANTENNA BEAM*	Transmitting station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.9	Transmitting station in the frequency bands listed in Nos. 5.457, 5.537A, 5.530E, 5.532AA, 5.534A, 5.543B, 5.550D and 5.552A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.457, 5.534A, 5.543B, 5.550DB and 5.552A for the application of No. 11.9	Item identifier
3.5.e	the geographical coordinates of the centre of the circular area in which the associated ground station(s) are operating The latitude and longitude are provided in degrees, minutes and seconds *Note* – For the fixed service in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz different centres of the circular area may be provided for the UAC, SAC and if applicable RAC (see the most recent version of Recommendation ITU-R F.1500) Required if neither a geographical area (3.5.d) or geographical coordinates of a given zone (3.5.c.a) are provided	+	+	+	+	3.5.e
3.5.f	the radius, in km, of the circular area *Note* – For the fixed service in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz, a separate radius is provided for each of the UAC, SAC and if applicable RAC (see the most recent version of Recommendation ITU-R F.1500) Required if neither a geographical area (3.5.d) nor geographical coordinates of a given zone (3.5.c.a) are provided	+	+	+	+	3.5.f
	CLASS OF STATION AND NATURE OF SERVICE					
3.6.a	the class of station, using the symbols from the Preface	**X**	**X**	**X**	**X**	3.6.a
3.6.b	the nature of service, using the symbols from the Preface	**X**	**X**	**X**	**X**	3.6.b
	CLASS OF EMISSION AND NECESSARY BANDWIDTH *(in accordance with Article **2** and Appendix **1**)*					
3.7.a	the class of emission	**X**	**X**	**X**	**X**	3.7.a
3.7.b	the necessary bandwidth	**X**	**X**	**X**	**X**	3.7.b
	POWER CHARACTERISTICS OF THE TRANSMISSION					
3.8	the symbol (X, Y or Z, as appropriate) describing the type of power (see Article **1**) corresponding to the class of emission	**X**	**X**	**X**	**X**	3.8
3.8.b	the radiated power, in dBW, in one of the forms described in Nos. **1.161** to **1.163** *Note* – For a receiving HAPS, the radiated power refers to the associated transmitting mobile station(s)		**X**			3.8.b

Item identifier	*3 - CHARACTERISTICS TO BE PROVIDED FOR EACH FREQUENCY ASSIGNMENT FOR EACH INDIVIDUAL OR COMPOSITE HAPS ANTENNA BEAM*	Transmitting station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.312B, 5.314A, 5.388A and 5.409A for the application of No. 11.9	Transmitting station in the frequency bands listed in Nos. 5.457, 5.537A, 5.530E, 5.532AA, 5.534A, 5.543B, 5.550D and 5.552A for the application of No. 11.2	Receiving station in the frequency bands listed in Nos. 5.457, 5.534A, 5.543B, 5.550DB and 5.552A for the application of No. 11.9	Item identifier
3.8.aa	the power delivered to the antenna, in dBW, excluding the level of power control in 3.8.BA under clear-sky conditions *Note* – For a receiving HAPS, the power delivered to the antenna refers to the associated transmitting ground station(s)	X		X	X	3.8.aa
3.8.AB	the power density[1] averaged over the worst 1 MHz band delivered to the antenna under clear-sky conditions	X		X		3.8.AB
3.8.BA	the range of power control, in dB *Note* – For a receiving HAPS, the power control refers to its use by the associated transmitting ground station(s) In the case of a transmitting HAPS, required in the frequency bands, 21.4-22 GHz, 24.25-25.25 GHz, 27-27.5 GHz, 31-31.3 GHz, 38-39.5 GHz, 47.2-47.5 GHz and 47.9-48.2 GHz In the case of a receiving HAPS, required in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz	X		+	+	3.8.BA
	POLARIZATION AND RECEIVING SYSTEM NOISE TEMPERATURE					
3.9.d	the code indicating the type of polarization (see the Preface)	X	X	X	X	3.9.d
3.9.j	the reference radiation pattern of the associated ground station(s) Required in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz			+	+	3.9.j
3.9.k	the lowest total receiving system noise temperature, in kelvins, referred to the output of the receiving antenna		X		X	3.9.k
	HOURS OF OPERATION					
3.10.b	the regular hours of operation (in hours and minutes from ... to ...) of the frequency assignment, in UTC	X	X	X	X	3.10.b

ANNEX 2

Characteristics of satellite networks, earth stations or radio astronomy stations[2] (Rev.WRC-12)

Information relating to the data listed in the following Tables

In many cases the data requirements involve the use of standard symbols in submissions to the Radiocommunication Bureau. These standard symbols may be found in the "Preface to the BR International Frequency Information Circular", (BR IFIC) (Space Services), the ITU-R webpage and the Space Radiocommunication Stations on DVD-ROM. (In the Table, this is referred to simply as "the Preface".) Information relating to the provision of data may also be found in ITU-R Recommendations, for example, information on the mask data can be found in the most recent version of Recommendation ITU-R S.1503, and the most recent version of Recommendation ITU-R SM.1413 provides general information related to submission of data.

Key to the symbols used in Tables A, B, C and D

X	Mandatory information
+	Mandatory under the conditions specified in Column 2
O	Optional information
C	Mandatory if used as a basis to effect coordination with another administration
	The data item is not applicable to the corresponding notice

[2] The Radiocommunication Bureau shall develop and keep up-to-date forms of notice to meet fully the statutory provisions of this Appendix and related decisions of future conferences. Additional information on the items listed in this Annex together with an explanation of the symbols is to be found in the Preface to the BR IFIC (Space Services). (WRC-12)

Reading the Appendix 4 Tables

The rules used to link the sign with the text are based on the Table column headings covering specific procedures and specific services.

1 If any data item has a condition attached to it, then it has a "+".

A.6.c	if agreement has been reached, the related provision code (see the Preface)	+	A.6.c

C.8.f.1	the space station's nominal equivalent isotropically radiated power(s) (e.i.r.p.) on the beam axis Required only for a space-to-space link	+	C.8.f.1

2 Data items grouped under a common subheading that limits the range of procedures, services or frequency bands have a "X" as the conditional nature is shown in the subheading title.

A.4.b.5	**For space stations operating in a frequency band subject to the provisions of Nos. 9.11A, 9.12 or 9.12A, the data elements to characterize properly the orbital statistics of the non-geostationary-satellite system:**	**X**	A.4.b.5
A.4.b.5.a	the right ascension of the ascending node (Ω_j) for the j-th orbital plane, measured counter-clockwise in the equatorial plane from the direction of the vernal equinox to the point where the satellite makes its South-to-North crossing of the equatorial plane ($0° \leq \Omega_j < 360°$)		A.4.b.5.a

3 "In the case of", followed by a reference to the column heading, is used as shown below when the associated conditions are different for individual columns, or if the indication is not the same across all applicable columns.

A.3.a	the symbol for the operating administration or agency (see the Preface) that is in operational control of the space station, earth station or radio astronomy station In the case of Appendix **30B**, required only for notification under Article 8	**X**	+	A.3.a

Footnotes to Tables A, B, C and D

1 Not required for coordination under No. **9.7A**.

2 In calculating the maximum power density per Hz, see the most recent version of Recommendation ITU-R SF.675. For carriers below 15 GHz, the power density is averaged over the worst 4 kHz band. For carriers at or above 15 GHz, the power density is averaged over the worst 1 MHz band. (WRC-12)

Table of characteristics to be submitted for space and radio astronomy services
(Rev.WRC-12)

TABLE A

GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION (Rev.WRC-23)

Items in Appendix	*A - GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION*
A.1	**IDENTITY OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIOASTRONOMY STATION**
A.1.a	the identity of the satellite network or system
A.1.b	the beam identification In the case of Appendix **30** or **30A**, required only for modification, suppression or notification of Plan assignments In the case of Appendix **30B**, required only for a network derived from the Allotment Plan
A.1.c	if different from A.1.a, the identity of the satellite network or system containing the service link frequency assignments Required only for frequency assignments to space stations in bands where the use of the allocation is limited to feeder links
A.1.e	**Identity of the earth station or radio astronomy station:**
A.1.e.1	the type of earth station (specific or typical)
A.1.e.2	the name of the station
A.1.e.2*bis*	the country or geographical area in which the station is located, using the symbols from the Preface
A.1.e.3	**For a specific earth station or radio astronomy station:**
A.1.e.3.a	**Not used**
A.1.e.3.b	the geographical coordinates of each transmitting or receiving antenna site constituting the station (latitude and longitude in degrees and minutes) For a specific earth station, seconds are to be provided if the coordination area of the earth station overlaps the territory of another administration
A.1.f	**Administration and intergovernmental organization symbol:**
A.1.f.1	the symbol of the notifying administration (see the Preface)
A.1.f.2	if the notice is submitted by the notifying administration in association with other administrations, the symbols of each of the administrations (see the Preface)
A.1.f.3	if the notice is submitted on behalf of an intergovernmental satellite organization, the symbol of that organization (see the Preface)
A.1.g	indicator showing that the non-GSO satellite system is planned to be operated in accordance with Resolution **32 (Rev.WRC-23)** Required for advance publication and notification
A.1.g.1	**Not used**
A.1.g.2	**Not used**

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								A.1	
X	X	X	X		X	X	X	A.1.a	
					+	+	+	A.1.b	
	+	+	+					A.1.c	
								A.1.e	
				X				A.1.e.1	
				X				A.1.e.2	X
				X				A.1.e.2*bis*	X
								A.1.e.3	
								A.1.e.3.a	
				X				A.1.e.3.b	X
								A.1.f	
X	X	X	X	X	X	X	X	A.1.f.1	X
+	+	+	+		+	+	+	A.1.f.2	
+	+	+	+		+	+	+	A.1.f.3	
	X		+					A.1.g	
								A.1.g.1	
								A.1.g.2	

Items in Appendix	*A - GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION*
A.2	**DATE OF BRINGING INTO USE**
A.2.a	the date (actual or foreseen, as appropriate) of bringing the frequency assignment (new or modified) into use For a frequency assignment to a GSO space station, including frequency assignments in Appendices **30**, **30A** and **30B**, and for a frequency assignment to an Appendix **30B** ESIM, the date of bringing into use is as defined in Nos. **11.44B** and **11.44.2** For a frequency assignment to a non-GSO space station, the date of bringing into use is as defined in Nos. **11.44C**, **11.44D**, **11.44E** and **11.44.2**, as applicable For a frequency assignment to a non-GSO satellite system with a short-duration mission, the date of bringing into use is as defined in Resolution **32 (Rev.WRC-23)** Whenever the assignment is changed in any of its basic characteristics (except for a change under A.1.a), the date to be given shall be that of the latest change (actual or foreseen, as appropriate) Required only for notification and, in the case of Appendices **30** and **30A**, also for simultaneous submissions for modifications to the Region 2 Plan or entry into the Regions 1 and 3 List under Article 4 and notification under Article 5, and, in the case of Appendix **30B**, also for simultaneous submissions for entry into the List under § 6.17 and notification under § 8.1 and, in the case of an Appendix **30B** ESIM, also for simultaneous submissions for entry in the Appendix **30B** ESIM List and notification under Section A and Section B, respectively, of Part 1 of Annex 1 to Resolution **121 (WRC-23)**
A.2.b	for a space station, the period of validity of the frequency assignments (see Resolution **4 (Rev.WRC-03)** and Resolution **32 (Rev.WRC-23)**, as appropriate)
A.2.c	the date (actual or foreseen, as appropriate) on which reception of the frequency band begins or on which any of the basic characteristics are modified
A.3	**OPERATING ADMINISTRATION OR AGENCY**
A.3.a	the symbol for the operating administration or agency (see the Preface) that is in operational control of the space station, earth station or radio astronomy station
A.3.b	the symbol for the address of the administration (see the Preface) to which communication should be sent on urgent matters regarding interference, quality of emissions and questions referring to the technical operation of the network or system or station (see Article **15**)
A.4	**ORBITAL INFORMATION**
A.4.a	**For a space station onboard a geostationary-satellite:**
A.4.a.1	the nominal geographical longitude on the geostationary-satellite orbit (GSO)
A.4.a.2	**Orbital tolerances**
A.4.a.2.a	the planned longitudinal tolerance easterly limit
A.4.a.2.b	the planned longitudinal tolerance westerly limit
A.4.a.2.c	the planned inclination excursion
A.4.a.4	**Not used**
A.4.a.4.a	**Not used**
A.4.a.4.b	**Not used**

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								A.2	
		+	+	+	+	+	+	A.2.a	
	X	X	X					A.2.b	
								A.2.c	X
								A.3	
	X	X	X	X	X	X	X	A.3.a	X
	X	X	X	X	X	X	X	A.3.b	X
								A.4	
								A.4.a	
X		X			X	X	X	A.4.a.1	
								A.4.a.2	
		X			X	X	X	A.4.a.2.a	
		X			X	X	X	A.4.a.2.b	
		X					X	A.4.a.2.c	
								A.4.a.4	
								A.4.a.4.a	
								A.4.a.4.b	

Items in Appendix	*A - GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION*
A.4.b	**For space station(s) onboard non-geostationary satellite(s):**
A.4.b.1	the reference body code
A.4.b.2	the number of orbital planes
A.4.b.3	**For space station(s), where the Earth is the reference body:**
A.4.b.3.a	indicator of whether the non-geostationary-satellite system represents a "constellation", where the term "constellation" describes a satellite system, for which the relative distribution of the orbital planes and satellites is defined *Note* – Non-geostationary-satellite systems in frequency bands subject to the provisions of No. **9.12** or **9.12A** are considered as "constellations" only when they include more than one satellite. However, if subject to No. **22.5C**, **22.5D**, **22.5F** or **22.5L**, they are always considered as "constellations"
A.4.b.3.b	indicator of whether all the orbital planes identified under A.4.b.2 describe a) a single configuration where all frequency assignments to the satellite system will be in use or b) multiple configurations that are mutually exclusive where a sub-set of the frequency assignments to the satellite system will be in use on one of the sub-sets of orbital parameters to be determined at the notification and recording stage of the satellite system Required only for the: 1) advance publication information for a non-geostationary-satellite system representing a constellation (A.4.b.3.a), and 2) coordination request for non-geostationary-satellite systems
A.4.b.3.c	if the orbital planes identified under A.4.b.2 describe multiple mutually exclusive configurations, identification of the number of sub-sets of orbital characteristics that are mutually exclusive Required only for the: 1) advance publication information for a non-geostationary-satellite system representing a constellation (A.4.b.3.a), and 2) coordination request for non-geostationary-satellite systems
A.4.b.3.d	if the orbital planes identified under A.4.b.3.b describe multiple mutually exclusive configurations, identification of the orbital planes' id numbers that are associated with each of the mutually exclusive configurations Required only for the: 1) advance publication information for a non-geostationary-satellite system representing a constellation (A.4.b.3.a), and 2) coordination request for non-geostationary-satellite systems
A.4.b.3.e	**For space stations of a non-geostationary fixed-satellite service system operating in the frequency band 3 400-4 200 MHz:**
A.4.b.3.e.1	the maximum number of space stations (N_N) in a non-geostationary-satellite system simultaneously transmitting on a co-frequency basis in the fixed-satellite service in the Northern Hemisphere
A.4.b.3.e.2	the maximum number of space stations (N_S) in a non-geostationary-satellite system simultaneously transmitting on a co-frequency basis in the fixed-satellite service in the Southern Hemisphere

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								A.4.b	
	X		X					A.4.b.1	
	X		X					A.4.b.2	
								A.4.b.3	
	X		X					A.4.b.3.a	
	+		+					A.4.b.3.b	
	+		+					A.4.b.3.c	
	+		+					A.4.b.3.d	
								A.4.b.3.e	
	X		X					A.4.b.3.e.1	
	X		X					A.4.b.3.e.2	

Items in Appendix	*A - GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION*
A.4.b.4	**For each orbital plane, where the Earth is the reference body:**
A.4.b.4.a	the angle of inclination (i_j) of the orbital plane with respect to the Earth's equatorial plane ($0° \leq i_j < 180°$)
A.4.b.4.b	the number of satellites in the orbital plane
A.4.b.4.c	the period
A.4.b.4.d	the altitude, in kilometres, of the apogee of the space station
A.4.b.4.e	the altitude, in kilometres, of the perigee of the space station
A.4.b.4.f	the minimum altitude of the space station above the surface of the Earth at which any satellite transmits
A.4.b.4.g	**Not used**
A.4.b.4.h	the initial phase angle (ω_i) of the *i*-th satellite in its orbital plane at reference time $t = 0$, measured from the point of the ascending node ($0° \leq \omega_i < 360°$) Required only in the case of a non-geostationary-satellite system representing a "constellation" (A.4.b.3.a), and to be specified in: 1) the advance publication information, for any frequency assignment not subject to the provisions of Section II of Article **9** 2) the coordination request, for any frequency assignment subject to the provisions of Nos. **9.12**, **9.12A**, **22.5C**, **22.5D**, **22.5F** or **22.5L** 3) the notification, in all cases *Note* – The initial phase angle is the argument of perigee plus the true anomaly
A.4.b.4.i	the argument of perigee (ω_p), measured in the orbital plane, in the direction of motion, from the ascending node to the perigee ($0° \leq \omega_p < 360°$) Required only when the altitudes of apogee and perigee (A.4.b.4.d and A.4.b.4.e) are different, and to be specified in: 1) the advanced publication information, for any frequency assignment not subject to the provisions of Section II of Article **9** 2) the coordination request, for any frequency assignment subject to the provisions of Nos. **9.12**, **9.12A**, **22.5C**, **22.5D**, **22.5F** or **22.5L** 3) the notification, in all cases
A.4.b.4.j	the longitude of the ascending node (θ_j) for the *j*-th orbital plane, measured counter-clockwise in the equatorial plane from the Greenwich meridian to the point where the satellite orbit makes its South-to-North crossing of the equatorial plane ($0° \leq \theta_j < 360°$) at the reference time $t = 0$ Required only for orbits of a "constellation" (A.4.b.3.a), and to be specified in: 1) the advance publication information, for any frequency assignment not subject to the provisions of Section II of Article **9** 2) the coordination request, for any frequency assignment subject to the provisions of Nos. **9.12**, **9.12A**, **22.5C**, **22.5D**, **22.5F** or **22.5L** 3) the notification, in all cases

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								A.4.b.4	
	X		X					A.4.b.4.a	
	X		X					A.4.b.4.b	
	X		X					A.4.b.4.c	
	X		X					A.4.b.4.d	
	X		X					A.4.b.4.e	
	X		X					A.4.b.4.f	
								A.4.b.4.g	
	+		+					A.4.b.4.h	
	+		+					A.4.b.4.i	
	+		+					A.4.b.4.j	

Items in Appendix	*A - GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION*
A.4.b.4.k	**Not used**
A.4.b.4.l	**Not used**
A.4.b.4.m	indicator of whether the space station uses sun-synchronous orbit or not Required only in frequency bands not subject to the provisions of Nos **9.12** or **9.12A**
A.4.b.4.n	if the space station uses sun-synchronous orbit (A.4.b.4.m), indicator of whether the space station references the local time of the ascending node (solar local time when the space station is crossing the equatorial plane in the South-North direction in hours:minutes format) or the descending node (solar local time when the space station is crossing the equatorial plane in the North-South direction in hours:minutes format)
A.4.b.4.o	if the space station uses sun-synchronous orbit (A.4.b.4.m), the local time of the ascending (or descending, per A.4.b.4.n) node (solar local time when the space station is crossing the equatorial plane in the South-North (or North-South) direction in hours:minutes format)
A.4.b.4.p	an indicator (Y/N) of whether the space station uses station-keeping to maintain the altitudes of the apogee and perigee during its operational lifetime
A.4.b.4.q	for non-GSO satellite networks for which the indicator provided under A.4.b.4.p above is “N”, the altitude of the apogee and perigee (km) as a function of the time (days) beginning from the date of bringing into use for all orbital planes with different orbital characteristics
A.4.b.4.r	the distance to the apogee of the space station (distance, in kilometres, between the apogee of the space station and the centre of the Earth) Required only for FSS, BSS or MSS systems subject to Resolution **8 (WRC-23)**
A.4.b.4.s	the distance to the perigee of the space station (distance, in kilometres, between the perigee of the space station and the centre of the Earth) Required only for FSS, BSS or MSS systems subject to Resolution **8 (WRC-23)**
A.4.b.5	**Not used**
A.4.b.6	**For space stations operating in a frequency band subject to Nos. 22.5C, 22.5D, 22.5F or 22.5L, additional data elements to characterize properly the orbital operation of the non-geostationary-satellite system:**
A.4.b.6*bis*	an indicator showing whether the set of operating parameters is provided in A.14.d (extended set of operating parameters) or provided in A.4.b.6.a and A.4.b.7 (limited set of operating parameters)
A.4.b.6.a	**For each range of latitudes:** the limited set of operating parameters
A.4.b.6.a.1	the maximum number of non-geostationary satellites transmitting with overlapping frequencies to a given location
A.4.b.6.a.2	the associated start of the latitude range
A.4.b.6.a.3	the associated end of the latitude range

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								A.4.b.4.k	
								A.4.b.4.l	
	+		+					A.4.b.4.m	
	O		O					A.4.b.4.n	
	O		O					A.4.b.4.o	
			X					A.4.b.4.p	
			O					A.4.b.4.q	
			+					A.4.b.4.r	
			+					A.4.b.4.s	
								A.4.b.5	
								A.4.b.6	
			X					A.4.b.6*bis*	
								A.4.b.6.a	
			+					A.4.b.6.a.1	
			+					A.4.b.6.a.2	
			+					A.4.b.6.a.3	

Items in Appendix	*A - GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION*
A.4.b.6.b	**Not used**
A.4.b.6.c	an indicator showing whether the space station uses station-keeping to maintain a repeating ground track
A.4.b.6.d	if the space station uses station-keeping to maintain a repeating ground track, the time in seconds that it takes for the constellation to return to its starting position, i.e. such that all satellites are in the same location with respect to the Earth and each other
A.4.b.6.e	an indicator showing whether the space station should be modelled with a specific precession rate of the ascending node of the orbit instead of the J_2 term
A.4.b.6.f	if the space station is to be modelled with a specific precession rate of the ascending node of the orbit instead of the J_2 term, the precession rate in degrees/day, measured counter-clockwise in the equatorial plane
A.4.b.6.g	**Not used**
A.4.b.6.h	**Not used**
A.4.b.6.i	**Not used**
A.4.b.6.j	the longitudinal tolerance of the longitude of the ascending node
A.4.b.7	**For space stations operating in a frequency band subject to Nos. 22.5C, 22.5D, 22.5F or 22.5L, the data elements to characterize properly the performance of the non-geostationary-satellite system: to be provided, if A.4.b.6*bis* indicates the limited set of operating parameters**
A.4.b.7.a	the maximum number of non-geostationary satellites receiving simultaneously with overlapping frequencies from the associated earth stations within a given cell
A.4.b.7.b	the average number of associated earth stations with overlapping frequencies per square kilometre within a cell
A.4.b.7.c	the average distance, in kilometres, between co-frequency cells
A.4.b.7.c*bis*	the minimum elevation angle at which any associated earth station can transmit to or receive from a non-geostationary satellite
A.4.b.7.d	**For the exclusion zone about the geostationary-satellite orbit:**
A.4.b.7.d.1	the type of zone (based on topocentric angle or satellite-based angle for establishing the exclusion zone)
A.4.b.7.d.2	if the zone is based on a topocentric angle or a satellite-based angle, the width of the zone, in degrees
A.4.b.7.d.3	**Not used**
A.4.c	**For an earth station:**
A.4.c.1	the identity of the associated space station(s) with which communication is to be established
A.4.c.2	if communication is to be established with a geostationary space station, its orbital position
A.5	**COORDINATIONS**
A.5.a.1	the symbol of any administration (see the Preface) with which coordination has been successfully effected Required only for notification
A.5.a.1.a	the name of satellite network or system with which coordination has been successfully effected for all notified assignments

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								A.4.b.6.b	
			X					A.4.b.6.c	
			+					A.4.b.6.d	
			X					A.4.b.6.e	
			+					A.4.b.6.f	
								A.4.b.6.g	
								A.4.b.6.h	
								A.4.b.6.i	
			X					A.4.b.6.j	
								A.4.b.7	
			+					A.4.b.7.a	
			+					A.4.b.7.b	
			+					A.4.b.7.c	
			+					A.4.b.7.c*bis*	
								A.4.b.7.d	
			+					A.4.b.7.d.1	
			+					A.4.b.7.d.2	
								A.4.b.7.d.3	
								A.4.c	
				X				A.4.c.1	
				+				A.4.c.2	
								A.5	
		+	+	+[1]				A.5.a.1	
		O						A.5.a.1.a	

Items in Appendix	*A - GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION*
A.5.a.2	the symbol of any intergovernmental organization (see the Preface) with which coordination has been successfully effected Required only for notification
A.5.a.2.a	the name of satellite network or system with which coordination has been successfully effected for all notified assignments
A.5.b.1	the symbol of any administration (see the Preface) with which coordination has been sought but not completed
A.5.b.2	the symbol of any intergovernmental organization (see the Preface) with which coordination has been sought but not completed
A.5.c	if either A.5.a.1 (and A.5.a.2) or A.5.b.1 (and A.5.b.2) has been supplied, the related provision code (see the Preface) under which coordination has been sought or completed
A.6	**AGREEMENTS**
A.6.a	if appropriate, the symbol of any administration or administration representing a group of administrations (see the Preface) with which agreement has been reached, including where the agreement is to exceed the limits prescribed in these Regulations
A.6.a.1	the name of satellite network or system with which agreement has been reached for all notified assignments
A.6.b	if appropriate, the symbol of any intergovernmental organization (see the Preface) with which agreement has been reached, including where the agreement is to exceed the limits prescribed in these Regulations
A.6.b.1	the name of satellite network or system with which agreement has been reached for all notified assignments
A.6.c	if agreement has been reached, the related provision code (see the Preface)
A.7	**SPECIFIC EARTH STATION OR RADIO ASTRONOMY STATION SITE CHARACTERISTICS**
A.7.a	horizon elevation angle and distance
A.7.a.1	the horizon elevation angle, in degrees, for each azimuth around the earth station
A.7.a.2	the distance, in kilometres, from the earth station to the horizon for each azimuth around the earth station
A.7.b	minimum/maximum antenna main beam elevation
A.7.b.1	the planned minimum angle of elevation of the antenna's main beam axis, in degrees, from the horizontal plane For determining the minimum elevation angle of an earth station, due regard should be given to possible inclined-orbit operation of the associated geostationary space station Required only for earth stations operating with geostationary satellite
A.7.b.2	the planned maximum angle of elevation of the antenna's main beam axis, in degrees, from the horizontal plane Required only for earth stations operating with geostationary satellite

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
		+	+	+[1]				A.5.a.2	
		O						A.5.a.2.a	
		O	O	O				A.5.b.1	
		O	O					A.5.b.2	
		+	+	+[1]				A.5.c	
								A.6	
		+	+	+[1]	+	+	+	A.6.a	
		O						A.6.a.1	
		+	+	+[1]	+	+	+	A.6.b	
		O						A.6.b.1	
		+	+	+[1]	+	+	+	A.6.c	
								A.7	
								A.7.a	
				+[1]				A.7.a.1	
				O				A.7.a.2	
								A.7.b	
				+[1]				A.7.b.1	X
								A.7.b.2	X

Items in Appendix	*A - GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION*
A.7.c	operating azimuths of antenna main beam
A.7.c.1	the start azimuth for the planned range of operating azimuthal angles for the antenna's main beam axis, in degrees, clockwise from True North For determining the start azimuth of an earth station, due regard should be given to possible inclined-orbit operation of the associated geostationary space station Required only for earth stations operating with geostationary satellite
A.7.c.2	the end azimuth for the planned range of operating azimuthal angles for the antenna's main beam axis, in degrees, clockwise from True North For determining the end azimuth of an earth station, due regard should be given to possible inclined-orbit operation of the associated geostationary space station Required only for earth stations operating with geostationary satellite
A.7.d	the altitude, in metres, of the antenna above mean sea level
A.7.e	the minimum angle of elevation of the antenna's main beam axis, in degrees, from the horizontal plane for each azimuth around the earth station Required only for earth stations operating with non-geostationary space stations
A.7.f	the antenna diameter, in metres Required only for fixed-satellite service earth stations operating in the frequency bands 13.75-14 GHz, 14.5-14.75 GHz (in countries listed in Resolution **163 (WRC-15)** not for feeder links for the broadcasting-satellite service), 14.5-14.8 GHz (in countries listed in Resolution **164 (WRC-15)** not for feeder links for the broadcasting-satellite service), 24.65-25.25 GHz (Region 1) and 24.65-24.75 GHz (Region 3)
A.8	**Not used**
A.9	**Not used**
A.10	**EARTH STATION COORDINATION AREA DIAGRAMS**
A.10.a	the diagrams shall be drawn to an appropriate scale, indicating, for both transmission and reception, the location of the earth station and its associated coordination areas, or the coordination area related to the service area in which it is intended to operate the mobile earth station Required only for notification
A.11	**REGULAR HOURS OF OPERATION**
A.11.a	the start time UTC
A.11.b	the stop time UTC
A.12	**RANGE OF AUTOMATIC GAIN CONTROL, in dB**

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								A.7.c	
				+ [1]				A.7.c.1	X
				+ [1]				A.7.c.2	X
				+ [1]				A.7.d	
				+				A.7.e	
				+ [1]				A.7.f	
								A.8	
								A.9	
								A.10	
				+				A.10.a	
								A.11	
					X	X		A.11.a	
					X	X		A.11.b	
						X		**A.12**	

Items in Appendix	*A - GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION*
A.13	**REFERENCES TO THE PUBLISHED SPECIAL SECTIONS OF THE BUREAU'S INTERNATIONAL FREQUENCY INFORMATION CIRCULAR (see the Preface)**
A.13.a	the reference and number of the advance publication information in accordance with No. **9.1**
A.13.b	the reference and number of the coordination request in accordance with No. **9.6** For the notification of an earth station, the reference to the Special Section of the associated satellite network or system has to be provided For the notification of an earth station coordinated under No. **9.7A**, the coordination Special Section number of this earth station has to be provided
A.13.c	the reference and number of the information in accordance with Article 4 of Appendix **30**
A.13.d	the reference and number of the information in accordance with Article 4 of Appendix **30A**
A.13.e	the reference and number of the information in accordance with Article 6 of Appendix **30B** or, in the case of an Appendix **30B** ESIM, the reference and number of the information in accordance with Resolution **121 (WRC-23)** and the reference to the supporting Appendix **30B** assignment(s)
A.14	**FOR STATIONS OPERATING IN A FREQUENCY BAND SUBJECT TO Nos. 22.5C, 22.5D, 22.5F OR 22.5L: SPECTRUM MASKS**
A.14.a	**For each e.i.r.p. mask used by the non-geostationary space station:**
A.14.a.1	the mask identification code
A.14.a.2	the lowest frequency for which the mask is valid
A.14.a.3	the highest frequency for which the mask is valid
A.14.a.4	the mask pattern defined in terms of the power in the reference bandwidth for a series of angles measured at the non-geostationary space station between the line to the sub-satellite point and the line to a point on the geostationary arc, together with the bandwidth used
A.14.a.5	the reference bandwidth used for the mask pattern of A.14.a.4
A.14.b	**For each associated earth station e.i.r.p. mask:**
A.14.b.1	the mask identification code
A.14.b.2	the lowest frequency for which the mask is valid
A.14.b.3	the highest frequency for which the mask is valid
A.14.b.4	**Not used**
A.14.b.5	**Not used**
A.14.b.6	the mask pattern defined in terms of the power in the reference bandwidth as a function of latitude and the off-axis angle between the non-geostationary earth station boresight line and the line from the non-geostationary earth station to a point on the GSO arc or as a function of latitude, the non-geostationary earth station pointing angles (azimuth, elevation) and the difference in longitude between the non-geostationary earth station and a point on the geostationary arc
A.14.b.7	the reference bandwidth used for the mask pattern of A.14.b.6

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								A.13	
		X	X					A.13.a	
		X	X	X				A.13.b	
					X			A.13.c	
						X		A.13.d	
				X			X	A.13.e	
								A.14	
								A.14.a	
			X					A.14.a.1	
			X					A.14.a.2	
			X					A.14.a.3	
			X					A.14.a.4	
			X					A.14.a.5	
								A.14.b	
			X					A.14.b.1	
			X					A.14.b.2	
			X					A.14.b.3	
								A.14.b.4	
								A.14.b.5	
			X					A.14.b.6	
			X					A.14.b.7	

Items in Appendix	*A - GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION*
A.14.c	**For each pfd mask used by the non-geostationary space station:** *Note* – The space station pfd mask is defined by the maximum power flux-density generated by any space station in the interfering non-geostationary-satellite system as seen from any point on the surface of the Earth
A.14.c.1	the mask identification code
A.14.c.2	the lowest frequency for which the mask is valid
A.14.c.3	the highest frequency for which the mask is valid
A.14.c.4	the type of mask, among one of the following types: (Earth-based exclusion zone angle, difference in longitude, latitude) or (satellite azimuth, satellite elevation, latitude)
A.14.c.5	the mask pattern of the power flux-density defined in three dimensions
A.14.c.6	the reference bandwidth used for the mask pattern of A.14.c.5
A.14.d	**For each set of non-geostationary-satellite system operating parameters** to be provided, if A.4.b.6*bis* indicates the use of an extended set of operating parameters *Note* – There could be different sets of parameters at different frequency bands, but only one set of operating parameters for any frequency band used by the non-geostationary-satellite system
A.14.d.1	the parameter set identification code
A.14.d.2	the lowest frequency for which the mask is valid
A.14.d.3	the highest frequency for which the mask is valid
A.14.d.4	minimum limit of the latitude range of non-geostationary earth station locations in degrees North
A.14.d.5	maximum limit of the latitude range of non-geostationary earth station locations in degrees North
A.14.d.6	the average number of associated earth stations, per km^2, active at the same time
A.14.d.7	the average distance, in kilometres, between co-frequency cell or beam footprint centre
A.14.d.8	the minimum duration, in seconds, during which an earth station will track a non-geostationary satellite without handover for different ranges of latitude
A.14.d.9	the maximum number of co-frequency tracked non-geostationary satellites for different ranges of latitude
A.14.d.10	the exclusion zone angle (degrees), i.e. the minimum angle to the geostationary arc at the non-geostationary earth station at which it will operate, defined at the earth station's given latitude range *Note* – The exclusion zone angle could vary between non-geostationary-satellite system orbit planes. If the identification code of the orbital plane is not defined then it applies to all orbital planes
A.14.d.11	the minimum elevation angle (degrees) of the non-geostationary earth station when it is receiving or transmitting within a given latitude (degrees North) and azimuth (degrees from North) range

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								A.14.c	
			X					A.14.c.1	
			X					A.14.c.2	
			X					A.14.c.3	
			X					A.14.c.4	
			X					A.14.c.5	
			X					A.14.c.6	
								A.14.d	
			+					A.14.d.1	
			+					A.14.d.2	
			+					A.14.d.3	
			+					A.14.d.4	
			+					A.14.d.5	
			+					A.14.d.6	
			+					A.14.d.7	
			+					A.14.d.8	
			+					A.14.d.9	
			+					A.14.d.10	
			+					A.14.d.11	

Items in Appendix	*A – GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION*
A.14.d.12	the minimum angle in degrees at the surface of the Earth between the lines to any two active non-GSO satellites. Assumed to be zero if not provided *Note* – Can only be specified if the minimum track duration in A.14.d.8 is set to zero
A.14.d.13	the minimum angle in degrees at the non-GSO satellite between the lines to any two active non-GSO earth stations. Assumed to be zero if not provided
A.14.d.14	the maximum number of non-geostationary earth stations tracked co-frequency by a non-geostationary satellite. If a value is not provided, it is assumed that the maximum number of earth stations tracked co-frequency by a non-geostationary satellite is equal to the number of earth stations created for the epfd↑ run
A.15	**COMMITMENT REGARDING COMPLIANCE WITH ADDITIONAL OPERATIONAL EQUIVALENT POWER FLUX-DENSITY, epfd↓, LIMITS**
A.15.a	a commitment that the filed for system will meet the additional operational epfd↓ limits that are specified in Table **22-4A1** under No. **22.5I** Required only for non-geostationary-satellite systems operating in the fixed-satellite service in the frequency bands 10.7-11.7 GHz (in all Regions), 11.7-12.2 GHz (Region 2), 12.2-12.5 GHz (Region 3), and 12.5-12.75 GHz (Regions 1 and 3)
A.16	**COMMITMENT REGARDING COMPLIANCE WITH OFF-AXIS POWER LIMITATIONS, POWER FLUX-DENSITY (pfd) LIMITS OR SEPARATION DISTANCE**
A.16.a	a commitment that the associated earth stations operating with a geostationary-satellite network in the fixed-satellite service meet the off-axis power limitations given in Nos. **22.26** to **22.28** or **22.32** (as appropriate) under the conditions specified in Nos. **22.30**, **22.31** and **22.34** to **22.39** Required only for earth stations that are subject to those power limitations
A.16.b	a commitment by administrations that the filed system will meet the single entry power flux-density limits that are specified in No. **5.502** Required only for specific earth station antennas less than 4.5 m in diameter operating with geostationary space stations in the fixed-satellite service in the frequency band 13.75-14 GHz
A.16.c	a commitment by administrations that the earth station associated with the filed system will meet the separation distance as specified in No. **5.509E** and the power flux-density limits that are specified in No. **5.509D** Required only for earth stations of geostationary-satellite networks operating in the fixed-satellite service in the frequency band 14.5-14.8 GHz except feeder links for the broadcasting-satellite service
A.17	**COMPLIANCE WITH POWER FLUX-DENSITY (pfd) LIMITS**
A.17.a	a commitment of compliance with per-satellite power flux-density level produced at the Earth's surface of −129 dB(W/(m^2 · MHz)) in any 1 MHz band under free space propagation conditions Required only for satellite systems operating in the radionavigation-satellite service in the frequency band 1 164-1 215 MHz

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
			O					A.14.d.12	
			O					A.14.d.13	
			O					A.14.d.14	
								A.15	
			+					A.15.a	
								A.16	
		+						A.16.a	
				+				A.16.b	
		+						A.16.c	
								A.17	
		+	+					A.17.a	

Items in Appendix	*A - GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION*
A.17.a*bis*	the equivalent power flux-density (epfd) produced at the site of a radio astronomy station in the frequency band 1 610.6-1 613.8 MHz, as defined in No. **5.372** Required only for non-geostationary-satellite systems operating in the mobile-satellite service (space-to-Earth) in the frequency band 1 613.8-1 626.5 MHz
A.17.b.1	the calculated aggregate power flux-density produced at the Earth's surface by any geostationary radionavigation-satellite system in the frequency band 4 990-5 000 MHz in a 10 MHz bandwidth, as defined in *resolves* 1 of Resolution **741 (Rev.WRC-15)** Required only for geostationary-satellite systems operating in the radionavigation-satellite service in the frequency band 5 010-5 030 MHz
A.17.b.2	the calculated aggregate power flux-density produced at the Earth's surface by all space stations within any radionavigation-satellite service system in the frequency band 5 030-5 150 MHz in a 150 kHz bandwidth, as defined in No. **5.443B** Required only for satellite systems operating in the radionavigation-satellite service in the frequency band 5 010-5 030 MHz
A.17.b.3	the equivalent power flux-density produced at the Earth's surface by all space stations within any non-geostationary radionavigation-satellite service system in the frequency band 4 990-5 000 MHz in a 10 MHz bandwidth, as defined in *resolves* 2 of Resolution **741 (Rev.WRC-15)** Required only for non-geostationary-satellite systems operating in the radionavigation-satellite service in the frequency band 5 010-5 030 MHz
A.17.c	**Not used**
A.17.d	the mean power flux-density produced at the Earth's surface by any spaceborne sensor, as defined in No. **5.549A** for the frequency band 35.5-36 GHz Required only for satellite systems operating in the Earth exploration-satellite service (active) or space research service (active) in the frequency band 35.5-36 GHz
A.17.e.1	the calculated equivalent power flux-density produced at the site of a radio astronomy station in the frequency band 42.5-43.5 GHz, as defined in No. **5.551H** Required only for non-geostationary-satellite systems operating in the fixed-satellite service and broadcasting-satellite service in the frequency band 42-42.5 GHz
A.17.e.2	the calculated power flux-density produced at the site of a radio astronomy station in the frequency band 42.5-43.5 GHz, as defined in No. **5.551I** Required only for geostationary-satellite systems operating in the fixed-satellite service and broadcasting-satellite service in the frequency band 42-42.5 GHz
A.17.f	the calculated power flux-density produced at the site of a radio astronomy station in the frequency band 48.94-49.04 GHz, as defined in No. **5.555B** Required only for geostationary-satellite systems operating in the fixed-satellite service (space-to-Earth) in the frequency bands 48.2-48.54 GHz and 49.44-50.2 GHz

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
			+					A.17.a*bis*	
		+						A.17.b.1	
		+	+					A.17.b.2	
			+					A.17.b.3	
								A.17.c	
		+	+					A.17.d	
			+					A.17.e.1	
		+						A.17.e.2	
		+						A.17.f	

Items in Appendix	*A – GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION*
A.17.g.1	a commitment to observe the limit on equivalent power flux-density (epfd) produced at the site of a radio astronomy station in the frequency band 15.35-15.4 GHz, as defined in *resolves* 1.3 of Resolution **678 (WRC-23)** Required only for non-geostationary-satellite systems operating in the space research service in the frequency band 14.8-15.35 GHz
A.17.g.2	a commitment to observe the limit on power flux-density (pfd) produced at the site of a radio astronomy station in the frequency band 15.35-15.4 GHz, as defined in *resolves* 1.2 of Resolution **678 (WRC-23)** Required only for geostationary-satellite systems operating in the space research service in the frequency band 14.8-15.35 GHz
A.17.h	a commitment of compliance with the per-satellite power flux-density level produced at the Earth's surface of −170 dB(W/(m^2 · 14 kHz)) in any 14 kHz band in the frequency band 137-138 MHz under free-space propagation conditions Required only for out-of-band emissions from space stations operating in the aeronautical mobile-satellite (R) service in the frequency band 117.975-137 MHz
A.18	**COMPLIANCE WITH NOTIFICATION OF AIRCRAFT EARTH STATION(S)**
A.18.a	a commitment that the characteristics of the aircraft earth station (AES) in the aeronautical mobile-satellite service are within the characteristics of the specific and/or typical earth station published by the Bureau for the space station to which the AES is associated Required only for the frequency band 14-14.5 GHz, when an aircraft earth station in the aeronautical mobile-satellite service communicates with a space station in the fixed-satellite service
A.19	**COMPLIANCE WITH § 6.26 OF ARTICLE 6 OF APPENDIX 30B OR WITH OTHER PROVISIONS REFERENCED BY ARTICLE 5**
A.19.a	a commitment that the use of the assignment shall not cause unacceptable interference to, nor claim protection from, those assignments for which agreement still needs to be obtained Required only if the notice is submitted under § 6.25 of Article 6 of Appendix **30B** or under paragraph 20 of Section A of Part 1 of Annex 1 to Resolution **121 (WRC-23)**
A.19.b	a commitment in accordance with *resolves* 1.5 of Resolution **156** (**Rev.WRC-23**) that the administration responsible for the use of the assignment shall implement *resolves* 1.4 of Resolution **156** (**Rev.WRC-23**) Required only for geostationary-satellite networks operating in the fixed-satellite service in the frequency bands 19.7-20.2 GHz and 29.5-30 GHz communicating with transmitting earth stations in motion
A.20	**COMPLIANCE WITH *resolves* 1.1.4 OF RESOLUTION 169 (Rev.WRC-23)**
A.20.a	a commitment that the ESIM operation would be in conformity with the Radio Regulations and Resolution **169 (Rev.WRC-23)** Required only for the notification of earth stations in motion submitted in accordance with Resolution **169 (Rev.WRC-23)**

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
			+					A.17.g.1	
		+						A.17.g.2	
			+					A.17.h	
								A.18	
		+	+					A.18.a	
								A.19	
							+	A.19.a	
		+						A.19.b	
								A.20	
		+						A.20.a	

Items in Appendix	*A - GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION*
A.21	**COMPLIANCE WITH *resolves* 1.2.6 OF RESOLUTION 169 (Rev.WRC-23)**
A.21.a	a commitment that, upon receiving a report of unacceptable interference, the notifying administration for the GSO FSS network with which ESIMs communicate shall follow the procedures in *resolves* 4 of Resolution **169 (Rev.WRC-23)** Required only for the notification of earth stations in motion submitted in accordance with Resolution **169 (Rev.WRC-23)**
A.22	**COMPLIANCE WITH *resolves* 7 OF RESOLUTION 169 (Rev.WRC-23)**
A.22.a	a commitment that aeronautical ESIMs would be in conformity with the pfd limits on the Earth's surface specified in Part II of Annex 3 to Resolution **169 (Rev.WRC-23)** Required only for the notification of earth stations in motion submitted in accordance with Resolution **169 (Rev.WRC-23)**
A.23	**COMPLIANCE WITH RESOLUTION 35 (Rev.WRC-23)**
A.23.a	a commitment stating that the characteristics as modified will not cause more interference or require more protection than the characteristics provided in the latest notification information published in Part I-S of the BR IFIC for the frequency assignments to the non-geostationary-satellite system
A.24	**COMPLIANCE WITH NOTIFICATION OF A NON-GSO SHORT DURATION MISSION**
A.24.a	a commitment by the administration that, in the case that unacceptable interference caused by a non-GSO satellite network or system identified as short-duration mission in accordance with Resolution **32 (Rev.WRC-23)** is not resolved, the administration shall undertake steps to eliminate the interference or reduce it to an acceptable level Required only for notification
A.25	**COMPLIANCE WITH Nos. 22.22 to 22.25**
A.25.a	a commitment by the administration of compliance with Nos. **22.22**, **22.23**, **22.24** and **22.25** Required only for notification of a satellite network or system with 'Moon' as the reference body
A.25.b	a technical or operational description on how the notifying administration intends to ensure compliance with the requirements stipulated in Nos. **22.22** to **22.25**, using, where appropriate, the relevant protection criteria from the ITU-R Recommendations and Reports Required only for notification of a satellite network or system with "Moon" as the reference body
A.26	**FOR A NON-GEOSTATIONARY-SATELLITE NETWORK OR SYSTEM NOT SUBJECT TO COORDINATION UNDER SECTION II OF ARTICLE 9 IN THE FREQUENCY BANDS 7 250-7 750 MHz (SPACE-TO-EARTH), 7 900-8 025 MHz (EARTH-TO-SPACE), 20.2-21.2 GHz (SPACE-TO-EARTH) AND 30-31 GHz (EARTH-TO-SPACE)**
A.26.a	the maximum aggregate e.i.r.p. in a 1 MHz reference bandwidth of associated non-GSO earth stations operating co-frequency of a single non-GSO constellation/configuration towards any point within the geostationary arc Required for advance publication and notification

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								A.21	
		+						A.21.a	
								A.22	
		+						A.22.a	
								A.23	
			O					A.23.a	
								A.24	
			+					A.24a	
								A.25	
			+					A.25.a	
			+					A.25.b	
								A.26	
	+		+					A.26.a	

Items in Appendix	*A - GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION*
A.26.b	the maximum aggregate pfd in a 1 MHz reference bandwidth caused by all non-GSO space stations operating co-frequency towards the same location in a single non-GSO constellation/configuration at any point of the Earth's surface within the visibility area of the GSO Required for advance publication and notification
A.26.c	for the exclusion zone about the geostationary-satellite orbit, the type of zone (based on topocentric angle or satellite-based angle for establishing the exclusion zone) Required for advance publication and notification
A.26.d	for the exclusion zone about the geostationary-satellite orbit, if the zone is based on a topocentric angle or a satellite-based angle, the width of the zone, in degrees Required for advance publication and notification
A.27	**COMPLIANCE WITH RESOLUTION 679 (WRC-23)**
A.27.a	a commitment from the notifying administration of a non-GSO space station receiving in the frequency bands 27.5-28.6 GHz and 29.5-30 GHz that the equivalent power flux-density produced at any point in the geostationary-satellite orbit by emissions from all combined operations of inter-satellite and Earth-to-space links shall not exceed the limits given in Article **22**, Tables **22-1B**, **22-1C** and **22-2** Required only for non-GSO space stations submitted in accordance with Resolution **679 (WRC-23)**
A.27.b	a commitment from the notifying administration of space stations receiving in the frequency band 27.5-30 GHz that, upon receiving a report of unacceptable interference, the notifying administration will follow the procedures in *further resolves* 3 of Resolution **679 (WRC-23)** Required only for non-GSO space stations submitted in accordance with Resolution **679 (WRC-23)**
A.27.c	a commitment of compliance with the per-satellite power flux-density level in the frequency band 19.3-19.7 GHz, as defined in No. **5.523DA** Required only for the notification of space stations submitted in accordance with Resolution **679 (WRC-23)**
A.27.d	the exclusion zone angle in degrees, defined as a minimum angle between the geostationary arc and the inter-satellite link transmitting direction, measured at the non-geostationary transmitting space station Required only for non-geostationary space stations transmitting to another non-geostationary space station in the frequency bands 27.5-28.6 GHz and 29.5-30 GHz
A.27.e	the mask pattern defined in terms of the e.i.r.p. in a 40 kHz bandwidth as a function of the off-axis angle between the non-geostationary transmitting space station boresight line and the line from the non-geostationary transmitting space station to a point on the geostationary-satellite orbit, and as a function of the latitude at nadir of the non-geostationary transmitting space station Required only for non-geostationary space stations transmitting to another non-geostationary space station in the frequency bands 27.5-29.1 GHz and 29.5-30 GHz or non-geostationary space stations transmitting to another geostationary space station in the frequency band 27.5-30 GHz

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
	+		+					A.26.b	
	+		+					A.26.c	
	+		+					A.26.d	
								A.27	
	+		+					A.27.a	
	+		+					A.27.b	
			+					A.27.c	
			+					A.27.d	
			+					A.27.e	

Items in Appendix	*A - GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION*
A.27.f	**COMPLIANCE WITH *resolves* 3.3 OF RESOLUTION 679 (WRC-23)**
A.27.f.1	a commitment by the notifying administration for a non-GSO FSS system with an altitude of apogee of less than 20 000 km communicating with lower orbiting non-GSO space stations in the frequency bands 18.3-18.6 GHz and 18.8-19.1 GHz that the pfd shall be in conformity with the pfd limits on the Earth's surface specified in Annex 3 to Resolution **679 (WRC-23)** Required only for the notification of non-GSO space stations submitted in accordance with Resolution **679 (WRC-23)**
A.28	**COMPLIANCE WITH THE UNWANTED EMISSION LIMIT IN No. 5.550CA**
A.28.a	a commitment by the notifying administration for a non-GSO FSS system with an altitude of the apogee of more than 407 km and less than 2 000 km in the frequency band 37.5-38 GHz that the e.i.r.p. density in the frequency band 36-37 GHz shall be less than −21 dB(W/100 MHz) per space station for angles greater than 65° from nadir relative to the FSS space station Required only for notification
A.29	**COMPLIANCE WITH *resolves* 1.1.2 OF RESOLUTION 121 (WRC-23)**
A.29.a	a commitment that the characteristics of Appendix **30B** ESIMs shall remain within the envelope of typical characteristics of notified Appendix **30B** earth stations associated with the satellite networks with which ESIMs communicate, as published by the Bureau Required only for the notification of earth stations in motion submitted in accordance with Resolution **121 (WRC-23)** Not required for a submission under Appendix **30B**
A.30	**COMPLIANCE WITH *resolves* 1.1.4 OF RESOLUTION 121 (WRC-23)**
A.30.a	a commitment that the Appendix **30B** ESIM operation would be in conformity with the Radio Regulations and Resolution **121 (WRC-23)** Required only for the notification of earth stations in motion submitted in accordance with Resolution **121 (WRC-23)** Not required for a submission under Appendix **30B**
A.31	**COMPLIANCE WITH *resolves* 2.2 OF RESOLUTION 121 (WRC-23)**
A.31.a	a commitment that the Appendix **30B** ESIM operation would be in conformity with *resolves* 2.1 and *further resolves* 2, 2.1 and 2.2 of Resolution **121 (WRC-23)** Required only for the notification of earth stations in motion submitted in accordance with Resolution **121 (WRC-23)** Not required for a submission under Appendix **30B**
A.32	**COMPLIANCE WITH *further resolves* 2 OF RESOLUTION 121 (WRC-23)**
A.32.a	a commitment that, upon receiving a report of unacceptable interference, the notifying administration for the GSO FSS network with which the Appendix **30B** ESIM communicates shall follow the procedures in *resolves* 9 of Resolution **121 (WRC-23)** Required only for the notification of earth stations in motion submitted in accordance with Resolution **121 (WRC-23)** Not required for a submission under Appendix **30B**

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								A.27.f	
			+					A.27.f.1	
								A.28	
			+					A.28.a	
								A.29	
							+	A.29.a	
								A.30	
							+	A.30.a	
								A.31	
							+	A.31.a	
								A.32	
							+	A.32.a	

Items in Appendix	*A - GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION*
A.33	**COMPLIANCE WITH *resolves* 10.5 OF RESOLUTION 121 (WRC-23)**
A.33.a	a point of contact for the purpose of tracing any suspected cases of unacceptable interference from earth stations on aircraft and vessels and to respond immediately to such requests Required only for the notification of earth stations in motion submitted in accordance with Resolution **121 (WRC-23)** Not required for a submission under Appendix **30B**
A.34	**COMPLIANCE WITH *resolves* 1 OF RESOLUTION 123 (WRC-23)**
A.34.a	a commitment that the notifying administration will operate the non-GSO ESIMs in conformity with the Radio Regulations, including Resolution **123 (WRC-23)** Required only for the notification of earth stations in motion submitted in accordance with Resolution **123 (WRC-23)**
A.35	**COMPLIANCE WITH *resolves* 3.5 and *further resolves* 1, 2, 3 and 4 OF RESOLUTION 123 (WRC-23)**
A.35.a	a commitment that the notifying administration will operate the non-GSO ESIMs in conformity with *resolves* 3.5 and *further resolves* 1, 2, 3 and 4 of Resolution **123 (WRC-23)** Required only for the notification of earth stations in motion submitted in accordance with Resolution **123 (WRC-23)**
A.36	**FOR THE NOTIFICATION OF EARTH STATIONS IN MOTION SUBMITTED IN ACCORDANCE WITH RESOLUTION 123 (WRC-23)**
A.36.a	the minimum elevation angle at which any associated non-GSO A-ESIM can transmit to a non-GSO satellite in the frequency band 27.5-29.1 GHz and 29.5-30 GHz Required only for the notification of aeronautical earth stations in motion submitted in accordance with Resolution **123 (WRC-23)**
A.36.b	the aircraft fuselage attenuation mask associated with the non-GSO A-ESIM and based on ITU-R Recommendations. If none provided, the fuselage attenuation mask in Table 4 of Annex 2 to Resolution **123 (WRC-23)** Required only for the notification of aeronautical earth stations in motion submitted in accordance with Resolution **123 (WRC-23)**
A.36.c	a point of contact for the purpose of tracing any cases of unacceptable interference from non-GSO ESIMs and to respond immediately to requests from the focal point of the affected administration Required only for the notification of earth stations in motion submitted in accordance with Resolution **123 (WRC-23)**
A.37	**COMPLIANCE WITH *resolves* 3.7.1 OF RESOLUTION 123 (WRC-23)**
A.37.a	a commitment that the notifying administration will operate the non-GSO ESIMs in conformity with *resolves* 3.7 and *further resolves* 1, 2, 3 and 4 of Resolution **123 (WRC-23)**, see *resolves* 3.7.1 of Resolution **123 (WRC-23)** Required only for the notification of earth stations in motion submitted in accordance with Resolution **123 (WRC-23)**

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								A.33	
							+	A.33.a	
								A.34	
			+					A.34.a	
								A.35	
			+					A.35.a	
								A.36	
			+					A.36.a	
			+					A.36.b	
			+					A.36.c	
								A.37	
			+					A.37.a	

Items in Appendix	*A - GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION*
A.38	**COMPLIANCE WITH *further resolves* 1 OF RESOLUTION 123 (WRC-23)**
A.38.a	a firm, objective, actionable, measurable and enforceable commitment that in case of reported unacceptable interference, the notifying administration undertakes to immediately eliminate the interference or reduce it to an acceptable level Required only for the notification of earth stations in motion submitted in accordance with Resolution **123 (WRC-23)**
A.39	**COMPLIANCE WITH RESOLUTION 8 (WRC-23)**
A.39.a	a commitment stating that the characteristics as modified will not cause more interference or require more protection than the characteristics provided in the latest notification information published in Part I-S of the BR IFIC for the frequency assignments to the non-geostationary-satellite system
A.40	**COMPLIANCE WITH § 4.1.13*bis* of ARTICLE 4 OF APPENDIX 30/30A (WRC-23) or § 6.15*quat* of ARTICLE 6 OF APPENDIX 30B (WRC-23)**
A.40.a	a commitment to respect the power-flux density limits specified under § 4.1.13*bis* of Article 4 of Appendix **30/30A** or § 6.15*quat* of Article 6 of Appendix **30B**, as appropriate Required only for a submission under § 4.1.12 of Article 4 of Appendix **30/30A** or under §§ 6.17/6.25 of Article 6 of Appendix **30B**

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								A.38	
			+					A.38.a	
								A.39	
			O					A.39.a	
								A.40	
					+	+	+	A.40.a	

TABLE B

CHARACTERISTICS TO BE PROVIDED FOR EACH SATELLITE ANTENNA BEAM OR EACH EARTH STATION OR RADIO ASTRONOMY ANTENNA (Rev.WRC-23)

Items in Appendix	*B - CHARACTERISTICS TO BE PROVIDED FOR EACH SATELLITE ANTENNA BEAM OR EACH EARTH STATION OR RADIO ASTRONOMY ANTENNA*
B.1	**IDENTIFICATION AND DIRECTION OF THE SATELLITE ANTENNA BEAM**
B.1.a	the designation of the satellite antenna beam For an earth station, the designation of the satellite antenna beam of the associated space station
B.1.b	an indicator showing whether the antenna beam, under B.1.a, is fixed or whether it is steerable and / or reconfigurable
B.1.c	if the beam is part of a multiple-beam network, the multiple beam identification code
B.1.d	**For sensor operation**
B.1.d.1	an indicator showing whether the beam is for an active or passive sensor
B.2	**TRANSMISSION / RECEPTION INDICATOR FOR THE BEAM OF THE SPACE STATION OR THE ASSOCIATED SPACE STATION**
B.2*bis*	**Not used**
B.2*bis*.a	**Not used**
B.2*bis*.b	**Not used**
B.2.a	**For the space station transmitting beam, continuous/non-continuous transmission indicators**
B.2.a.1	an indicator specifying whether the space station only transmits when visible from the notified service area In the case of non-geostationary-satellite systems, required only for frequency assignments not subject to Nos. **22.5C**, **22.5D**, **22.5F** or **22.5L**
B.2.a.2	if the non-geostationary-satellite beam's transmissions are non-continuous, the minimum elevation angle above which transmissions occur when the space station is visible from the notified service area Not required for coordination and notification of frequency assignments subject to Nos. **22.5C**, **22.5D**, **22.5F** or **22.5L**
B.3	**SPACE STATION ANTENNA CHARACTERISTICS**
B.3.a	**For each space station antenna:**
B.3.a.1	the maximum co-polar isotropic gain, in dBi Where a steerable beam (see No. **1.191**) is used, if the effective boresight area (see No. **1.175**) is identical with the global service area, the maximum antenna gain, in dBi, is applicable to all points on the Earth's visible surface
B.3.a.2	if a non-elliptical beam, the maximum cross-polar isotropic antenna gain, in dBi

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for an Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								B.1	
	X	X	X	X	X	X	X	B.1.a	
	X	X	X		X	X	X	B.1.b	
							+	B.1.c	
								B.1.d	
	X	X	X					B.1.d.1	
	X	X	X	+[1]			X	**B.2**	
								B.2*bis*	
								B.2*bis*.a	
								B.2*bis*.b	
								B.2.a	
	X		+					B.2.a.1	
	O		O					B.2.a.2	
								B.3	
								B.3.a	
	X	X	X		X	X	X	B.3.a.1	
					+	+		B.3.a.2	

Items in Appendix	*B - CHARACTERISTICS TO BE PROVIDED FOR EACH SATELLITE ANTENNA BEAM OR EACH EARTH STATION OR RADIO ASTRONOMY ANTENNA*
B.3.b	**Antenna gain contours:**
B.3.b.1	the co-polar antenna gain contours plotted on a map of the Earth's surface, preferably in a radial projection from the satellite onto a plane perpendicular to the axis from the centre of the Earth to the satellite The space station antenna gain contours shall be drawn as isolines of the isotropic gain, at least for −2, −4, −6, −10 and −20 dB and at 10 dB intervals thereafter, as necessary, relative to the maximum antenna gain, when any of these contours is located either totally or partially anywhere within the limit of visibility of the Earth from the given geostationary satellite Whenever possible, the gain contours of the space station antenna should also be provided in a numerical format (e.g. equation or table) Where a steerable beam (see No. **1.191**) is used, if the effective boresight area (see No. **1.175**) is less than the global service area, the contours are the result of moving the boresight of the steerable beam around the limit defined by the effective boresight area and are to be provided as described above but shall also include the 0 dB relative gain isoline. In addition, for a steerable transmitting beam, except for the case of Appendix **30B**, see also No. **21.16** (and its associated Rules of Procedure) The antenna gain contours shall include the effects of the planned inclination excursion, longitudinal tolerance and the planned pointing accuracy of the antenna *Note* – Taking due account of applicable technical restrictions and allowing some reasonable degree of flexibility for satellite operations, administrations should, to the extent practicable, align the areas the satellite steerable beams could cover with the service area of their networks or systems with due regard to their service objectives. In the case of Appendix **30**, **30A**, **30B** or **30B** ESIM, required only for non-elliptical beams
B.3.b.2	if a non-elliptical beam, the cross-polar gain contours shall be provided as defined under B.3.b.1
B.3.c	**Antenna radiation patterns:**
B.3.c.1	the co-polar antenna radiation pattern In the case of geostationary space stations required only for an antenna radiation beam that is directed towards another satellite In the case of Appendix **30**, **30A**, **30B** or **30B** ESIM, required only for elliptical antenna beams
B.3.c.2	if an elliptical beam, the cross-polar antenna radiation pattern
B.3.d	the pointing accuracy of the antenna In the case of Appendix **30**, **30A** or **30B**, required only for elliptical beams
B.3.e	if the space station is operating in a frequency band allocated in the Earth-to-space direction and in the space-to-Earth direction, the gain of the antenna in the direction of those parts of the geostationary-satellite orbit which are not obstructed by the Earth. In the case of Appendix 30, required only for the frequency band 12.5-12.7 GHz
B.3.f	**For a space station submitted in accordance with Appendix 30, 30A or 30B:**
B.3.f.1	the boresight or aim point of the antenna beam (longitude and latitude)
B.3.f.2	**For each elliptical beam:**
B.3.f.2.a	the rotational accuracy, in degrees
B.3.f.2.b	the major axis orientation, in degrees, anticlockwise from the Equator
B.3.f.2.c	the major axis, in degrees, at the half-power beamwidth
B.3.f.2.d	the minor axis, in degrees, at the half-power beamwidth

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for an Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								B.3.b	
		X			+	+	+	B.3.b.1	
					+	+		B.3.b.2	
								B.3.c	
	X	+	X		+	+	+	B.3.c.1	
					+	+		B.3.c.2	
		X			+	+	+	B.3.d	
		+			+	+		B.3.e	
								B.3.f	
					X	X	X	B.3.f.1	
								B.3.f.2	
					X	X	X	B.3.f.2.a	
					X	X	X	B.3.f.2.b	
					X	X	X	B.3.f.2.c	
					X	X	X	B.3.f.2.d	

Items in Appendix	*B - CHARACTERISTICS TO BE PROVIDED FOR EACH SATELLITE ANTENNA BEAM OR EACH EARTH STATION OR RADIO ASTRONOMY ANTENNA*
B.4	**ADDITIONAL CHARACTERISTICS FOR NON-GEOSTATIONARY SPACE STATION ANTENNA**
B.4.a.1	the reference number of each orbital plane in which the space station antenna characteristics are used
B.4.a.2	if the antenna characteristics of a space station are not common to every satellite in the specified orbital plane, the reference number of each satellite in the specified orbital plane, on which the space station antenna characteristics are used
B.4.a.2*bis*	for transmitting antennas with fixed beam pointed away from the nadir direction only, the satellite antenna gain $G(\theta_e)$ as a function of the elevation angle (θ_e) above the horizontal plane at the Earth's surface at the minimum altitude at which any satellite within the satellite system operates
B.4.a.2*ter*	for transmitting antennas with steerable beam, the satellite antenna gain $G_{max}(\theta_e)$ as a function of the elevation angle (θ_e) above the horizontal plane at the Earth's surface
B.4.a.3	**For a space station submitted in accordance with Nos. 9.11A, 9.12, 9.12A or for active or passive sensors on board a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9:**
B.4.a.3.a	**For the orientation angles of the satellite transmitting and receiving antenna beams (required only for fixed beams):**
B.4.a.3.a.1	the orientation angle alpha, in degrees (see the most recent version of Recommendation ITU-R SM.1413)
B.4.a.3.a.2	the orientation angle beta, in degrees (see the most recent version of Recommendation ITU-R SM.1413)
B.4.b	**For a space station submitted in accordance with Nos. 9.11A, 9.12 or 9.12A:**
B.4.b.1	**Not used**
B.4.b.1.a	**Not used**
B.4.b.1.b	**Not used**
B.4.b.2	**Not used**
B.4.b.3	**Not used**
B.4.b.4	**For each transmitting beam:**
B.4.b.4.a	the maximum beam peak e.i.r.p./4 kHz
B.4.b.4.a*bis*	for fixed beam pointed away from the nadir direction only, the maximum beam peak e.i.r.p./4 kHz $eirp4kHz_{max}$ (θ_e) as a function of the elevation angle (θ_e) above the horizontal plane at the Earth's surface at the minimum altitude at which any satellite within the satellite system operates
B.4.b.4.a*ter*	for steerable beam, the maximum beam peak e.i.r.p./4 kHz $eirp4kHz_{max}(\theta_e)$ as a function of the elevation angle (θ_e) above the horizontal plane at the Earth's surface
B.4.b.4.b	the average beam peak e.i.r.p./4 kHz
B.4.b.4.c	the maximum beam peak e.i.r.p./1 MHz

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for an Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								B.4	
	X		**X**					B.4.a.1	
	+		+					B.4.a.2	
			O					B.4.a.2*bis*	
			O					B.4.a.2*ter*	
								B.4.a.3	
								B.4.a.3.a	
	X		**X**					B.4.a.3.a.1	
	X		**X**					B.4.a.3.a.2	
								B.4.b	
								B.4.b.1	
								B.4.b.1.a	
								B.4.b.1.b	
								B.4.b.2	
								B.4.b.3	
								B.4.b.4	
			X					B.4.b.4.a	
			O					B.4.b.4.a*bis*	
			O					B.4.b.4.a*ter*	
			X					B.4.b.4.b	
			X					B.4.b.4.c	

Items in Appendix	*B - CHARACTERISTICS TO BE PROVIDED FOR EACH SATELLITE ANTENNA BEAM OR EACH EARTH STATION OR RADIO ASTRONOMY ANTENNA*
B.4.b.4.c*bis*	for fixed beam pointed away from the nadir direction only, the maximum beam peak e.i.r.p./1 MHz $eirp1MHz_{max}$ (θ_e) as a function of the elevation angle (θ_e) above the horizontal plane at the Earth's surface at the minimum altitude at which any satellite within the satellite system operates
B.4.b.4.c*ter*	for steerable beam, the maximum beam peak e.i.r.p./1 MHz $eirp1MHz_{max}$ (θ_e) as a function of the elevation angle (θ_e) above the horizontal plane at the Earth's surface
B.4.b.4.d	the average beam peak e.i.r.p./1 MHz
B.4.b.5	the calculated peak value of power flux-density produced within ±5° inclination of the geostationary-satellite orbit Required only for the fixed-satellite service (space-to-Earth) in the frequency band 6 700-7 075 MHz
B.5	**EARTH STATION ANTENNA CHARACTERISTICS**
B.5.a	the isotropic gain, in dBi, of the antenna in the direction of maximum radiation (see No. **1.160**)
B.5.b	the half-power beamwidth, in degrees
B.5.c	either the measured radiation pattern of the antenna or the reference radiation pattern to be used for coordination For coordination under No. **9.7A**, the reference radiation pattern is to be provided
B.5.d	antenna dimension aligned with the geostationary arc (D_{GSO}), in metres (see the most recent version of Recommendation ITU-R S.1855) Except for Appendix **30** or **30A**
B.6	**RADIO ASTRONOMY STATION ANTENNA CHARACTERISTICS**
B.6.a	the antenna type (see the Preface)
B.6.b	the antenna dimensions (see the Preface)
B.6.c	the effective area of the antenna (see the Preface)

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for an Appendix ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
			O					B.4.b.4.c*bis*	
			O					B.4.b.4.c*ter*	
			X					B.4.b.4.d	
			+					B.4.b.5	
								B.5	
					X			B.5.a	
					+[1]			B.5.b	
					X			B.5.c	
					O			B.5.d	
								B.6	
								B.6.a	X
								B.6.b	X
								B.6.c	X

TABLE C

CHARACTERISTICS TO BE PROVIDED FOR EACH GROUP OF FREQUENCY ASSIGNMENTS FOR A SATELLITE ANTENNA BEAM OR AN EARTH STATION OR RADIO ASTRONOMY ANTENNA (Rev.WRC-23)

Items in Appendix	*C- CHARACTERISTICS TO BE PROVIDED FOR EACH GROUP OF FREQUENCY ASSIGNMENTS FOR A SATELLITE ANTENNA BEAM OR AN EARTH STATION OR RADIO ASTRONOMY ANTENNA*
C.1	**FREQUENCY RANGE**
C.1.a	the lower limit of the frequency range within which the carriers and the bandwidth of the emission will be located for each Earth-to-space or space-to-Earth service area, or for each space-to-space relay
C.1.b	the upper limit of the frequency range within which the carriers and the bandwidth of the emission will be located for each Earth-to-space or space-to-Earth service area, or for each space-to-space relay
C.2	**ASSIGNED FREQUENCY (FREQUENCIES)**
C.2.a.1	the assigned frequency (frequencies), as defined in No. **1.148** – in kHz up to 28 000 kHz inclusive – in MHz above 28 000 kHz to 10 500 MHz inclusive – in GHz above 10 500 MHz If the basic characteristics are identical, with the exception of the assigned frequency, a list of frequency assignments may be provided In the case of advance publication, required only for active sensors In the case of geostationary and non-geostationary-satellite networks or systems, required for all space applications except passive sensors In the case of Appendix **30B**, required only for notification under Article **8** In the case of Appendix **30B** ESIM, required only for notification under Section B of Part 1 of Annex 1 to Resolution **121 (WRC-23)**
C.2.a.2	the channel number
C.2.b	the centre of the frequency band observed – in kHz up to 28 000 kHz inclusive – in MHz above 28 000 kHz to 10 500 MHz inclusive – in GHz above 10 500 MHz In the case of satellite networks or systems, required only for passive sensors
C.2.c	if the frequency assignment is to be filed under No. **4.4**, an indication to that effect
C.3	**ASSIGNED FREQUENCY BAND**
C.3.a	the bandwidth of the assigned frequency band, in kHz (see No. **1.147**) In the case of advance publication, required only for active sensors In the case of geostationary and non-geostationary-satellite networks or systems, required for all space applications except passive sensors In the case of Appendix **30B**, required only for notification under Article **8** In the case of Appendix **30B** ESIM, required only for notification under Section B of Part 1 of Annex 1 to Resolution **121 (WRC-23)**

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for an Appendix 30B FSM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								C.1	
X	X						X	C.1.a	
X	X						X	C.1.b	
								C.2	
	+	+	+	X	X	X	+	C.2.a.1	
					X	X		C.2.a.2	
	+	+	+					C.2.b	X
	+	+	+	+				C.2.c	+
								C.3	
	+	+	+	X	X	X	+	C.3.a	

Items in Appendix	*C - CHARACTERISTICS TO BE PROVIDED FOR EACH GROUP OF FREQUENCY ASSIGNMENTS FOR A SATELLITE ANTENNA BEAM OR AN EARTH STATION OR RADIO ASTRONOMY ANTENNA*
C.3.b	the bandwidth of the frequency band, in kHz, observed by the station In the case of satellite networks or systems, required only for passive sensors
C.4	**CLASS OF STATION AND NATURE OF SERVICE**
C.4.a	the class of station, using the symbols from the Preface
C.4.b	the nature of service performed, using the symbols from the Preface
C.5	**RECEIVING SYSTEM NOISE TEMPERATURE**
C.5.a	the lowest total receiving system noise temperature, in kelvins, referred to the output of the receiving antenna of the space station In the case of satellite networks or systems, required for all space applications except for active or passive sensors
C.5.b	the lowest total receiving system noise temperature, in kelvins, referred to the output of the receiving antenna of the earth station under clear-sky conditions This value shall be indicated for the nominal value of the angle of elevation when the associated transmitting station is onboard a geostationary satellite and, in other cases, for the minimum value of the angle of elevation
C.5.c	the overall receiving system noise temperature, in kelvins, referred to the output of the receiving antenna
C.5.d	**For active sensors:**
C.5.d.1	the system noise temperature at the output of the signal processor
C.5.d.2	the receiver noise bandwidth
C.6	**POLARIZATION**
C.6.a	the type of polarization (see the Preface) For circular polarization, this includes the sense of polarization (see Nos. **1.154** and **1.155**) In the case of a space station submitted in accordance with Appendix **30** or **30A**, see § 3.2 of Annex 5 to Appendix **30**
C.6.b	if linear polarization is used, the angle, in degrees, measured counter-clockwise in a plane normal to the beam axis from the equatorial plane to the electric vector of the waves as seen from the satellite In the case of a space station submitted in accordance with Appendix **30** or **30A**, see § 3.2 of Annex 5 to Appendix **30**
C.7	**NECESSARY BANDWIDTH AND CLASS OF EMISSION** *(in accordance with Article **2** and Appendix **1**)* For advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article **9**, changes to this information within the limits specified under C.1 shall not affect consideration of notification under Article **11** Not required for active or passive sensors

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 4 and 8) or for an Appendix 30B FSM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
	+	+	+					C.3.b	X
								C.4	
	X	X	X	X	X	X	X	C.4.a	X
	X	X	X	X				C.4.b	X
								C.5	
	+	+	+			X	X	C.5.a	
				X				C.5.b	
								C.5.c	X
								C.5.d	
	X	X	X					C.5.d.1	
	X	X	X					C.5.d.2	
								C.6	
	X	X	X	+[1]	X	X		C.6.a	
	+	+	+	+[1]	+	+		C.6.b	
								C.7	

Items in Appendix	*C - CHARACTERISTICS TO BE PROVIDED FOR EACH GROUP OF FREQUENCY ASSIGNMENTS FOR A SATELLITE ANTENNA BEAM OR AN EARTH STATION OR RADIO ASTRONOMY ANTENNA*
C.7.a	the necessary bandwidth and the class of emission: for each carrier In the case of Appendix 30B, required only for notification under Article **8** (including simultaneous submissions for entry into the List under § 6.17 and notification under § 8.1) *Note* – For simultaneous submissions, the Bureau will use predefined values for the necessary bandwidth when examining the notice under § 6.17 of Article 6 of Appendix **30B** In the case of Appendix **30B** ESIM, required only for notification under Section B of Part 1 of Annex 1 to Resolution **121 (WRC-23)** (including simultaneous submissions for entry in the Appendix **30B** ESIM List and notification under Section A and Section B, respectively, of Part 1 of Annex 1 to Resolution **121 (WRC-23)**) *Note* – For simultaneous submissions, the Bureau will use predefined values for the necessary bandwidth when examining the notice under Annex 1 (except Section B) of Resolution **121 (WRC-23)**
C.7.b	the carrier frequency or frequencies of the emission(s)
C.8	**POWER CHARACTERISTICS OF THE TRANSMISSION** *Not required for passive sensors*
C.8.a	**For the case where individual carriers can be identified:**
C.8.a.1	the maximum value of the peak envelope power, in dBW, supplied to the input of the antenna for each carrier type Required if neither C.8.b.1 nor C.8.b.3.a is provided
C.8.a.2	the maximum power density, in dB(W/Hz), supplied to the input of the antenna for each carrier type[2] In the case of satellite networks or systems, required if neither C.8.b.2 nor C.8.b.3.b is provided In the case of Appendix **30B**, required only for notification under Article **8**, or simultaneous submissions for entry into the List under § 6.17 and notification under § 8.1 In the case of Appendix **30B** ESIM, required only for notification under Section B of Part 1 of Annex 1 to Resolution **121 (WRC-23)** (including simultaneous submissions for entry in the Appendix **30B** ESIM List and notification under Section A and Section B, respectively, of Part 1 of Annex 1 to Resolution **121 (WRC-23)**)
C.8.a.3	the minimum power density, in dB(W/Hz), supplied to the input of the antenna for each carrier type[2] In the case of Appendix **30B** ESIM, required only for notification under Section B of Part 1 of Annex 1 to Resolution **121 (WRC-23)** (including simultaneous submissions for entry in the Appendix **30B** ESIM List and notification under Section A and Section B, respectively, of Part 1 of Annex 1 to Resolution **121 (WRC-23)**) to be used for examination of the power flux-density limits specified in Annex 2 to Resolution **121 (WRC-23)** Not required for a submission under Appendix **30B**

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 4 and 8) or for an Appendix 30B FSM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
	X	X	X	X	X	X	+	C.7.a	
	X	C	C	C				C.7.b	
								C.8	
								C.8.a	
	+	+	+	C				C.8.a.1	
	+	+	+	O			+	C.8.a.2	
							+	C.8.a.3	

Items in Appendix	*C - CHARACTERISTICS TO BE PROVIDED FOR EACH GROUP OF FREQUENCY ASSIGNMENTS FOR A SATELLITE ANTENNA BEAM OR AN EARTH STATION OR RADIO ASTRONOMY ANTENNA*
C.8.b	**For the case where it is not appropriate to identify individual carriers:**
C.8.b.1	the total peak envelope power, in dBW, supplied to the input of the antenna For coordination or notification of an Appendix **30A** earth station the values shall include the maximum range of power control In the case of satellite networks or systems, required if neither C.8.a.1 nor C.8.b.3.a is provided
C.8.b.2	the maximum power density, in dB(W/Hz), supplied to the input of the antenna[2] For coordination or notification of an Appendix **30A** earth station the values shall include the maximum range of power control In the case of satellite networks or systems, required if neither C.8.a.2 nor C.8.b.3.b is provided In the case of Appendix **30B**, required only for submission under Article 6 In the case of Appendix **30B** ESIM, required only for submissions under Section A of Part 1 of Annex 1 to Resolution **121 (WRC-23)**
C.8.b.3	**For the case of active sensors:**
C.8.b.3.a	the mean peak envelope power, in dBW, supplied to the input of the antenna Required if neither C.8.a.1 nor C.8.b.1 is provided
C.8.b.3.b	the mean power density, in dB(W/Hz), supplied to the input of the antenna Required if neither C.8.a.2 nor C.8.b.2 is provided
C.8.b.3.c	the necessary bandwidth for active sensors Required only for active sensors operating in the Earth exploration-satellite service (active) in the frequency bands 9 200-9 300 MHz and 9 900-10 400 MHz
C.8.c	**For all space applications, except active or passive sensors:**
C.8.c.1	the minimum value of the peak envelope power, in dBW, supplied to the input of the antenna for each carrier type If not provided, the reason for absence under C.8.c.2
C.8.c.2	if C.8.c.1 is not provided, the reason for absence of the minimum value of the peak envelope power
C.8.c.3	the minimum power density, in dB(W/Hz), supplied to the input of the antenna for each carrier type[2] If not provided, the reason for absence under C.8.c.4
C.8.c.4	if C.8.c.3 is not provided, the reason for absence of the minimum power density

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 4 and 8) or for an Appendix 30B FSM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								C.8.b	
	+	+	+	+[1]	X	X		C.8.b.1	
	+	+	+	+[1]	X	X	+	C.8.b.2	
								C.8.b.3	
	+	+	+					C.8.b.3.a	
	+	+	+					C.8.b.3.b	
		+	+					C.8.b.3.c	
								C.8.c	
	+	+	+	+[1]				C.8.c.1	
	+	+	+	+[1]				C.8.c.2	
	+	+	+	+[1]				C.8.c.3	
	+	+	+	+[1]				C.8.c.4	

Items in Appendix	*C – CHARACTERISTICS TO BE PROVIDED FOR EACH GROUP OF FREQUENCY ASSIGNMENTS FOR A SATELLITE ANTENNA BEAM OR AN EARTH STATION OR RADIO ASTRONOMY ANTENNA*
C.8.d.1	the maximum total peak envelope power, in dBW, supplied to the input of the antenna for each contiguous satellite bandwidth For a satellite transponder, this corresponds to the maximum saturated peak envelope power Required only for a space-to-Earth or space-to-space link
C.8.d.2	if the contiguous satellite bandwidth is different from the bandwidth of the assigned frequency band (C.3.a), each contiguous satellite bandwidth For the maximum saturated peak envelope power of the satellite transponder, this corresponds to the bandwidth of each transponder Required only for a space-to-Earth or space-to-space link
C.8.e.1	for space-to-Earth, Earth-to-space or space-to-space links. for each carrier type, the greater of either the carrier-to-noise ratio, in dB, required to meet the performance objective of the link under clear-sky conditions or the carrier-to-noise ratio, in dB, required to meet the short-term performance objective of the link, inclusive of necessary margins If not provided, the reason for absence under C.8.e.2
C.8.e.2	if C.8.e.1 is not provided, the reason for absence of the carrier-to-noise ratio
C.8.f.1	the space station's nominal equivalent isotropically radiated power(s) (e.i.r.p.) on the beam axis Required only for a space-to-space link
C.8.f.2	the associated space station's nominal equivalent isotropically radiated power(s) (e.i.r.p.) on the beam axis Required only for a space-to-space link
C.8.g.1	the maximum aggregate power, in dBW, of all carriers (per transponder, if applicable) supplied to the input of the transmitting antenna of the earth station or the associated earth station Not required for coordination of a specific earth station under Nos. **9.15**, **9.17** or **9.17A**
C.8.g.2	the aggregate bandwidth of all carriers (per transponder, if applicable) supplied to the input of the transmitting antenna of the earth station or the associated earth station Not required for coordination of a specific earth station under Nos. **9.15**, **9.17** or **9.17A**
C.8.g.3	an indicator showing whether the bandwidth of the transponder corresponds to the aggregate bandwidth of all carriers (per transponder, if applicable) supplied to the input of the transmitting antenna of the earth station or the associated earth station Not required for coordination of a specific earth station under Nos. **9.15**, **9.17** or **9.17A**
C.8.h	the maximum power density per Hz supplied to the input of the antenna, in dB(W/Hz), averaged over the necessary bandwidth
C.8.i	If power control is used, the maximum range of power control, in dB
C.8.j	**Not used**

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 4 and 8) or for an Appendix 30B FSM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
	O	+	+					C.8.d.1	
	O	+	+					C.8.d.2	
	+	+	+	+[1]				C.8.e.1	
	+	+	+	+[1]				C.8.e.2	
	+							C.8.f.1	
	+							C.8.f.2	
		C	C	C				C.8.g.1	
		C	C	C				C.8.g.2	
		C	C	C				C.8.g.3	
					X	X	X	C.8.h	
						+		C.8.i	
								C.8.j	

Items in Appendix	*C - CHARACTERISTICS TO BE PROVIDED FOR EACH GROUP OF FREQUENCY ASSIGNMENTS FOR A SATELLITE ANTENNA BEAM OR AN EARTH STATION OR RADIO ASTRONOMY ANTENNA*
C.9	**INFORMATION ON MODULATION CHARACTERISTICS** *For all space applications except active or passive sensors*
C.9.a	**For each carrier, according to the nature of the signal modulating the carrier:**
C.9.a.1	the type of modulation In the case of a non-geostationary space station required only for Nos. **9.11A**, **9.12** or **9.12A**
C.9.a.2	**For a carrier frequency modulated by a frequency-division multichannel telephony baseband (FDM/FM) or by a signal that can be represented by a multichannel telephony baseband:**
C.9.a.2.a	the lowest frequency of the baseband
C.9.a.2.b	the highest frequency of the baseband
C.9.a.2.c	the r.m.s. frequency deviation of the pre-emphasized signal for a test tone as a function of baseband frequency
C.9.a.3	**For a carrier frequency modulated by a television signal:**
C.9.a.3.a	the peak-to-peak frequency deviation of the pre-emphasized signal
C.9.a.3.b	the pre-emphasis characteristic
C.9.a.3.c	if applicable, the characteristics of the multiplexing of the video signal with the sound signal(s) or other signals
C.9.a.4	**For a carrier phase-shift modulated by a digital signal:**
C.9.a.4.a	the bit rate
C.9.a.4.b	the number of phases
C.9.a.5	**For an amplitude modulated carrier (including single sideband):**
C.9.a.5.a	the nature of the modulating signal, as precisely as possible
C.9.a.5.b	the kind of amplitude modulation used
C.9.a.6	**For a frequency modulated carrier:**
C.9.a.6.a	the peak-to-peak frequency deviation, in MHz, of the energy dispersal waveform
C.9.a.6.b	the sweep frequency, in kHz, of the energy dispersal waveform
C.9.a.6.c	the energy dispersal waveform
C.9.a.7	if other forms of modulation than frequency modulation are being used, the type of energy dispersal
C.9.a.8	for all other types of modulation, such particulars as may be useful for an interference study
C.9.a.9	the TV standard
C.9.b	**For analogue carriers:**
C.9.b.1	the sound-broadcasting characteristics
C.9.b.2	the composition of the baseband

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8) or for an Appendix 30B ESIM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								C.9	
								C.9.a	
	O	C	+		X	X		C.9.a.1	
								C.9.a.2	
	O	C	C					C.9.a.2.a	
	O	C	C					C.9.a.2.b	
	O	C	C					C.9.a.2.c	
								C.9.a.3	
	O	C	C		X	X		C.9.a.3.a	
	O	C	C		X	X		C.9.a.3.b	
	O	C	C		+	+		C.9.a.3.c	
								C.9.a.4	
	O	C	C					C.9.a.4.a	
	O	C	C					C.9.a.4.b	
								C.9.a.5	
	O	C	C					C.9.a.5.a	
	O	C	C					C.9.a.5.b	
								C.9.a.6	
	O	C	C		X	X		C.9.a.6.a	
	O	C	C		X	X		C.9.a.6.b	
	O	C	C		X	X		C.9.a.6.c	
	O	C	C		+	+		C.9.a.7	
	O	C	C					C.9.a.8	
	O	C	C		X	X		C.9.a.9	
								C.9.b	
					X	X		C.9.b.1	
					X	X		C.9.b.2	

Items in Appendix	*C– CHARACTERISTICS TO BE PROVIDED FOR EACH GROUP OF FREQUENCY ASSIGNMENTS FOR A SATELLITE ANTENNA BEAM OR AN EARTH STATION OR RADIO ASTRONOMY ANTENNA*
C.9.c	**For a non-geostationary space station submitted in accordance with Nos. 9.11A, 9.12 or 9.12A:**
C.9.c.1	the type of multiple access
C.9.c.2	the spectrum mask
C.9.d	**For stations operating in a frequency band subject to Nos. 22.5C, 22.5D, 22.5F or 22.5L:**
C.9.d.1	the type of mask
C.9.d.2	the pfd mask identification code
C.9.d.3	the space station's e.i.r.p. mask identification code
C.9.d.4	the associated earth station's e.i.r.p. mask identification code
C.10	**TYPE AND IDENTITY OF THE ASSOCIATED STATION(S)** *(the associated station may be another space station, a typical earth station of the network or system or a specific earth station)* *For all space applications except active or passive sensors*
C.10.a	**For an associated space station:**
C.10.a.1	the identity of the station
C.10.a.2	if the associated space station is in the geostationary orbit, its nominal longitude
C.10.b	**For an associated earth station:**
C.10.b.1	the name of the station
C.10.b.2	the type of station (specific or typical)
C.10.c	**For a specific associated earth station:**
C.10.c.1	the geographical coordinates of the antenna site
C.10.c.2	the country or geographical area in which the earth station is located, using the symbols from the Preface
C.10.d	**For an associated earth station (whether specific or typical):**
C.10.d.1	the class of station, using the symbols from the Preface
C.10.d.2	the nature of service performed, using the symbols from the Preface
C.10.d.3	the isotropic gain, in dBi, of the antenna in the direction of maximum radiation (see No. **1.160**)
C.10.d.4	the beamwidth, in degrees, between the half-power points (described in detail if not symmetrical)
C.10.d.5.a	either the measured co-polar radiation pattern of the antenna or the co-polar reference radiation pattern
C.10.d.5.b	either the measured cross-polar radiation pattern of the antenna or the cross-polar reference radiation pattern

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 4 and 8) or for an Appendix 30B ESM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								C.9.c	
			X					C.9.c.1	
			X					C.9.c.2	
								C.9.d	
			X					C.9.d.1	
			X					C.9.d.2	
			X					C.9.d.3	
			X					C.9.d.4	
								C.10	
								C.10.a	
	X	X	X					C.10.a.1	
	+	+	+					C.10.a.2	
								C.10.b	
	X	X	X			X		C.10.b.1	
	X	X	X					C.10.b.2	
								C.10.c	
	X	X	X			X		C.10.c.1	
	X	X	X			X		C.10.c.2	
								C.10.d	
	X	X	X					C.10.d.1	
	X	X	X					C.10.d.2	
	X	X	X		X	X	X	C.10.d.3	
	O	X	X		X	X	X	C.10.d.4	
	X	X	X		X	X	X	C.10.d.5.a	
					X	X		C.10.d.5.b	

Items in Appendix	*C – CHARACTERISTICS TO BE PROVIDED FOR EACH GROUP OF FREQUENCY ASSIGNMENTS FOR A SATELLITE ANTENNA BEAM OR AN EARTH STATION OR RADIO ASTRONOMY ANTENNA*
C.10.d.6	if the associated station is a receiving earth station, the lowest total receiving system noise temperature, in kelvins, referred to the output of the receiving antenna of the earth station under clear-sky conditions
C.10.d.7	the antenna diameter, in metres In cases other than Appendix **30A**, required only for fixed-satellite service networks or systems operating in the frequency bands 13.75-14 GHz, 14.5-14.75 GHz (in countries listed in Resolution **163 (WRC-15)** not for feeder links for the broadcasting-satellite service), 14.5-14.8 GHz (in countries listed in Resolution **164 (WRC-15)** not for feeder links for the broadcasting-satellite service), 24.65-25.25 GHz (Region 1), 24.65-24.75 GHz (Region 3) and 51.4-52.4 GHz and for maritime mobile-satellite service networks or systems operating in the frequency band 14-14.5 GHz
C.10.d.8	the equivalent antenna diameter (i.e. the diameter, in metres, of a parabolic antenna with the same off-axis performance as the receiving associated earth station antenna)
C.10.d.9	antenna dimension aligned with the geostationary arc (D_{GSO}), in metres (see the most recent version of Recommendation ITU-R S.1855) Except for Appendix **30** or **30A**
C.10.d.10	the minimum elevation angle at which any associated Appendix **30B** A-ESIM can transmit to geostationary satellite Required only for the notification of aeronautical earth stations in motion submitted in accordance with Resolution **121 (WRC-23)** Not required for a submission under Appendix **30B**
C.10.d.11	the aircraft fuselage attenuation mask associated with the Appendix **30B** A-ESIM and based on ITU-R Recommendations. If none provided, the fuselage attenuation mask in Table 4 of Annex 4 to Resolution **121 (WRC-23)** Required only for the notification of aeronautical earth stations in motion submitted in accordance with Resolution **121 (WRC-23)** Not required for a submission under Appendix **30B**
C.11	**SERVICE AREA (S)** *For all space applications except active or passive sensors*
C.11.a	the service area or areas of the satellite beam on the Earth, when the associated transmitting or receiving stations are earth stations For a space station submitted in accordance with Appendix **30**, **30A** or **30B**, the service area identified by a set of a maximum of 100 test points and by a service area contour on the surface of the Earth or defined by a minimum elevation angle *Note* – When an assignment converted from an allotment is reinstated in the Appendix **30B** Plan, the notifying administration may choose a maximum of 20 test points within its national territory for the reinstated allotment

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 4 and 8) or for an Appendix 30B FSM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
	+	+	+				+	C.10.d.6	
		+	+			X		C.10.d.7	
					X			C.10.d.8	
		O					O	C.10.d.9	
							+	C.10.d.10	
							+	C.10.d.11	
								C.11	
	X	X	X		X	X	X	C.11.a	

Items in Appendix	*C – CHARACTERISTICS TO BE PROVIDED FOR EACH GROUP OF FREQUENCY ASSIGNMENTS FOR A SATELLITE ANTENNA BEAM OR AN EARTH STATION OR RADIO ASTRONOMY ANTENNA*
C.11.b	the appropriate information required to calculate the affected region (as defined in Recommendation ITU-R M.1187-1) Required only for a non-geostationary space station in the mobile-satellite service submitted in accordance with No. **9.11A** in frequency bands between 1 and 3 GHz
C.12	**REQUIRED PROTECTION RATIO**
C.12.a	if the aggregate carrier-to-interference ratio is less than 21 dB, the minimum acceptable aggregate carrier-to-interference ratio The carrier-to-interference ratio is to be expressed in terms of the power averaged over the necessary bandwidth of the modulated wanted and interfering signals, assuming both the desired carrier and interfering signals have equivalent bandwidths and modulation types Not required for Appendix **30B** ESIM
C.13	**CHARACTERISTICS OF OBSERVATIONS FOR RADIO ASTRONOMY STATIONS**
C.13.a	the class of observations to be taken on the frequency band shown under C.3.b – Class A observations are those in which the sensitivity of the equipment is not a primary factor – Class B observations are those of such a nature that they can be made only with advanced low-noise receivers using the best techniques
C.13.b	the type of radio astronomy station in the frequency band shown under C.3.b – Single-dish, “S”, telescope used for spectral-line or continuum observations using single-dishes or closely connected arrays – Very long baseline interferometry (VLBI), “V”, station used only for VLBI observations
C.13.c	the minimum elevation angle θ_{min} at which the radio astronomy station conducts single-dish or VLBI observations in the frequency band
C.14	**Not used**
C.15	**DESCRIPTION OF THE GROUP(S) REQUIRED IN THE CASE OF NON-SIMULTANEOUS EMISSIONS**
C.15.a	if part of an exclusive operation group, the group identification code
C.16	**DESCRIPTION OF ACTIVE AND PASSIVE SENSOR SYSTEMS**
C.16.a	**For active sensors:**
C.16.a.1	the pulse length, in μs
C.16.a.2	the pulse repetition frequency, in kHz
C.16.b	**For passive sensors:**
C.16.b.1	the sensitivity threshold, in kelvins

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 4 and 8) or for an Appendix 30B EPM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
			+					C.11.b	
								C.12	
							+	C.12.a	
								C.13	
								C.13.a	**X**
								C.13.b	**X**
								C.13.c	**X**
								C.14	
								C.15	
				+	+	+		C.15.a	
								C.16	
								C.16.a	
	X	**X**	**X**					C.16.a.1	
	X	**X**	**X**					C.16.a.2	
								C.16.b	
	X	**X**	**X**					C.16.b.1	

TABLE D

OVERALL LINK CHARACTERISTICS (Rev.WRC-23)

Items in Appendix	***D – OVERALL LINK CHARACTERISTICS***
	For non-planned services, this data may be provided by administrations that so desire but only when simple frequency-changing transponders are used on the space station onboard a geostationary satellite
D.1	**CONNECTION BETWEEN EARTH-TO-SPACE AND SPACE-TO-EARTH FREQUENCIES IN THE NETWORK**
D.1.a	the connection between uplink and downlink frequency assignments for each intended combination of receiving and transmitting beams In the case of Appendix **30** or **30A**, required only for Region 2 In the case of Appendix **30B**, required only for submission of both Earth-to-space and space-to-Earth links
D.2	**TRANSMISSION GAINS AND ASSOCIATED EQUIVALENT SATELLITE LINK NOISE TEMPERATURES**
D.2.a	**For each entry under D.1.a:**
D.2.a.1	the lowest equivalent satellite link noise temperature These values shall be indicated for the nominal value of the angle of elevation
D.2.a.2	the associated transmission gain of the lowest equivalent satellite link noise temperature These values shall be indicated for the nominal value of the angle of elevation The transmission gain is evaluated from the output of the receiving antenna of the space station to the output of the receiving antenna of the earth station
D.2.b.1	the values of associated equivalent satellite link noise temperature that correspond to the highest ratio of transmission gain to equivalent satellite link noise temperature
D.2.b.2	the values of transmission gain that correspond to the highest ratio of transmission gain to equivalent satellite link noise temperature

Advance publication of a geostationary-satellite network	Advance publication of a non-geostationary-satellite network or system not subject to coordination under Section II of Article 9	Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)	Notification or coordination of a non-geostationary-satellite network or system	Notification or coordination of an earth station (including notification under Appendices 30A or 30B)	Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)	Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)	Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 4 and 8) or for an Appendix 30B ESAM in accordance with Resolution 121 (WRC-23)	Items in Appendix	Radio astronomy
								D.1	
		O			+	+	+	D.1.a	
								D.2	
								D.2.a	
		O						D.2.a.1	
		O						D.2.a.2	
		O						D.2.b.1	
		O						D.2.b.2	

APPENDIX 5 (REV.WRC-23)

Identification of administrations with which coordination is to be effected or agreement sought under the provisions of Article 9

1 For the purpose of effecting coordination under Article **9**, except in the case under No. **9.21**, and for identifying the administrations with which coordination is to be effected, the frequency assignments to be taken into account are those in the same frequency band as the planned assignment, pertaining to the same service or to another service to which the frequency band is allocated with equal rights or a higher category[1] of allocation, which might affect or be affected, as appropriate, and which are: (WRC-15)

a) in conformity with No. **11.31**[2]; and

b) either recorded in the Master International Frequency Register (Master Register) with a favourable finding with respect to No. **11.32**; or

c) recorded in the Master Register with an unfavourable finding with respect to No. **11.32** and a favourable finding with respect to No. **11.32A** or No. **11.33**, as appropriate; or

cbis) recorded in the Master Register under No. **11.41**; or (WRC-03)

d) coordinated under the provisions of Article **9**; or

e) included in the coordination procedure with effect from the date of receipt by the Radiocommunication Bureau, in accordance with No. **9.34**, of those characteristics specified in Appendix **4** as mandatory or required, or from the date of dispatch, in accordance with No. **9.29**, of the appropriate information listed in Appendix **4**; or (WRC-23)

f) where appropriate, in conformity with a world or regional allotment or assignment plan and the associated provisions;

g) for terrestrial radiocommunication stations or earth stations operating in the opposite direction of transmission[4] and, in addition, operating in accordance with these Regulations, or to be so operated prior to the date of bringing the earth station assignment into service, or within the next three years from the date of dispatch of coordination data under No. **9.29**, whichever is the longer, or from the date of the publication referred to in No. **9.38**, as appropriate. (WRC-2000)

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[1] The coordination under Nos. **9.11A** to **9.19** applies only to assignments in frequency bands allocated with equal rights. (WRC-15)

[2] For the purpose of effecting coordination, an assignment for which the process of obtaining agreement under No. **9.21** has been initiated is considered to be in conformity with No. **11.31** with respect to No. **9.21**.

[3] (SUP – WRC-23)

[4] The associated space network characteristics must have been communicated to the Bureau under No. **9.30** or under § 4.1.3/4.2.6 of Article 4 of Appendix **30** or § 4.1.3/4.2.6 of Article 4 of Appendix **30A**. (WRC-2000)

2 For the application of No. **9.21**, the agreement of an administration may be required with respect to the frequency assignments in the same frequency band as the planned assignment, pertaining to the same service or to another service to which the band is allocated with equal rights or a higher category of allocation, which may affect or be affected, as appropriate, and:

a) in cases involving a station in a space radiocommunication service with respect to any other station or involving a terrestrial radiocommunication station with respect to an earth station:

i) which are in conformity with No. **11.31**, and comply with the relevant conditions listed in § 1 *b)* to 1 *g)*; or

ii) for which the procedure under No. **9.21** has been initiated, with effect from the date of receipt by the Bureau, in accordance with No. **9.34**, of the basic characteristics specified in Appendix **4**;

or

b) for terrestrial radiocommunication stations operating in accordance with these Regulations, or to be so operated prior to the date of bringing the other terrestrial station assignment into service, or within the next three months, whichever is the longer.

3 For each of the frequency assignments to a station of a terrestrial or space radiocommunication service referred to in § 1 and 2 above, the level of interference shall be determined using the method referred to in Table 5-1 which is appropriate to the particular case.

4 The assignment is considered to affect or be affected, as appropriate, and coordination must be sought under the procedure of Article **9**, if:

a) the threshold levels given in Table 5-1 are exceeded; and

b) the condition specified in Table 5-1 is applicable.

5 Threshold values to determine whether coordination under No. **9.11A** is required are given in Table 5-2.

6 No coordination is required:

a) when the use of a new frequency assignment will not cause or suffer, as appropriate, in respect of any service of another administration, an increase in the level of interference above the threshold calculated in accordance with the method referred to in Tables 5-1 and 5-2; or

b) when the characteristics of a new or a modified frequency assignment or a new earth station are within the limits of those of a frequency assignment which has previously been coordinated; or

c) to change the characteristics of an existing assignment in such a way as not to increase the interference to or from, as appropriate, the assignments of other administrations; or

d) for assignments to stations comprising a satellite network in relation to assignments of other satellite networks:

i) for a new frequency assignment to a receiving station, when the notifying administration states that it accepts the interference resulting from the frequency assignments referred to in No. **9.27**; or

ii) between earth stations using frequency assignments in the same direction (either Earth-to-space or space-to-Earth); or

e) for assignments to earth stations in relation to terrestrial stations or earth stations operating in the opposite direction of transmission, when an administration proposes:

i) to bring into use an earth station the coordination area of which does not include any of the territory of any other country;

ii) to operate a mobile earth station. However, if the coordination area associated with the operation of such a mobile earth station includes any of the territory of another country, the operation of such a station shall be subject to agreement on coordination between the administrations concerned. This agreement shall apply to the characteristics of the mobile earth station(s), or to the characteristics of a typical mobile earth station, and shall apply to a specified service area. Unless otherwise stipulated in the agreement, it shall apply to any mobile earth stations in the specified service area provided that interference caused by them shall not be greater than that caused by a typical earth station for which the technical characteristics appear in the notice and have been or are being submitted in accordance with Section I of Article **11**; or

iii) to bring into use a new frequency assignment to a receiving earth station and the notifying administration states that it accepts the interference resulting from existing and future terrestrial station assignments or assignments to earth stations operating in the opposite direction of transmission. In such case, administrations responsible for the terrestrial stations or earth stations operating in the opposite direction of transmission are not required to apply the provisions of No. **9.18** or No. **9.17A** of Article **9** respectively:

f) to bring into use an assignment to a terrestrial station or an earth station operating in the opposite direction of transmission which is located, in relation to an earth station, outside the coordination area of that earth station; or

g) to bring into use an assignment to a terrestrial station or an earth station operating in the opposite direction of transmission within the coordination area of an earth station, provided that the proposed assignment to a terrestrial station or an earth station operating in the opposite direction of transmission is outside any part of a frequency band coordinated for reception by that earth station.

TABLE 5-1 (Rev.WRC-23)

Technical conditions for coordination
(see Article **9**)

Reference of Article 9	**Case**	**Frequency bands (and Region) of the service for which coordination is sought**	**Threshold/condition**	**Calculation method**	**Remarks**
No. **9.7** GSO/GSO	A station in a satellite network using the geostationary-satellite orbit (GSO), in any space radiocommunication service, in a frequency band and in a Region where this service is not subject to a Plan, in respect of any other satellite network using that orbit, in any space radiocommunication service in a frequency band and in a Region where this service is not subject to a Plan, with the exception of the coordination between earth stations operating in the opposite direction of transmission	1) 3 400-4 200 MHz 5 725-5 850 MHz (Region 1) and 5 850-6 725 MHz 7 025-7 075 MHz 2) 10.95-11.2 GHz 11.45-11.7 GHz 11.7-12.2 GHz (Region 2) 12.2-12.5 GHz (Region 3) 12.5-12.75 GHz (Regions 1 and 3) 12.7-12.75 GHz (Region 2) and 13.75-14.8 GHz	i) Bandwidth overlap, and ii) any network in the fixed-satellite service (FSS) and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±7° of the nominal orbital position of a proposed network in the FSS i) Bandwidth overlap, and ii) any network in the FSS or broadcasting-satellite service (BSS), not subject to a Plan, and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±6° of the nominal orbital position of a proposed network in the FSS or BSS, not subject to a Plan iii) in the frequency band 14.5-14.8 GHz any network in the space research service (SRS) or FSS not subject to a Plan and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±6° of the nominal orbital position of a proposed network in the SRS or FSS not subject to a Plan		With respect to the space services listed in the threshold/condition column in the frequency bands in 1), 2), 2*bis*), 3), 3*bis*), 4), 5), 6), 7) and 8), an administration may request, pursuant to No. **9.41**, to be included in requests for coordination, indicating the networks for which the value of $\Delta T/T$ calculated by the method in § 2.2.1.2 and 3.2 of Appendix **8** exceeds 6%. When the Bureau, on request by an affected administration, studies this information pursuant to No. **9.42**, the calculation method given in § 2.2.1.2 and 3.2 of Appendix **8** shall be used

TABLE 5-1 (*continued*) (Rev.WRC-23)

Reference of Article 9	Case	Frequency bands (and Region) of the service for which coordination is sought	Threshold/condition	Calculation method	Remarks
No. **9.7** GSO/GSO (*cont.*)		2*bis*) 13.4-13.65 GHz (Region 1)	i) Bandwidth overlap, and ii) any network in the space research service (SRS) or any network in the FSS and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±6° of the nominal orbital position of a proposed network in the FSS or SRS		
		3) 17.7-19.7 GHz, (Region 3), 17.3-19.7 GHz (Regions 1 and 2) and 27.5-29.5 GHz	i) Bandwidth overlap, and ii) any network in the FSS and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8° of the nominal orbital position of a proposed network in the FSS		
		3*bis*) 19.7-20.2 GHz and 29.5-30 GHz	i) Bandwidth overlap, and ii) any network in the FSS or in the mobile-satellite service (MSS) and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8° of the nominal orbital position of a proposed network in the FSS or in the MSS.		

TABLE 5-1 (*continued*) (Rev.WRC-23)

Reference of Article 9	Case	Frequency bands (and Region) of the service for which coordination is sought	Threshold/condition	Calculation method	Remarks
No. **9.7** GSO/GSO (*cont.*)		4) 17.3-17.7 GHz (Regions 1 and 2)	i) Bandwidth overlap, and ii) a) any network in the FSS and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8° of the nominal orbital position of a proposed network in the BSS, or b) any network in the BSS and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8° of the nominal orbital position of a proposed network in the FSS		
		5) 17.7-17.8 GHz	i) Bandwidth overlap, and ii) a) any network in the FSS and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8° of the nominal orbital position of a proposed network in the BSS, or b) any network in the BSS and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8° of the nominal orbital position of a proposed network in the FSS NOTE – No. **5.517** applies in Region 2.		

TABLE 5-1 (*continued*) (Rev.WRC-23)

Reference of Article 9	Case	Frequency bands (and Region) of the service for which coordination is sought	Threshold/condition	Calculation method	Remarks
No. **9.7** GSO/GSO (*cont.*)		6) 18.0-18.3 GHz (Region 2) 18.1-18.4 GHz (Regions 1 and 3)	i) Bandwidth overlap, and ii) any network in the FSS or meteorological-satellite service and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8° of the nominal orbital position of a proposed network in the FSS or the meteorological-satellite service		
		6*bis*) 21.4-22 GHz (Regions 1 and 3)	i) Bandwidth overlap; and ii) any network in the BSS and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±12° of the nominal orbital position of a proposed network in the BSS (see also Resolutions **554 (WRC-12)** and **553 (WRC-12)**).		No. **9.41** does not apply.
		7) Bands above 17.3 GHz, except those defined in 3), 3*bis*) and 6)	i) Bandwidth overlap, and ii) any network in the FSS and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8° of the nominal orbital position of a proposed network in the FSS (see also Resolution **901 (Rev.WRC-15)**)		

TABLE 5-1 (*continued*) (Rev.WRC-23)

Reference of Article 9	Case	Frequency bands (and Region) of the service for which coordination is sought	Threshold/condition	Calculation method	Remarks
No. **9.7** GSO/GSO (*cont.*)		8) Bands above 17.3 GHz except those defined in 4), 5) and 6*bis*)	i) Bandwidth overlap, and ii) any network in the FSS or BSS, not subject to a Plan, and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±16° of the nominal orbital position of a proposed network in the FSS or BSS, not subject to a Plan, except in the case of a network in the FSS with respect to a network in the FSS (see also Resolution **901 (Rev.WRC-15)**)		
		9) All frequency bands, other than those in 1), 2), 2*bis*), 3), 3*bis*), 4), 5), 6), 6*bis*), 7) and 8), allocated to a space service, and the frequency bands in 1), 2), 2*bis*), 3), 3*bis*), 4), 5), 6), 6*bis*), 7) and 8) where the radio service of the proposed network or affected networks is other than the space services listed in the threshold/condition column, or in the case of coordination of space stations operating in the opposite direction of transmission	i) Bandwidth overlap, and ii) Value of $\Delta T/T$ exceeds 6%	Appendix **8**	In application of Article 2A of Appendix **30** for the space operation functions using the guardbands defined in § 3.9 of Annex 5 of Appendix **30**, the threshold/condition specified for the FSS in the frequency bands in 2) applies. In application of Article 2A of Appendix **30A** for the space operation functions using the guardbands defined in § 3.1 and 4.1 of Annex 3 of Appendix **30A**, the threshold/condition specified for the FSS in the frequency bands in 2) and 7) applies, as appropriate

TABLE 5-1 (*continued*) (Rev.WRC-23)

Reference of Article 9	Case	Frequency bands (and Region) of the service for which coordination is sought	Threshold/condition	Calculation method	Remarks
No. **9.7A** GSO earth station/ non-GSO system	A specific earth station in a GSO satellite network in the FSS in respect of a non-GSO satellite system in the FSS	10.7-11.7 GHz (space-to-Earth) 11.7-12.2 GHz (space-to-Earth) in Region 2 12.2-12.75 GHz (space-to-Earth) in Region 3 12.5-12.75 GHz (space-to-Earth) in Region 1 17.8-18.6 GHz (space-to-Earth), and 19.7-20.2 GHz (space-to-Earth)	i) Bandwidths overlap; and ii) the GSO satellite network has specific receive earth stations which meet all of the following conditions: a) earth station antenna maximum isotropic gain greater than or equal to 64 dBi for the frequency bands 10.7-12.75 GHz or 68 dBi for the frequency bands 17.8-18.6 GHz and 19.7-20.2 GHz; b) *G/T* of 44 dB/K or higher; c) emission bandwidth of 250 MHz or higher for the frequency bands below 12.75 GHz or 800 MHz or higher for the frequency bands above 17.8 GHz; and	i) Check by using the assigned frequencies and bandwidths; ii) use the maximum antenna gain (*G*), the lowest total receiving system noise temperature (*T*), and the emission bandwidth of the specific receive earth station as given in the Appendix **4** data; and	The threshold/condition for coordination does not apply to typical receive earth stations operating in GSO satellite networks

TABLE 5-1 (*continued*) (Rev.WRC-23)

Reference of Article 9	Case	Frequency bands (and Region) of the service for which coordination is sought	Threshold/condition	Calculation method	Remarks
No. **9.7A** GSO earth station/ non-GSO system (*cont.*)			iii) the equivalent power flux-density, epfd↓, from the non-GSO satellite system exceeds: a) in the frequency band 10.7-12.75 GHz: −174.5 dB(W/(m^2 · 40 kHz)) for any percentage of time for non-GSO satellite systems with all satellites only operating at or below 2 500 km altitude, or −202 dB(W/(m^2 · 40 kHz)) for any percentage of the time for non-GSO satellite systems with any satellites operating above 2 500 km altitude; b) in the frequency bands 17.8-18.6 GHz or 19.7-20.2 GHz: −157 dB(W/(m^2 · MHz)) for any percentage of time for non-GSO satellite systems with all satellites only operating at or below 2 500 km altitude, or −185 dB(W/(m^2 · MHz)) for any percentage of the time for non-GSO satellite systems with any satellites operating above 2 500 km altitude	iii) use the epfd↓ radiated by the non-GSO FSS satellite system into the earth station employing the very large antenna when this antenna is pointed towards the wanted GSO satellite	

TABLE 5-1 (*continued*) (Rev.WRC-23)

Reference of Article 9	**Case**	**Frequency bands (and Region) of the service for which coordination is sought**	**Threshold/condition**	**Calculation method**	**Remarks**
No. **9.7B** Non-GSO system/GSO earth station	A non-GSO satellite system in the FSS in respect of a specific earth station in a GSO satellite network in the FSS	10.7-11.7 GHz (space-to-Earth) 11.7-12.2 GHz (space-to-Earth) in Region 2 12.2-12.75 GHz (space-to-Earth) in Region 3 12.5-12.75 GHz (space-to-Earth) in Region 1 17.8-18.6 GHz (space-to-Earth), and 19.7-20.2 GHz (space-to-Earth)	i) Bandwidths overlap; and ii) the GSO satellite network has specific receive earth stations which meet all of the following conditions: a) earth station antenna maximum isotropic gain greater than or equal to 64 dBi for the frequency bands 10.7-12.75 GHz or 68 dBi for the frequency bands 17.8-18.6 GHz and 19.7-20.2 GHz; b) *G/T* of 44 dB/K or higher; c) emission bandwidth of 250 MHz or higher for the frequency bands below 12.75 GHz or 800 MHz or higher for the frequency bands above 17.8 GHz; and	i) Check by using the assigned frequencies and bandwidths; ii) use the maximum antenna gain (*G*), the lowest total receiving system noise temperature (*T*), and the emission bandwidth of the specific receive earth station as given in the Appendix **4** data;	The threshold/condition for coordination do not apply to typical receive earth stations operating in GSO satellite networks

TABLE 5-1 (*continued*) (Rev.WRC-23)

Reference of Article 9	**Case**	**Frequency bands (and Region) of the service for which coordination is sought**	**Threshold/condition**	**Calculation method**	**Remarks**
No. **9.7B** Non-GSO system/GSO earth station (*cont.*)			iii) the epfd↓ from the non-GSO satellite system exceeds: a) in the frequency band 10.7-12.75 GHz: −174.5 dB(W/(m^2 · 40 kHz)) for any percentage of time for non-GSO satellite systems with all satellites only operating at or below 2 500 km altitude, or −202 dB(W/(m^2 · 40 kHz)) for any percentage of the time for non-GSO satellite systems with any satellites operating above 2 500 km altitude; b) in the frequency bands 17.8-18.6 GHz or 19.7-20.2 GHz: −157 dB(W/(m^2 · MHz)) for any percentage of time for non-GSO satellite systems with all satellites only operating at or below 2 500 km altitude, or −185 dB(W/(m^2 · MHz)) for any percentage of the time for non-GSO satellite systems with any satellites operating above 2 500 km altitude	iii) use the epfd↓ radiated by the non-GSO FSS satellite system into the earth station employing the very large antenna when this antenna is pointed towards the wanted GSO satellite	

TABLE 5-1 (*continued*) (REV.WRC-23)

Reference of Article 9	Case	Frequency bands (and Region) of the service for which coordination is sought	Threshold/condition	Calculation method	Remarks
No. **9.11** GSO, non-GSO/ terrestrial	A space station in the BSS in any band shared on an equal primary basis with terrestrial services and where the BSS is not subject to a Plan, in respect of terrestrial services	1 452-1 492 MHz 2 310-2 360 MHz (No. **5.393**) 2 535-2 655 MHz (No. **5.418**) 17.7-17.8 GHz (Region 2) 74-76 GHz	Bandwidths overlap: The detailed conditions for the application of No. **9.11** in the frequency bands 2 630-2 655 MHz and 2 605-2 630 MHz are provided in Resolution **539 (Rev.WRC-19)** for non-GSO BSS (sound) systems pursuant to No. **5.418**, and in No. **5.418** for GSO BSS (sound) networks pursuant to those provisions. The detailed conditions for the application of No. **9.11** in the frequency band 1 452-1 492 MHz are provided in Resolution **761 (Rev.WRC-19)** for Regions 1 and 3. The coordination thresholds for the application of No. **9.11** in the frequency band 17.7-17.8 GHz correspond to the pfd limits specified in Table **21-4** for the FSS in the same frequency band.	Check by using the assigned frequencies and bandwidths	
No. **9.12** Non-GSO/ non-GSO	A station in a non-GSO satellite network in the frequency bands for which a footnote refers to No. **9.11A** or No. **9.12**, in respect of any other non-GSO satellite network, with the exception of coordination between earth stations operating in the opposite direction of transmission	Frequency bands for which a footnote refers to No. **9.11A** or No. **9.12**	Bandwidths overlap	Check by using the assigned frequencies and bandwidths	

TABLE 5-1 (*continued*) (Rev.WRC-23)

Reference of Article 9	**Case**	**Frequency bands (and Region) of the service for which coordination is sought**	**Threshold/condition**	**Calculation method**	**Remarks**
No. **9.12A** Non-GSO/ GSO	A station in a non-GSO satellite network in the frequency bands for which a footnote refers to No. **9.11A** or No. **9.12A**, in respect of any GSO satellite network, with the exception of coordination between earth stations operating in the opposite direction of transmission	Frequency bands for which a footnote refers to No. **9.11A** or No. **9.12A**	Bandwidths overlap	Check by using the assigned frequencies and bandwidths	
No. **9.13** GSO/ non-GSO	A station in a GSO satellite network in the frequency bands for which a footnote refers to No. **9.11A** or No. **9.13**, in respect of any other non-GSO satellite network, with the exception of coordination between earth stations operating in the opposite direction of transmission	Frequency bands for which a footnote refers to No. **9.11A** or No. **9.13**	1) Bandwidths overlap 2) For the band 1 668-1 668.4 MHz with respect to MSS network coordination with **SRS** (passive) networks, in addition to bandwidth overlap, the e.i.r.p. spectral density of mobile earth stations in a GSO network of the mobile-satellite service operating in this band exceeds −2.5 dB(W/4 kHz) or the power spectral density delivered to the mobile earth station antenna exceeds −10 dB(W/4 kHz)	1) Check by using the assigned frequencies and bandwidths 2) Check by using MSS network Appendix **4** data	

TABLE 5-1 (*continued*) (Rev.WRC-23)

Reference of Article 9	**Case**	**Frequency bands (and Region) of the service for which coordination is sought**	**Threshold/condition**	**Calculation method**	**Remarks**
No. **9.14** Non-GSO/ terrestrial, GSO/ terrestrial	A space station in a satellite network in the frequency bands for which a footnote refers to No. **9.11A** or to No. **9.14**, in respect of stations of terrestrial services where threshold(s) is (are) exceeded	1) Frequency bands for which a footnote refers to No. **9.11A**; or 2) 11.7-12.2 GHz (Region 2 GSO FSS) 3) 5 030-5 091 MHz	1) See § 1 of Annex 1 to this Appendix; In the bands specified in No. **5.414A**, the detailed conditions for the application of No. **9.14** are provided in No. **5.414A** for MSS networks or 2) In the band 11.7-12.2 GHz (Region 2 GSO FSS): -124 dB(W/(m^2 · MHz)) for $0° \leq \theta \leq 5°$ $-124 + 0.5\ (\theta - 5)$ dB(W/(m^2 · MHz)) for $5° < \theta \leq 25°$ -114 dB(W/(m^2 · MHz)) for $\theta > 25°$ where θ is the angle of arrival of the incident wave above the horizontal plane (degrees) 3) Bandwidth overlap	1) See § 1 of Annex 1 to this Appendix	
No. **9.15** Non-GSO/ terrestrial	A specific earth station or a typical earth station, in respect of terrestrial stations in frequency bands for which a footnote refers to No. **9.11A** allocated with equal rights to space and terrestrial services, where the coordination area of the earth station includes the territory of another country	Frequency bands for which a footnote refers to No. **9.11A**	The coordination area of the earth station covers the territory of another administration	Appendix **7**	

TABLE 5-1 (*continued*) (Rev.WRC-23)

Reference of Article 9	**Case**	**Frequency bands (and Region) of the service for which coordination is sought**	**Threshold/condition**	**Calculation method**	**Remarks**
No. **9.16** Terrestrial/ non-GSO	A transmitting station in a terrestrial service within the coordination area of an earth station in a non-GSO satellite network in frequency bands for which a footnote refers to No. **9.11A**	Frequency bands for which a footnote refers to No. **9.11A**	Transmitting terrestrial station is situated within the coordination area of a receiving earth station		The coordination area of the affected earth station has already been determined using the calculation method of Appendix **7**
No. **9.17** GSO, non-GSO/ terrestrial	A specific earth station or a typical mobile earth station in frequency bands above 100 MHz allocated with equal rights to space and terrestrial services, in respect of terrestrial stations, where the coordination area of the earth station includes the territory of another country, with the exception of the coordination under No. **9.15**	Any frequency band allocated to a space service	The coordination area of the earth station covers the territory of another administration	Appendix **7**	

TABLE 5-1 (*continued*) (Rev.WRC-23)

Reference of Article 9	Case	Frequency bands (and Region) of the service for which coordination is sought	Threshold/condition	Calculation method	Remarks
No. **9.17A** GSO, non-GSO/ GSO, non-GSO	A specific earth station in respect of other earth stations operating in the opposite direction of transmission or for any typical mobile earth station in respect of specific earth stations operating in the opposite direction of transmission in frequency bands allocated with equal rights to space radiocommunication services in both directions of transmission, where the coordination area of the earth station includes the territory of another country or the earth station is located within the coordination area of a coordinated earth station, with the exception of coordination under No. **9.19**	Any frequency band allocated to a space service	The coordination area of the earth station covers the territory of another administration or the earth station is located within the coordination area of an earth station	Appendix **7**	
No. **9.18** Terrestrial/ GSO, non-GSO	Any transmitting station of a terrestrial service in the bands referred to in No. **9.17** within the coordination area of an earth station, in respect of this earth station, with the exception of the coordination under Nos. **9.16** and **9.19**	Any frequency band allocated to a space service	Transmitting terrestrial station is situated within the coordination area of a receiving earth station	See Remarks column	The coordination area of the affected earth station has already been determined using the calculation method of No. **9.17**

TABLE 5-1 (*continued*) (Rev.WRC-23)

Reference of Article 9	**Case**	**Frequency bands (and Region) of the service for which coordination is sought**	**Threshold/condition**	**Calculation method**	**Remarks**
No. **9.19** Terrestrial, GSO, non-GSO/ GSO, non-GSO	Any transmitting station of a terrestrial service or a transmitting earth station in the FSS (Earth-to-space) in a frequency band shared on an equal primary basis with the BSS, with respect to typical earth stations included in the service area of a space station in the BSS	1 452-1 492 MHz 2 310-2 360 MHz (terrestrial services in all three Regions in respect of BSS allocation in No. **5.393**) 2 520-2 670 MHz (see No. **5.416**) 11.7-12.7 GHz (see Article 6 of Appendix **30**) 12.5-12.7 GHz (terrestrial services in Nos. **5.494** and **5.496** as well as in Regions 2 and 3, or transmitting earth station in the FSS (Earth-to-space) in Region 1, in respect of BSS allocation in Region 3) 12.7-12.75 GHz (terrestrial services in Nos. **5.494** and **5.496** as well as in Regions 2 and 3, or transmitting earth station in the FSS (Earth-to-space) in Regions 1 and 2, in respect of BSS allocation in Region 3) 17.7-17.8 GHz (terrestrial services in all three Regions in respect of BSS allocation in Region 2)	i) Necessary bandwidths overlap; and ii) the power flux-density (pfd) of the interfering station at the edge of the BSS service area exceeds the permissible level	Check by using the assigned frequencies and bandwidths	See also Article 6 of Appendix **30**

TABLE 5-1 (*end*) (Rev.WRC-23)

Reference of Article 9	Case	Frequency bands (and Region) of the service for which coordination is sought	Threshold/condition	Calculation method	Remarks
No. **9.19** Terrestrial, GSO, non-GSO/ GSO, non-GSO (*cont.*)		17.3-17.8 GHz (transmitting earth stations in the FSS (Earth-to-space) in respect of BSS allocation in Region 2) (see Article 4 of Appendix **30A**) 40.5-42.5 GHz 74-76 GHz			
No. **9.21** Terrestrial, GSO, non-GSO/ terrestrial, GSO, non-GSO	A station of a service for which the requirement to obtain the agreement of other administrations is included in a footnote to the Table of Frequency Allocations referring to No. **9.21**	Band(s) indicated in the relevant footnote except 13.4-13.65 GHz in Region 1 13.4-13.65 GHz in Region 1 indicated in No. **5.499A**	Incompatibility established by the use of Appendices **7**, **8**, technical Annexes of Appendices **30** or **30A**, pfd values specified in some of the footnotes, other technical provisions of the Radio Regulations or ITU-R Recommendations, as appropriate i) Bandwidth overlap, and ii) any network in the space research service (SRS) with a space station within an orbital arc of ±20° of the nominal orbital position of a proposed network in the FSS	Methods specified in, or adapted from, Appendices **7**, **8**, **30**, **30A**, other technical provisions of the Radio Regulations or ITU-R Recommendations	

ANNEX 1 (REV.WRC-23)

1 Coordination thresholds for sharing between MSS (space-to-Earth) and terrestrial services in the same frequency bands and between non-GSO MSS feeder links (space-to-Earth) and terrestrial services in the same frequency bands and between RDSS (space-to-Earth) and terrestrial services in the same frequency bands (WRC-12)

1.1 Below 1 GHz*

1.1.1 In the frequency bands 137-138 MHz and 400.15-401 MHz, coordination of a space station of the MSS (space-to-Earth) with respect to terrestrial services (except aeronautical mobile (OR) service networks operated by the administrations listed in Nos. **5.204** and **5.206** as of 1 November 1996) is required only if the pfd produced by this space station exceeds −125 dB(W/(m^2 · 4 kHz)) at the Earth's surface. (WRC-23)

1.1.2 In the frequency band 137-138 MHz, coordination of a space station of the MSS (space-to-Earth) with respect to the aeronautical mobile (OR) service is required only if the pfd produced by this space station at the Earth's surface exceeds: (WRC-23)

– −125 dB(W/(m^2 · 4 kHz)) for networks for which complete Appendix **3**** coordination information has been received by the Bureau prior to 1 November 1996;

– −140 dB(W/(m^2 · 4 kHz)) for networks for which complete Appendix **4/S4/3**** coordination information has been received by the Bureau after 1 November 1996 for the administrations referred to in § 1.1.1 above.

1.1.3 In the frequency band 137-138 MHz, coordination is also required for a space station on a replacement satellite of a MSS network for which complete Appendix **3**** coordination information has been received by the Bureau prior to 1 November 1996 and the pfd exceeds −125 dB(W/(m^2 · 4 kHz)) at the Earth's surface for the administrations referred to in § 1.1.1 above. (WRC-23)

1.1.4 In the frequency band 132-137 MHz, coordination of a space station of the aeronautical mobile-satellite (R) service (space-to-Earth) with respect to the aeronautical mobile (OR) service is required only if the pfd produced by this space station exceeds −140 dB(W/(m^2 · 4 kHz)) on the territory of countries listed in No. **5.201** or No. **5.202**. (WRC-23)

1.1.5 In the frequency band 117.975-137 MHz, coordination of a space station of the aeronautical mobile-satellite (R) service (space-to-Earth) with respect to the aeronautical mobile (R) service is required only if the pfd produced by this space station exceeds −150 dB(W/(m^2 · 4 kHz)) at the Earth's surface over the territory of a country. (WRC-23)

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* These provisions apply only to the MSS.

** *Note by the Secretariat*: Edition of 1990, revised in 1994.

1.2 Between 1 and 3 GHz

1.2.1 Objectives

Generally, pfd thresholds were used to determine the need for coordination between space stations of the MSS (space-to-Earth) and terrestrial services and for coordination between space stations of the RDSS (space-to-Earth) and terrestrial services. However, to facilitate sharing between digital fixed service stations and non-GSO MSS space stations, the concept of fractional degradation in performance (FDP) was adopted. This concept involves new methods described in this Annex.

As a consequence of this new concept, the need for coordination between space stations of the MSS (space-to-Earth) and terrestrial services is determined using two methods:

– simple method: FDP (simple definition of the MSS system and characteristics of reference FS stations are used in inputs) or power flux-density trigger value;

– more detailed method: system specific methodology (SSM) (specific characteristics of the MSS system and characteristics of reference fixed service stations are used in inputs) as described, for example, in Annex 1 to the most recent version of Recommendation ITU-R M.1143.

If one of the two methods gives a result that does not exceed the criteria relevant to each method, there is no need for coordination.

If only one method is available in an administration, the result of this method must be taken into account. (WRC-15)

1.2.2 General considerations

1.2.2.1 Method for calculating the value of FDP

The FDP is used in cases of sharing between digital fixed service stations with non-GSO MSS stations (space-to-Earth).

To calculate the value of the FDP, the following parameters are needed:

– technical characteristics of digital fixed service station;

– technical characteristics of non-GSO MSS constellation.

The FDP is calculated:

– by simulating the proposed MSS constellation using the information given in § A.4 of Annex 2 to Appendix **4**;

– by positioning the fixed service station at a certain latitude (each station is assumed to operate at an elevation angle of 0°);

– by calculating for each pointing azimuth (*Az*) varying between 0° and 360°:

  – at each instant in time of the simulation, the aggregate interference from all visible space stations received at the fixed service station;

– the FDP_{Az} for the azimuth Az, using the following formula:

$$FDP_{Az} = \sum_{I_i = \min}^{\max} \frac{I_i f_i}{N_T}$$

– by the following formula:

$$FDP = \max(FDP_{Az})$$

(The formula for FDP applies to the 1-3 GHz frequency range only. A different formula may apply at frequencies above 3 GHz.)

where:

I_i: interference noise power level (W)

f_i: the fractional period of time during which the interference power equals I_i

N_T: station receiving system noise power level = $k\,T\,B$ (W)

k: Boltzmann's constant = 1.38×10^{-23} (J/K)

T: FS station receiving system effective noise temperature (T should be calculated by the following formula:

$$10 \log T = NF + 10 \log T_0$$

where NF (dB) is the receiver noise figure given in Annex 1 and T_0 should be assumed as 290 K)

B: reference bandwidth = 1 MHz.

NOTE – For the purpose of FDP calculation according to this Annex, it should be assumed that all space stations in the same MSS constellation operate on the same frequencies.

1.2.2.2 Characteristics of reference systems in the fixed service

The following parameters represent the set of reference parameters of the fixed service.

1.2.2.2.1 Characteristics of reference digital point-to-point systems

Three different digital systems are described in the following Table:

– 64 kbit/s capacity used, for example, for outside plant (individual subscriber connection);

– 2 Mbit/s capacity used, for example, for business subscriber connections for the local part of the inside plant;

– 45 Mbit/s capacity used, for example, for trunk networks.

Capacity	64 kbit/s	2 Mbit/s	45 Mbit/s
Modulation	4-PSK	8-PSK	64-QAM
Antenna gain (dB)	33	33	33
Transmit power (dBW)	7	7	1
Feeder/multiplexer loss (dB)	2	2	2
e.i.r.p. (dBW)	38	38	32
Receiver IF bandwidth (MHz)	0.032	0.7	10
Receiver noise figure (dB)	4	4.5	4
Receiver input level for a BER of 10^{-3} (dBW)	−137	−120	−106

Antenna pattern:

$$G(\varphi) = G_{max} - 2.5 \times 10^{-3} \left(\frac{D\varphi}{\lambda}\right)^2 \quad \text{for} \quad 0 < \varphi < \varphi_m$$

$$G(\varphi) = 39 - 5 \log (D/\lambda) - 2.5 \log \varphi \quad \text{for} \quad \varphi_m \leq \varphi < 48°$$

$$G(\varphi) = -3 - 5 \log (D/\lambda) \quad \text{for} \quad 48° \leq \varphi \leq 180°$$

where:

$G(\varphi)$: gain relative to an isotropic antenna (dBi)

φ: off-axis angle (degrees)

D: antenna diameter

λ: wavelength expressed in the same unit as D

G_1: gain of the first side-lobe = 2 + 15 log (D/λ)

(D/λ may be estimated from 20 log (D/λ) ≈ G_{max} – 7.7)

G_{max}: main lobe antenna gain (dBi)

$$\varphi_m = 20 \ (\lambda/D) \times \sqrt{(G_{max} - G_1)}$$

It should be noted that the above antenna radiation pattern corresponds to the average side-lobe pattern and it is recognized that individual side-lobes may exceed it by up to 3 dB.

1.2.2.2.2 Characteristics of reference analogue point-to-point systems

Reference circuit	12 hops with 50 km distance between stations
Antenna gain (dBi)	33
e.i.r.p. (dBW)	36
Feeder/multiplexer loss (dB)	3
Receiver noise figure (referred to input of receiver) (dB)	8
Maximum short- and long-term interference in the reference circuit:	
– baseband interfering signal power level not to be exceeded for more than 20% of the time	240 pW0p
– baseband interfering signal power level not to be exceeded for more than 0.01% of the time	50 000 pW0p

Antenna pattern: use antenna pattern of § 1.2.2.2.1.

1.2.2.2.3 Characteristics of reference point-to-multipoint systems

NOTE – In application of the standard computation program, the use of the point-to-multipoint reference fixed service system parameters for the 2 170-2 200 MHz band is not required.

Parameter	Central station	Outstation
Antenna type	Omni/sectoral	Dish/horn
Antenna gain (dBi)	10/13	20 (analogue) 27 (digital)
e.i.r.p. (max) (dBW): – analogue – digital	 12 24	 21 34
Noise figure (dB)	3.5	3.5
Feeder/multiplexer loss (dB)	2	2
IF bandwidth (MHz)	3.5	3.5

Antenna pattern:

For the outstation antenna pattern, the reference pattern described in § 1.2.2.2.1 is to be used.

The reference radiation pattern for omnidirectional or sectoral antennas is the following:

$$G(\theta) = G_0 - 12\,(\theta/\varphi_3)^2 \qquad \text{for} \quad 0 \le \theta < \varphi_3$$

$$G(\theta) = G_0 - 12 - 10 \log (\theta/\varphi_3) \qquad \text{for} \quad \varphi_3 \le \theta < 90°$$

where:

G_0: maximum gain in the horizontal plane (dBi)

θ: radiation angle above the horizontal plane (degrees)

φ_3 (degrees) is given by:

$$\varphi_3 = \frac{1}{\alpha^2 - 0.818}$$

where:

$$\alpha = \frac{10^{0.1G_0} + 172.4}{191}$$

1.2.3 Determination of the need for coordination between MSS and RDSS space stations (space-to-Earth) and terrestrial stations (WRC-12)

1.2.3.1 Method for the determination of the need for coordination between MSS and RDSS space stations (space-to-Earth) and other terrestrial services sharing the same frequency band in the 1 to 3 GHz range

Coordination of assignments for transmitting space stations of the MSS and RDSS with respect to terrestrial services is not required if the pfd produced at the Earth's surface or the FDP of a station in the fixed service does not exceed the threshold values shown in the following table. (WRC-12)

TABLE 5-2 (Rev.WRC-19)

Frequency band (MHz)	**Terrestrial service to be protected**	**Coordination threshold values**				
		GSO space stations		**Non-GSO space stations**		
		pfd (per space station) calculation factors (NOTE 2)		**pfd (per space station) calculation factors (NOTE 2)**		**% FDP (in 1 MHz) (NOTE 1)**
		P	***r* dB/ degrees**	***P***	***r* dB/ degrees**	
1 518-1 525	Analogue FS telephony (NOTE 5)	−146 dB(W/m^2) in 4 kHz and −128 dB(W/m^2) in 1 MHz	0.5	−146 dB(W/m^2) in 4 kHz and −128 dB(W/m^2) in 1 MHz	0.5	
	All other cases FS telephony (NOTES 4 and 8)	−128 dB(W/m^2) in 1 MHz	0.5	−128 dB(W/m^2) in 1 MHz	0.5	25
1 525-1 530	Analogue FS telephony (NOTE 5)	−146 dB(W/m^2) in 4 kHz and −128 dB(W/m^2) in 1 MHz	0.5	−146 dB(W/m^2) in 4 kHz and −128 dB(W/m^2) in 1 MHz	0.5	
	All other cases	−128 dB(W/m^2) in 1 MHz	0.5	−128 dB(W/m^2) in 1 MHz	0.5	25
2 160-2 200 (NOTE 3)	Analogue FS telephony (NOTE 5)	−146 dB(W/m^2) in 4 kHz and −128 dB(W/m^2) in 1 MHz	0.5	−141 dB(W/m^2) in 4 kHz and −123 dB (W/m^2) in 1 MHz (NOTE 6)	0.5	
	All other cases	−128 dB(W/m^2) in 1 MHz	0.5	−123 dB(W/m^2) in 1 MHz (NOTE 6)	0.5	25
2 483.5-2 500 (mobile-satellite service)	All cases	–146 dB(W/m^2) in 4 kHz and –128 dB(W/m^2) in 1 MHz	0.5	−144 dB(W/m^2) in 4 kHz and −126 dB(W/m^2) in 1 MHz (NOTE 9)	0.65	
2 483.5-2 500 (radiodeterm-ination-satellite service) (NOTE 10)	All cases except the radiolocation service in the countries listed in No. **5.398A**	−152 dB(W/m^2) in 4 kHz −128 dB(W/m^2) in 1 MHz	–	−153 dB(W/m^2) in 4 kHz −129 dB(W/m^2) in 1 MHz (NOTE 9)		
2 500-2 520 (SUP - WRC-07)						
2 520-2 535 (SUP - WRC-07)						

Notes for Table 5-2:

NOTE 1 – The calculation of FDP is contained in § 1.2.2.1, using the reference FS parameters contained in § 1.2.2.2.1 and 1.2.2.2.3. The use of FDP threshold is limited to the case of digital FS systems.

NOTE 2 – The following formula should be used for deriving the coordination threshold in terms of pfd:

P for $0° \leq \delta \leq 5°$

$P + r(\delta - 5)$ for $5° < \delta \leq 25°$

$P + 20r$ for $25° < \delta \leq 90°$

where δ is the angle of arrival (degrees).

The threshold values are obtained under assumed free-space propagation conditions.

NOTE 3 – The coordination thresholds in the band 2 160-2 170 MHz (Region 2) and 2 170-2 200 MHz (all Regions) to protect other terrestrial services do not apply to International Mobile Telecommunications (IMT) systems, as the satellite and the terrestrial components are not intended to operate in the same area or on common frequencies within these bands. (WRC-12)

NOTE 4 – Exceptions for the band 1 518-1 525 MHz are as follows:

4.1 For the land mobile service on the territory of Japan (No. **5.348A**): −150 dB(W/m^2) in 4 kHz at all angles of arrival is applicable to all satellite space-to-Earth emissions.

4.2 For the aeronautical mobile service for telemetry on the territory of the administrations listed in No. **5.342**: −140 dB(W/m^2) in 4 kHz at all angles of arrival.

4.3 For the point-to-multipoint systems operating in the fixed service in the territory of New Zealand: −138 dB(W/m^2) in 1 MHz for angles of arrival less than or equal to 5° above the horizon and increasing linearly to −125 dB(W/m^2) in 1 MHz for angles of arrival equal to 25° or greater above the horizon. (WRC-03)

NOTE 5 – In all cases involving sharing with analogue systems for telephony in the FS, further coordination is only required when the pfd values are greater than or equal to the coordination threshold values in both reference bandwidths.

NOTE 6 – The pfd values specified for the band 2 160-2 200 MHz provide full protection for analogue radio-relay systems using the sharing criteria established by the most recent version of Recommendation ITU-R SF.357, for operation with a non-GSO MSS system employing narrow-band time division multiple access/frequency division multiple access techniques.

NOTE 7 – (SUP - WRC-12)

NOTE 8 – In the band 1 518-1 520 MHz, for the point-to-multipoint systems operating in the fixed service on the territory of Australia: –138 dB(W/m^2) in 1 MHz for angles of arrival less than or equal to 5° above the horizon and increasing linearly to –125 dB(W/m^2) in 1 MHz for angles of arrival equal to 25° or greater above the horizon. (WRC-03)

NOTE 9 – Instead of the values in the Table, the pfd coordination thresholds of −142.5 dB(W/m^2) in 4 kHz and −124.5 dB(W/m^2) in 1 MHz for the MSS and −152 dB(W/m^2) in 4 kHz and −128 dB(W/m^2) in 1 MHz for the RDSS shall apply in Albania, Germany, Andorra, Antigua and Barbuda, Argentina, Australia, Austria, Bahamas, Barbados, Belgium, Belize, Bolivia (Plurinational State of), Bosnia and Herzegovina, Brazil, Bulgaria, Canada, Chile, Cyprus, Vatican, Colombia, Congo (Rep. of the), Costa Rica, Croatia, Denmark, Dominican Rep., Dominica, El Salvador, Ecuador, Spain, Estonia, United States, Finland, France, Greece, Grenada, Guatemala, Guyana, Haiti, Honduras, Hungary, Ireland, Iceland, Israel, Italy, Jamaica, Latvia, Liechtenstein, Lithuania, Luxembourg, North Macedonia, Malta, Mexico, Monaco, Montenegro, Nicaragua, Nigeria, Norway, Panama, Paraguay, Netherlands, Peru, Poland, Portugal, Türkiye, Slovakia, Czech Rep., Romania, United Kingdom, Saint Lucia, Saint Kitts and Nevis, San Marino, Saint Vincent and the Grenadines, Serbia, Slovenia, Sweden, Switzerland, Suriname, Trinidad and Tobago, Uruguay and Venezuela. (WRC-23)

NOTE 10 – These pfd values apply only to systems submitted after 17 February 2012 and do not apply to systems for which complete coordination information has been received before 18 February 2012 (see No. **5.401**). (WRC-12)

1.2.3.2 A system specific methodology (SSM) to be used in determining the need for detailed coordination of non-GSO MSS (space-to-Earth) systems with fixed service systems

The purpose of the SSM is to allow a detailed assessment of the need to coordinate frequency assignments to non-GSO MSS space stations (space-to-Earth) with frequency assignments to receiving stations in a fixed service network of a potentially affected administration. The SSM takes into account specific characteristics of the non-GSO MSS system and reference fixed service characteristics.

Those administrations planning to establish the need for coordination between non-GSO MSS networks and fixed service systems are encouraged to use the most recent version of Recommendation ITU-R M.1143. While urgent additional development work is being undertaken in the ITU-R to facilitate the use of the methodology described in the most recent version of Recommendation ITU-R M.1143, administrations may be able to effect coordination by applying this SSM. (WRC-15)

1.3 (SUP - WRC-15)

2 (SUP - WRC-2000)

3 (SUP - WRC-2000)

APPENDIX 7 (REV.WRC-23)

Methods for the determination of the coordination area around an earth station in frequency bands between 100 MHz and 105 GHz

1 Introduction

This Appendix addresses the determination of the coordination area (see No. **1.171**) around a transmitting or receiving earth station that is sharing spectrum in frequency bands between 100 MHz and 105 GHz with terrestrial radiocommunication services or with earth stations operating in the opposite direction of transmission.

The coordination area represents the area surrounding an earth station sharing the same frequency band with terrestrial stations, or the area surrounding a transmitting earth station that is sharing the same bidirectionally allocated frequency band with receiving earth stations, within which the permissible level of interference may be exceeded and hence coordination is required. The coordination area is determined on the basis of known characteristics for the coordinating earth station and on conservative assumptions for the propagation path and for the system parameters for the unknown terrestrial stations (see Tables 7 and 8), or the unknown receiving earth stations (see Table 9), that are sharing the same frequency band.

Throughout this Appendix, the word "unknown", when applied to terrestrial stations or earth stations, refers to such stations whose specific operational parameters and potential location within the coordination area are unknown. (WRC-23)

1.1 Overview

This Appendix contains procedures and system parameters for calculating an earth station's coordination area, including predetermined distances.

The procedures allow the determination of a distance in all azimuthal directions around a transmitting or receiving earth station beyond which the predicted path loss would be expected to exceed a specified value for all but a specified percentage of the time. This distance is called the coordination distance (see No. **1.173**). When the coordination distance is determined for each azimuth around the coordinating earth station it defines a distance contour, called the coordination contour (see No. **1.172**), that encloses the coordination area.

It is important to note that, although the determination of the coordination area is based on technical criteria, it represents a regulatory concept. Its purpose is to identify the area within which detailed evaluations of the interference potential need to be performed in order to determine whether the coordinating earth station or any of the terrestrial stations, or in the case of a bidirectional allocation any of the receiving earth stations that are sharing the same frequency band, will experience unacceptable levels of interference. Hence, the coordination area is not an exclusion zone within which the sharing of frequencies between the earth station and terrestrial stations or other earth stations is prohibited, but a means for determining the area within which more detailed calculations need to be performed. In most cases a more detailed analysis will show that sharing within the coordination area is possible since the procedure for the determination of the coordination area is based on unfavourable assumptions with regard to the interference potential.

For the determination of the coordination area, two separate cases are to be considered:

– case when the earth station is transmitting and hence capable of interfering with receiving terrestrial stations or earth stations;

– case when the earth station is receiving and hence may be the subject of interference from transmitting terrestrial stations.

Calculations are performed separately for great circle propagation mechanisms (propagation mode (1)) and, if required by the sharing scenario (see § 1.4), for scattering from hydrometeors (propagation mode (2)). The coordination contour is then determined using the greater of the two distances predicted by the propagation mode (1) and propagation mode (2) calculations for each azimuth around the coordinating earth station. Separate coordination contours are produced for each sharing scenario. Guidance and examples of the construction of coordination contours, and their component propagation mode (1) and propagation mode (2) contours, are provided in § 1.6.

To facilitate bilateral discussion it can be useful to calculate additional contours, defining smaller areas, that are based on less conservative assumptions than those used for the calculation of the coordination contour.

1.2 Structure of this Appendix

In this Appendix the general principles are separated from the detailed text on methods. The general principles are contained in the main body of the Appendix, while the methods are contained in a series of Annexes, enabling the user to select only those sections that are relevant for a specific sharing scenario.

Table 1 is provided to help the user to navigate through the Appendix and the Annexes; it also indicates the relevant sections that need to be explored for a specific coordination case.

TABLE 1

Cross-reference between sharing scenarios and calculation methods

	Sharing scenarios of § 1.4						
Applicable sections and Annexes	§ 1.4.1 Earth stations operating with geostationary space stations	§ 1.4.2 Earth stations operating with non-geostationary space stations[1]	§ 1.4.3 Earth stations operating with both geostationary and non-geostationary space stations	§ 1.4.4 Earth stations operating in bidirectionally allocated frequency bands	§ 1.4.5 Broadcasting-satellite service earth stations	§ 1.4.6 Mobile (except aeronautical mobile) earth stations	§ 1.4.7 Aeronautical mobile earth stations
§ 1.3 Basic concepts	X	X	X	X	X	X	X
§ 1.5 Propagation model concepts	X	X	X	X	See § 1.4.1, 1.4.2, 1.4.3 or 1.4.4 as applicable and § 1.6	See § 1.4.1, 1.4.2, 1.4.3 or 1.4.4 as applicable and § 1.6	See § 1.4.1, 1.4.2, 1.4.3 or 1.4.4 as applicable and § 1.6
§ 1.6 The coordination contour: concepts and construction	X	X	X	X			
§ 2.1 Earth stations operating with geostationary space stations	X		X				
§ 2.2 Earth stations operating with non-geostationary space stations		X	X				
§ 3 Determination of the coordination area between earth stations operating in bidirectionally allocated frequency bands				X			
§ 4 General considerations for the determination of the propagation mode (1) required distance	X	X	X	X			
§ 5 General considerations for the determination of the propagation mode (2) required distance	X		X				
Annex 1 Determination of the required distance for propagation mode (1)	X	X	X	X			
Annex 2 Determination of the required distance for propagation mode (2)	X		X				
Annex 3 Antenna gain towards the horizon for an earth station operating with a geostationary space station	X		X				
Annex 4 Antenna gain towards the horizon for earth stations operating with non-geostationary space stations		X	X	X			
Annex 5 Determination of the coordination area for a transmitting earth station with respect to receiving earth stations operating with geostationary space stations in bidirectionally allocated frequency bands				X			
Annex 6 Supplementary and auxiliary contours	X	X	X	X			
Annex 7 System parameters and predetermined coordination distances for determination of the coordination area around an earth station	X	X	X	X			

[1] For an earth station using a non-tracking antenna the procedure of § 2.1 is used. For an earth station using a non-directional antenna the procedures of § 2.1.1 are used.

1.3 Basic concepts

Determination of the coordination area is based on the concept of the permissible interference power at the antenna terminals of a receiving terrestrial station or earth station. Hence, the attenuation required to limit the level of interference between a transmitting terrestrial station or earth station and a receiving terrestrial station or earth station to the permissible interference power for p% of the time is represented by the "minimum required loss", which is the loss that needs to be equalled or exceeded by the predicted path loss for all but p% of the time[1].

For propagation mode (1) the following equation applies:

$$L_b(p) = P_t + G_t + G_r - P_r(p) \qquad \text{dB} \qquad (1)$$

where:

p: maximum percentage of time for which the permissible interference power may be exceeded

$L_b(p)$: propagation mode (1) minimum required loss (dB) for p% of the time; this value must be exceeded by the propagation mode (1) predicted path loss for all but p% of the time

P_t: maximum available transmitting power level (dBW) in the reference bandwidth at the terminals of the antenna of a transmitting terrestrial station or earth station

$P_r(p)$: permissible interference power of an interfering emission (dBW) in the reference bandwidth to be exceeded for no more than p% of the time at the terminals of the antenna of a receiving terrestrial station or earth station that may be subject to interference, where the interfering emission originates from a single source

G_t: gain (dB relative to isotropic) of the antenna of the transmitting terrestrial station or earth station. For a transmitting earth station, this is the antenna gain towards the physical horizon on a given azimuth; for a transmitting terrestrial station, the maximum main beam axis antenna gain is to be used

G_r: gain (dB relative to isotropic) of the antenna of the receiving terrestrial or earth station that may be subject to interference. For a receiving earth station, this is the gain towards the physical horizon on a given azimuth; for a receiving terrestrial station, the maximum main beam axis antenna gain is to be used.

In the case of a receiving earth station, the permissible interference power $P_r(p)$ is specified with respect to the actual percentage of time the receiver is in operation, rather than the total elapsed time.

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[1] When p is a small percentage of the time, in the range 0.001% to 1.0%, the interference is referred to as "short-term"; if $p \geq 20$%, it is referred to as "long-term" (see § 1.5.3).

For propagation mode (2), a volume scattering process is involved and a modification of the above approach is necessary. Where the coordinating earth station antenna beam intersects a rain cell, a common volume may be formed with a terrestrial station beam or an earth station beam (operating in the opposite direction of transmission in bidirectionally allocated frequency bands). In the case of a terrestrial station, the assumptions are made that the terrestrial station beamwidth is relatively large in comparison with that of the coordinating earth station (terrestrial station gain values are given in Tables 7 and 8) and that the terrestrial station is some distance from the common volume. The terrestrial station beam is therefore assumed to illuminate the whole rain cell, which is represented by a vertical cylinder filled with hydrometeors that give rise to isotropically scattered signals. This scattering process may give rise to unwanted coupling between the coordinating earth station and terrestrial stations or other earth stations operating in bidirectionally allocated frequency bands, via the common volume.

The earth station antenna gain and its beamwidth are interdependent. The size of the common volume, and the number of scattered signals arising within that volume, increases as the gain of the earth station antenna transmitting or receiving those signals decreases, the one effect compensating for the other. A term which approximates the full integral required to evaluate the volume scattering process within the earth station antenna beam is included in equation (72). Therefore in the procedure for evaluation of interference that may arise from propagation mode (2) mechanisms a simplifying assumption can be made that the path loss is independent of the earth station antenna gain[2].

Hence for propagation mode (2), equation (1) reduces to:

$$L_x(p) = P_t + G_x - P_r(p) \qquad \text{dB} \qquad (2)$$

where:

$L_x(p)$: minimum loss required for propagation mode (2)

G_x: maximum antenna gain (dBi) assumed for the terrestrial station. Tables 7 and 8 give values of G_x for the various frequency bands.

To facilitate the calculation of propagation mode (2) auxiliary contours (see Annex 6) the calculation is further modified by placing the terrestrial network antenna gain G_x within the iterative loop for the propagation mode (2) required loss calculations[3].

Hence equation (2) further reduces to:

$$L(p) = P_t - P_r(p) \qquad \text{dB} \qquad (3)$$

---

[2] If the earth station antenna has a wide beamwidth, the method can still be used to determine the propagation mode (2) contour. However, the fact that the antenna beam may be wider than the rain cell and hence not actually fully filled with hydrometeors will mean that the interference potential may be slightly overestimated.

[3] See equation (82).

where:

$L(p)$: propagation mode (2) minimum required loss (dB) for p% of the time; this value must be exceeded by the propagation mode (2) predicted path loss for all but p% of the time.

For both modes of propagation, P_t and $P_r(p)$ are defined for the same radio-frequency bandwidth (the reference bandwidth). Further, $L_b(p)$, $L(p)$ and $P_r(p)$ are defined for the same small percentage of the time, and these values are set by the performance criteria of the receiving terrestrial station or receiving earth station that may be subject to interference.

For an earth station operating with a geostationary space station, Annex 3 provides the numerical method for determining the minimum angle between the earth station antenna main beam axis and the physical horizon as a function of azimuth, and the corresponding antenna gain. In the case of a space station in a slightly inclined geostationary orbit, the minimum elevation angle and corresponding horizon gain will depend on the maximum inclination angle to be coordinated.

For an earth station operating with non-geostationary space stations, the antenna gain of the earth station in the direction of the horizon varies as a function of time and Annex 4 provides the numerical methods for its determination.

For an earth station operating in a frequency band with a bidirectional allocation, the antenna gain to be used in determining the propagation mode (1) minimum required loss is calculated using the methods in Annex 3 or Annex 4, as appropriate.

Determination of the coordination area requires the calculation of the predicted path loss and its comparison with the minimum required loss, for every azimuth around the coordinating earth station, where:

– the predicted path loss is dependent on several factors including the length and general geometry of the interfering path (e.g. antenna pointing, horizon elevation angle), antenna directivity, radio climatic conditions, and the percentage of the time during which the predicted path loss is less than the minimum required loss; and

– the minimum required loss is based on system and interference model considerations.

The required coordination distance is the distance at which these two losses are considered to be equal for the stated percentage of time.

In determining the coordination area, the pertinent parameters of the coordinating earth station are known, but knowledge of the terrestrial stations or other earth stations sharing that frequency range is limited. Hence it is necessary to rely on assumed system parameters for the unknown terrestrial stations or the unknown receiving earth stations. Furthermore, many aspects of the interference path between the coordinating earth station and the terrestrial stations or other earth stations (e.g. antenna geometry and directivity) are unknown.

The determination of the coordination area is based on unfavourable assumptions regarding system parameter values and interference path geometry. However, in certain circumstances, to assume that all the worst-case values will occur simultaneously is unrealistic, and leads to unnecessarily large values of minimum required loss. This could lead to unnecessarily large coordination areas. For propagation mode (1), detailed analyses, supported by extensive operational experience, have shown that the requirement for the propagation mode (1) minimum required loss can be reduced because of the very small probability that the worst-case assumptions for system parameter values and interference path geometry will exist simultaneously. Therefore, a correction is applied within the calculation for the propagation mode (1) predicted path loss in the appropriate sharing scenario to allow benefit to be derived from these mitigating effects. The application of this correction factor is described in more detail in § 4.4.

This correction applies to cases of coordination with the fixed service. It is frequency, distance and path dependent. It does not apply in the case of the coordination of an earth station with mobile stations, nor with other earth stations operating in the opposite direction of transmission, nor in the case of propagation via hydrometeor scatter (propagation mode (2)).

A number of propagation models are used to cover the propagation mechanisms that exist in the full frequency range. These models predict the path loss as a monotonically increasing function of distance. Therefore, coordination distances are determined by calculating the path loss iteratively for an increasing distance until either the minimum required loss is achieved, or a maximum calculation distance limit is reached (see § 1.5.3).

The iteration method always starts at a defined value of minimum distance, d_{min} (km), and iteration is performed using a uniform step size, s (km), for increasing the distance. A step size of 1 km is recommended.

1.4 Sharing scenarios

The following subsections describe the basic assumptions made for the various earth station sharing scenarios. These subsections need to be read in conjunction with the information contained in Table 1 and § 1.6 which contains guidance on the development of a coordination contour. Except as discussed in § 1.4.5 to 1.4.7, the earth stations around which coordination areas are determined are assumed to be fixed earth stations authorized to operate at a single permanent location. In cases of earth stations that can be operated from a number of fixed locations, the coordination areas are determined for each individual location.[4]

[4] While some fixed satellite systems transmit to fixed earth stations operating at unspecified locations within a service area defined by an administration, methods for determining the coordination areas are specified only for individual sites. To minimize the number of individual earth stations requiring detailed coordination in these cases, administrations may wish to develop bilateral agreements based on distances, calculated in accordance with Recommendation ITU-R SM.1448, extended from the periphery of a service area.

1.4.1 Earth stations operating with geostationary space stations

For an earth station operating with a space station in the geostationary orbit, the space station appears to be stationary with respect to the Earth. However variations in gravitational forces acting on the space station and limitations in positional control mean that a geostationary space station's orbital parameters are not constant. Movement from the space station's nominal orbital position in an east/west direction (longitudinal tolerance) is limited under the Radio Regulations (see Nos. **22.6** to **22.18**), but movement in the north/south direction (inclination excursion) is not specified.

Relaxation in the north/south station-keeping of a geostationary space station allows its orbit to become inclined, with an inclination that increases gradually with time. Therefore the determination of the coordination area requires consideration of the range of movement of the earth station antenna. Although the direction of pointing of the earth station antenna may in practice vary with time, the earth station antenna may also be pointing in one direction for considerable periods of time. Hence the gain of the earth station antenna in the direction of the horizon is assumed to be constant. For an earth station operating with a space station in an orbit as described above, an assumption of constant horizon gain as the inclination angle increases may lead to a conservative estimation of the coordination area, the degree of conservatism increasing with increasing inclination angle.

For an earth station operating with a geostationary space station the coordination area is determined using the procedures described in § 2.1.

1.4.2 Earth stations operating with non-geostationary space stations

Earth stations operating with non-geostationary space stations may use a directional or a non-directional antenna. Furthermore, earth stations using a directional antenna may track the orbital path of a non-geostationary space station.

While an earth station operating with a geostationary space station is assumed to have a constant antenna gain towards the horizon, for an earth station antenna that is tracking the orbital path of a non-geostationary space station, the antenna gain towards the horizon will vary with time. Therefore, it is necessary to estimate the variation of the antenna gain with time towards the horizon for each azimuth in order to determine the coordination area. The procedure is described in § 2.2.

For an earth station operating with a non-geostationary space station, the motion of a relatively high gain tracking antenna reduces the probability of interference due to propagation mode (2) mechanisms and hence the propagation mode (2) required distances will be relatively short. The minimum coordination distance d_{min} (see § 1.5.3) will provide adequate protection in these cases. The propagation mode (2) contour is therefore taken to be identical to a circle whose radius is the minimum coordination distance. Propagation mode (2) calculations are not required in these circumstances and the coordination area is determined using the propagation mode (1) procedure in § 2.2 only.

For an earth station operating with a non-geostationary space station using a non-directional antenna, a similar situation applies, and the low gain means that propagation mode (2) required distances will be less than the minimum coordination distance. Hence, for the case of a non-directional antenna the propagation mode (2) contour is also coincident with the circle of radius d_{min}, and the coordination area is determined using the propagation mode (1) procedures described in § 2.1.1 only.

For an earth station operating with a non-geostationary space station using a non-tracking directional antenna, the potential for interference arising from propagation mode (2) is the same as for an earth station operating with a geostationary space station. Hence, for the case of non-tracking directional antenna the coordination area is determined using both the propagation mode (1) and propagation mode (2) procedures described in § 2.1.

1.4.3 Earth stations operating with both geostationary and non-geostationary space stations

For earth stations that are sometimes intended to operate with geostationary space stations and at other times with non-geostationary space stations, separate coordination areas are determined for each type of operation. In such cases, the coordination area for the geostationary space station is determined using the procedures described in § 2.1 and the coordination area for the non-geostationary space station is determined using the procedure described in § 2.2. For each case, the percentage of time, p, is specified for all the operational time that the receiving earth station is expected to spend in reception from geostationary space stations or non-geostationary space stations, as appropriate.

1.4.4 Earth stations operating in bidirectionally allocated frequency bands

For earth stations operating in some frequency bands there may be allocations with equal rights to space services operating in both the Earth-to-space and space-to-Earth directions. In this case, where two earth stations are operating in opposite directions of transmission it is only necessary to establish the coordination area for the transmitting earth station, as receiving earth stations will automatically be taken into consideration. Hence, a receiving earth station operating in a bidirectionally allocated frequency band will only be involved in coordination with a transmitting earth station if it is located within the transmitting earth station's coordination area.

For a transmitting earth station operating with either geostationary or non-geostationary satellites in a bidirectionally allocated frequency band, the coordination area is determined using the procedures described in § 3. (WRC-03)

1.4.5 Broadcasting-satellite service earth stations

For earth stations in the broadcasting-satellite service operating in the unplanned bands, the coordination area is determined by extending the periphery of the specified service area within which the earth stations are operating by the coordination distance based on a typical BSS earth station. In calculating the coordination distance, no additional protection can be assumed to be available from the earth station horizon elevation angle, i.e. A_h = 0 dB in Annex 1, for all azimuth angles around the earth station.

1.4.6 Mobile (except aeronautical mobile) earth stations

For a mobile (except aeronautical mobile) earth station, the coordination area is determined by extending the periphery of the specified service area, within which the mobile (except aeronautical mobile) earth stations are operating, by the coordination distance. The coordination distance may be represented by a predetermined coordination distance (see Table 10), or it may be calculated. In calculating the coordination distance, no additional protection can be assumed to be available from the earth station horizon elevation angle, i.e. A_h = 0 dB in Annex 1, for all azimuths around the earth station.

1.4.7 Aeronautical mobile earth stations

For aeronautical mobile earth stations, the coordination area is determined by extending the periphery of the specified service area within which the aeronautical mobile earth station operates, by an appropriate predetermined coordination (see Table 10) distance for the respective services.

1.5 Propagation model concepts

For each mode of propagation, according to the requirements of the specific sharing scenario (see § 1.4) it is necessary to determine the predicted path loss. The determination of this predicted path loss is based on a number of propagation mechanisms.

Interference may arise through a range of propagation mechanisms whose individual dominance depends on climate, radio frequency, time percentage in question, distance and path topography. At any given point in time, one or more mechanisms may be present. The propagation mechanisms that are considered within this Appendix in the determination of the interference potential are as follows:

– *Diffraction*: Insofar as it relates to diffraction losses occurring over the earth station's local physical horizon. This effect is referred to below as "site shielding". The remainder of the path along each radial is considered to be flat and therefore free of additional diffraction losses.

– *Tropospheric scatter*: This mechanism defines the "background" interference level for paths longer than about 100 km, beyond which the diffraction field becomes very weak.

– *Surface ducting*: This is the most important short-term interference mechanism over water and in flat coastal land areas, and can give rise to high signal levels over greater distances, sometimes exceeding 500 km. Such signals can exceed the equivalent "free-space" level under certain conditions.

– *Elevated layer reflection and refraction*: The treatment of reflection and/or refraction from layers at heights of up to a few hundred metres is an important mechanism that enables signals to by-pass any diffraction losses due to the underlying terrain under favourable path geometry situations. Here again, the impact can be significant over long distances.

– *Hydrometeor scatter*: Hydrometeor scatter can be a potential source of interference between terrestrial station transmitters and earth stations because it may act isotropically, and can therefore have an impact irrespective of whether the common volume is on or off the great-circle interference path between the coordinating earth station and terrestrial stations, or other receiving earth stations operating in bidirectionally allocated frequency bands.

In this Appendix, propagation phenomena are classified into two modes as follows:

– *Propagation mode (1)*: propagation phenomena in clear air (tropospheric scatter, ducting, layer reflection/refraction, gaseous absorption and site shielding). These phenomena are confined to propagation along the great-circle path.

– *Propagation mode (2)*: hydrometeor scatter.

1.5.1 Propagation mode (1)

For the determination of the propagation mode (1) required distances, the applicable frequency range has been divided into three parts:

– For VHF/UHF frequencies between 100 MHz and 790 MHz and for time percentages from 1% to 50% of an average year.

– From 790 MHz to 60 GHz and for time percentages from 0.001% to 50% of an average year.

– From 60 GHz to 105 GHz and for time percentages from 0.001% to 50% of an average year.

The variation in predicted path loss due to the horizon elevation angle around an earth station is calculated by the method described in § 1 of Annex 1, using the horizon elevation angles and distances along different radials from the earth station. For all frequencies between 100 MHz and 105 GHz, the attenuation arising from the horizon characteristics is included in the value of propagation mode (1) predicted path loss, unless its use is specifically prohibited for a particular sharing scenario (see § 1.4.5 and § 1.4.6).

In the determination of the propagation mode (1) required distance, the world is divided into four basic radio-climatic zones. These zones are defined as follows:

– Zone A1: coastal land, i.e. land adjacent to a Zone B or a Zone C area (see below), up to an altitude of 100 m relative to mean sea or water level, but limited to a maximum distance of 50 km from the nearest Zone B or Zone C area; in the absence of precise information on the 100 m contour, an approximation (e.g. 300 feet) may be used. Large inland areas of at least 7 800 km^2 which contain many small lakes, or a river network, comprising more than 50% water, and where more than 90% of the land is less than 100 m above the mean water level may be included in Zone A1[5].

– Zone A2: all land, other than coastal land as defined in Zone A1 above.

[5] These additional areas may be declared as coastal Zone A1 areas by administrations for inclusion in the ITU Digital World Map (IDWM).

– Zone B: “cold” seas, oceans and large bodies of inland water situated at latitudes above 30°, with the exception of the Mediterranean Sea and the Black Sea. A “large” body of inland water is defined, for the administrative purpose of coordination, as one having an area of at least 7 800 km^2, but excluding the area of rivers. Islands within such bodies of water are to be included as water within the calculation of this area if they have elevations lower than 100 m above the mean water level for more than 90% of their area. Islands that do not meet these criteria should be classified as land for the purposes of calculating the area of the water.

– Zone C: “warm” seas, oceans and large bodies of inland water situated at latitudes below 30°, as well as the Mediterranean Sea and the Black Sea.

1.5.2 Propagation mode (2)

For the determination of the propagation mode (2) required distance, interference arising from hydrometeor scatter can be ignored at frequencies below 1 000 MHz and above 40.5 GHz outside the minimum coordination distance (see § 1.5.3.1). Below 1 000 MHz, the level of the scattered signal is very low and above 40.5 GHz, although significant scattering occurs, the scattered signal is then highly attenuated along the path from the scatter volume to the receiving terrestrial station or earth station. Site shielding is not relevant to propagation mode (2) mechanisms as the interference path is via the main beam of the coordinating earth station antenna.

1.5.3 Distance limits

The effect of interference on terrestrial and space systems often needs to be assessed by considering long- and short-term interference criteria. These criteria are generally represented by a permissible interference power not to be exceeded for more than a specified percentage of time.

The long-term interference criterion (typically associated with percentages of time ≥ 20%) allows the error performance objective (for digital systems) or noise performance objective (for analogue systems) to be met. This criterion will generally represent a low level of interference and hence require a high degree of isolation between the coordinating earth station and terrestrial stations, or other receiving earth stations operating in bidirectionally allocated bands.

The short-term criterion is a higher level of interference, typically associated with time percentages in the range 0.001% to 1% of time, which will either make the interfered-with system unavailable, or cause its specified short-term interference objectives (error rate or noise) to be exceeded.

This Appendix addresses only the protection provided by the short-term criterion. There is therefore an implicit assumption that if the short-term criterion is satisfied, then any associated long-term criteria will also be satisfied. This assumption may not remain valid at short distances because additional propagation effects (diffraction, building/terrain scattering etc.) requiring a more detailed analysis become significant. A minimum coordination distance is therefore needed to avoid this difficulty. This minimum coordination distance is always the lowest value of coordination distance used. At distances equal to or greater than the minimum coordination distance, it can be assumed that interference due to continuous (long-term) propagation effects will not exceed levels permitted by the long-term criteria.

In addition to the minimum coordination distance, it is also necessary to set an upper limit to the calculation distance. Hence the coordination distance, on any azimuth, must lie within the range between the minimum coordination distance and the maximum calculation distance.

1.5.3.1 Minimum coordination distance

For the reasons stated in § 1.5.3, it is necessary to set a lower limit, d_{min}, for the coordination distance. The iterative calculation of the coordination distance starts at this minimum distance, and this distance varies according to radiometeorological factors and the frequency band (see § 4.2). This same minimum coordination distance applies both to propagation mode (1) and propagation mode (2) calculations.

1.5.3.2 Maximum calculation distance

Maximum calculation distances are required for propagation modes (1) and (2). In the case of mode (1), this distance corresponds to the maximum coordination distance, d_{max1}, given in § 4.3 for each of the four radioclimatic Zones. The propagation mode (1) maximum calculation distance is therefore dependent on the mixture of radioclimatic Zones in the propagation path, as described in § 4.3.

The maximum calculation distance for propagation mode (2) is given in § 2 of Annex 2.

1.6 The coordination contour: concepts and construction

The coordination distance, determined for each azimuth around the coordinating earth station, defines the coordination contour that encloses the coordination area. The coordination distance lies within the range defined by the minimum coordination distance and the maximum calculation distance.

In this Appendix, the procedures determine the distance at which the minimum required loss is equal to the predicted path loss. In addition, some procedures[6] require that, for any azimuth, the greater of the distances determined for propagation mode (1) and propagation mode (2) is the distance to be used in determining the coordination contour. In both these cases, the distance at which the minimum required loss is equal to the predicted path loss may or may not be within the range of valid values that define the limits for the coordination distance. Hence, the distance determined from the application of all the procedures is referred to as the required distance.

The coordination area is determined by one of the following methods:

– calculating, in all directions of azimuth from the earth station, the coordination distances and then drawing to scale on an appropriate map the coordination contour; or

– extending the service area in all directions by the calculated coordination distance(s); or

– for some services and frequency bands, extending the service area in all directions by a predetermined coordination distance.

Where a coordination contour includes the potential interference effects arising from both propagation mode (1) and propagation mode (2), the required distance used for any azimuth is the greater of the propagation mode (1) and propagation mode (2) required distances.

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6 The same procedures are also used to develop supplementary and auxiliary contours (see Annex 6).

The sharing scenarios and the various procedures contained in this Appendix are based on different assumptions. Hence, the coordination area developed for one sharing scenario is likely to be based on different sharing considerations, interference paths and operational constraints than the coordination area developed under a different sharing scenario. Separate coordination areas are therefore required for each sharing scenario described in § 1.4, and each coordination area is specific to the radiocommunication services covered by the sharing scenario under which it was developed. Further, the coordination area developed for one sharing scenario cannot be used to determine the extent of any impact on the radiocommunication services covered by a different sharing scenario. Thus, a coordinating earth station operating in a bidirectionally allocated frequency band that is also allocated to terrestrial services will have two separate coordination areas:

– one coordination area for determining those administrations with terrestrial services that may be affected by the operation of the coordinating earth station; and

– one coordination area for determining those administrations with receiving earth stations that may be affected by the operation of the coordinating (transmitting) earth station.

This means that the establishment of the coordination area for an earth station will generally require the determination of several individual coordination areas, each drawn on a separate map. For example, an earth station which transmits to a geostationary space station in the band 10.7-11.7 GHz will need to develop the following coordination areas with respect to:

– analogue terrestrial services which receive in the same band; this will comprise the potential effects arising from both propagation mode (1) and propagation mode (2) interference paths;

– an earth station operating with a geostationary space station which receives in the same band; this will comprise the potential effects arising from both propagation mode (1) and propagation mode (2) interference paths;

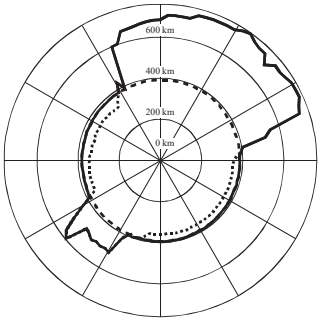
– an earth station operating with a non-geostationary space station which receives in the same band; this will comprise the potential effects arising from propagation mode (1) interference paths.

In addition, separate coordination contours are produced if the earth station both transmits and receives in bands shared with terrestrial services. However, for earth stations in bidirectionally allocated frequency bands, the coordination contours with respect to other earth stations are only produced for a transmitting earth station (see § 1.4.4).

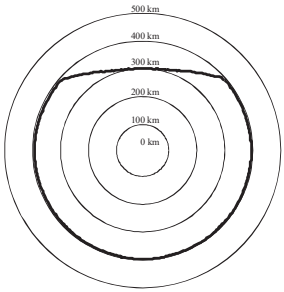
Examples of coordination contours for each of the sharing scenarios in § 1.4 is provided in Fig. 1. It will be noticed that for some of the sharing scenarios there is a commonality to the construction of the coordination contour (shown by a solid line) that encompasses each coordination area. For those sharing scenarios where both propagation mode (1) and propagation mode (2) interference paths need to be taken into consideration, the parts of the propagation mode (1) contour and that part of the propagation mode (2) contour located within the overall coordination contour may be drawn using dashed lines.

FIGURE 1

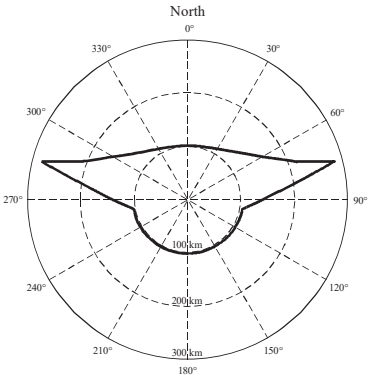
Examples of coordination contours for each of the sharing scenarios listed in § 1.4



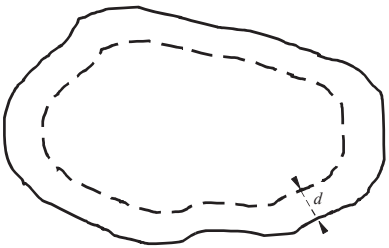
a) Example of the coordination contour for an earth station operating with a GSO space station in § 1.4.1 and § 1.4.3. The coordination contour is marked by the outer line and is comprised of a propagation mode (1) contour and a circular propagation mode (2) contour. The propagation mode (1) contour could also be an example of an earth station with a non-tracking directional antenna operating with a non-GSO space station in § 1.4.2



b) Example of the coordination contour for an earth station with a tracking antenna operating with a non-GSO space station in § 1.4.2 and § 1.4.3



c) Example of the coordination contour for an earth station operating in bidirectionally allocated frequency bands in § 1.4.4. The coordination contour has been developed from a propagation mode (1) contour for a coordinating earth station operating with a non-GSO space station with respect to unknown earth stations operating with GSO space stations. For a propagation mode (2) contour for the GSO-GSO case see Annex 5



d) Example of the coordination contour for an earth station operating in a specified service area in § 1.4.5, § 1.4.6 and § 1.4.7. The coordination contour is marked by the solid outer line and the specified service area by the broken inner line. The coordination distance, *d*, may be a constant value, or vary with azimuth, depending on the sharing scenario and the type of radiocommunication service

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In addition to the coordination contour, supplementary contours and auxiliary contours (see Annex 6) may be drawn to facilitate more detailed sharing discussions. Supplementary contours are based on the coordinating earth station sharing frequency bands with other radiocommunication services, or other types of radio systems in the same service, that have less onerous sharing criteria than the radio system used for developing the coordination area. These supplementary contours may be developed by the same method used to determine the coordination contour, or by other methods as agreed on a bilateral basis between administrations. For example, the Time Variant Gain method described in § 4 of Annex 6 can be used to generate supplementary contours for earth stations operating with non-geostationary space stations. Auxiliary contours are based on less conservative assumptions, with regard to the interference path and operational constraints, for the unknown terrestrial stations, or earth stations. Auxiliary contours are developed separately for propagation mode (1) and propagation mode (2) interference paths. In this context, the contours from which the coordination contour was developed are called main contours, and the auxiliary contours for propagation mode (1) and propagation mode (2) are referenced to the appropriate main contour. The various assumptions used for developing auxiliary contours to the propagation mode (1) contour, or the propagation mode (2) contour, can also be applied to supplementary contours. Hence, auxiliary contours may be drawn for both a main or a supplementary contour.

Supplementary contours are always drawn on a separate map as they apply to other types of radio system within the same radiocommunication service, or to radio systems in different radiocommunication services. However, as auxiliary contours apply to the various assumptions used in developing the main, or supplementary, contour they are always drawn on the same map that contains the corresponding main, or supplementary, contour.

While the use of supplementary or auxiliary contours allows less conservative assumptions with regard to the interference path and operational constraints to be taken into consideration, earth stations may transmit or receive a variety of classes of emissions. Hence, the earth station parameters to be used in the determination of the coordination contour, and any supplementary or auxiliary contours, are those which lead to the greatest distances for each earth station antenna beam and each allocated frequency band which the coordinating earth station shares with other radiocommunication systems.

2 Determination of the earth station coordination area with respect to terrestrial stations

This section contains the procedures for determining the coordination area for the case of earth stations sharing frequency bands with terrestrial stations. These procedures cover the cases for earth stations operating with space stations in the geostationary orbit, or in non-geostationary orbits, and are described in the following subsections.

For earth stations operating with space stations in non-geostationary orbits, consideration has to be given to the potential time-varying nature of the earth station’s antenna gain towards the horizon.

2.1 Earth stations operating with geostationary space stations

For an earth station operating with a geostationary space station, the value of G_t and G_r towards the horizon is considered to be constant with time. The percentage of time associated with L_b in equation (1) is the same as the time percentage, p, associated with $P_t(p)$. When determining the coordination area between a coordinating earth station operating with a geostationary space station and terrestrial systems, the coordination distance on any azimuth is the greater of the propagation mode (1) and propagation mode (2) required distances. The required distances for propagation mode (1) and propagation mode (2) are determined using the procedures described in § 2.1.1 and § 2.1.2 respectively, after taking into consideration the following discussion on station-keeping.

When the north/south station-keeping of a geostationary space station is relaxed, the orbit of the space station becomes inclined with an inclination that increases gradually with time. This movement of the space station from its nominal position may require small corresponding adjustments in the elevation angle of the earth station antenna beam. Hence, to avoid considering the time variation in antenna gain in the direction of the horizon, the coordination area of an earth station operating with a space station in a slightly inclined geostationary orbit is determined for the minimum angle of elevation and the associated azimuth at which the space station is visible to the earth station (see Annex 3).

2.1.1 Determination of the coordinating earth station's propagation mode (1) contour

Determination of the propagation mode (1) contour is based on great circle propagation mechanisms and it is assumed, for the interference path, that all the terrestrial stations are pointing directly at the coordinating earth station's location. The required distance, on each azimuth, for propagation mode (1) is that distance which will result in a value of propagation mode (1) predicted path loss that is equal to the propagation mode (1) minimum required loss, $L_b(p)$ (dB), as defined in § 1.3.

$$L_b(p) = P_t + G_e + G_x - P_t(p) \qquad \text{dB} \qquad (4)$$

where:

P_t and $P_t(p)$: as defined in § 1.3

G_e: gain of the coordinating earth station antenna (dBi) towards the horizon at the horizon elevation angle and azimuth under consideration

G_x: maximum antenna gain (dBi) assumed for the terrestrial station. Tables 7 and 8 give values for G_x for the various frequency bands.

The propagation mode (1) required distance is determined using the procedures described in § 4, and the detailed methods in Annex 1. Specific guidance relevant to the application of the procedures is provided in § 4.4.

2.1.2 Determination of the coordinating earth station's propagation mode (2) contour

The required distance for hydrometeor scatter is that distance that will result in a propagation mode (2) predicted path loss equal to the propagation mode (2) minimum required loss $L(p)$, as defined in equation (3). This propagation mode (2) required distance is determined using the guidance in § 5, and the detailed methods in Annex 2.

For an earth station operating with a geostationary space station having a slightly inclined orbit, the rain-scatter contours for each of the satellite's two most extreme orbit positions are determined individually, using the relevant elevation angles and their associated azimuths to the satellite. The rain scatter area is the total area contained within the two resulting overlapping contours.

2.2 Earth stations operating with non-geostationary space stations

For an earth station that operates with non-geostationary space stations and whose antennas track the space stations, the antenna gain in the direction of the horizon on any azimuth varies with time. The method used to determine the coordination contour is the time invariant gain (TIG) method.

This method uses fixed values of antenna gain based on the maximum assumed variation in horizon antenna gain on each azimuth under consideration. In considering the horizon gain of the antenna for either a transmitting or a receiving earth station, only the horizon antenna gain values during the operational time are to be considered. The horizon antenna gain may be determined using Annex 4. Reference or measured antenna radiation patterns may be used as described in Annex 3. The values of horizon antenna gain defined below are used for each azimuth when applying equation (4) to determine the propagation mode (1) required distances:

$$\begin{aligned} G_e &= G_{max} && \text{for} && (G_{max} - G_{min}) \leq 20 \text{ dB} \\ G_e &= G_{min} + 20 && \text{for} && 20 \text{ dB} < (G_{max} - G_{min}) < 30 \text{ dB} \\ G_e &= G_{max} - 10 && \text{for} && (G_{max} - G_{min}) \geq 30 \text{ dB} \end{aligned} \tag{5}$$

where:

G_e: gain of the coordinating earth station antenna (dBi) towards the horizon at the horizon elevation angle and azimuth under consideration in equation (4)

G_{max}, G_{min}: maximum and minimum values of the horizon antenna gain (dBi), respectively, on the azimuth under consideration.

The maximum and minimum values of the horizon antenna gain, on the azimuth under consideration, are derived from the antenna pattern and the maximum and minimum angular separation of the antenna main beam axis from the direction of the physical horizon at the azimuth under consideration.

Where a single value of minimum elevation angle for the main beam axis of the earth station antenna is specified for all azimuths, the minimum and maximum values of the horizon gain can be determined, for each azimuth under consideration, from the antenna pattern and the horizon elevation angle at that azimuth. The plot of the horizon elevation angle against azimuth is called the horizon profile of the earth station.

Additional constraints may be included in the determination of the maximum and minimum values of the horizon antenna gain where an earth station is operating with a constellation of non-geostationary satellites at a latitude for which no satellite is visible at the earth station's specified minimum elevation angle over a range of azimuths. Over this range of azimuth angles, the minimum elevation angle of the earth station antenna main beam axis is given by the minimum elevation angle at which any satellite of the constellation is visible at that azimuth. The azimuthal dependence of this minimum satellite visibility elevation angle may be determined from consideration of the orbital altitude and inclination of the satellites in the constellation, without recourse to simulation, using the procedure in § 1.1 of Annex 4. In this case, the horizon antenna gain to be used in the method depends on the profile of the composite minimum elevation angle. This minimum composite elevation angle at any azimuth is the greater of the minimum satellite visibility elevation angle, at the azimuth under consideration, and the specified minimum elevation angle for the earth station which is independent of the azimuth.

Thus, at each azimuth under consideration, the maximum horizon antenna gain will be determined from the minimum value of the angular separation between the earth station horizon profile at this azimuth and the profile of the minimum composite elevation angle. Similarly, the minimum horizon antenna gain will be determined from the maximum value of the angular separation from the earth station horizon profile at this azimuth to the profile of the minimum composite elevation angle. The procedure for calculating the minimum and maximum angular separations from the profile of the minimum composite elevation angle is given in § 1.2 of Annex 4.

The propagation mode (1) required distance is then determined using the procedures described in § 4, and the detailed methods in Annex 1. Specific guidance relevant to the application of the propagation calculations is provided in § 4.4.

3 Determination of the coordination area between earth stations operating in bidirectionally allocated frequency bands

This section describes the procedures to be used for determination of the coordination area for an earth station transmitting in a frequency band allocated to space services in both Earth-to-space and space-to-Earth directions.

There are various coordination scenarios, involving only non-time-varying antenna gains, or only time-varying antenna gains (both earth stations operate with non-geostationary space stations) or, one time-varying antenna gain and one non-time-varying antenna gain.

The following subsections describe the methods for the determination of coordination area which are specific to each of these bidirectional cases. The procedures applicable to the coordination scenario where both earth stations operate with geostationary space stations are given in § 3.1. The other bidirectional coordination scenarios are considered in § 3.2, where particular attention is given to the approaches for using the horizon antenna gain of the receiving earth station for each of the possible coordination scenarios in the appropriate procedure of § 2.

Table 9 provides the parameters that are to be used in the determination of the coordination area. Table 9 also indicates whether, in each band, the receiving earth stations operate with geostationary or non-geostationary space stations. In some bands, receiving earth stations may operate with both geostationary and non-geostationary space stations. Table 2 indicates the number of coordination contours which need to be drawn for each coordination scenario and the section(s) containing the applicable calculation methods. Once drawn, each coordination contour must be appropriately labelled.

TABLE 2

Coordination contours required for each bidirectional scenario

Coordinating earth station operating to a space station in the	Unknown receiving earth station operating with a space station in the	Section containing the method to determine G_t and G_r	Contours required	
			No.	Details
Geostationary orbit	Geostationary orbit	§ 3.1	1	A coordination contour comprising both propagation mode (1) and propagation mode (2) contours
	Non-geostationary orbit	§ 3.2.1	1	A propagation mode (1) coordination contour
	Geostationary or non-geostationary orbits[1]	§ 3.1 and 3.2.1	2	Two separate coordination contours, one for the geostationary orbit (propagation mode (1) and mode (2) contours) and one for the non-geostationary orbit (propagation mode (1) contour)
Non-geostationary orbit	Geostationary orbit	§ 3.2.2	1	A propagation mode (1) coordination contour
	Non-geostationary orbit	§ 3.2.3	1	A propagation mode (1) coordination contour
	Geostationary or non-geostationary orbits[1]	§ 3.2.2 and 3.2.3	2	Two separate propagation mode (1) coordination contours, one for the geostationary orbit and one for the non-geostationary orbit

[1] In this case, the bidirectional frequency band may contain allocations in the space-to-Earth direction for space stations in both the geostationary orbit and non-geostationary orbits. Hence, the coordinating administration will not know whether the unknown receiving earth stations are operating with space stations in the geostationary orbit or non-geostationary orbit.

3.1 Coordination of known and unknown earth stations operating with geostationary space stations

When both the known and the unknown earth stations operate with space stations in the geostationary orbit, it is necessary to develop a coordination contour comprising both propagation mode (1) and propagation mode (2) contours, using the procedures described in § 3.1.1 and 3.1.2, respectively.

3.1.1 Determination of the coordinating earth station's propagation mode (1) contour

The procedure for the determination of the propagation mode (1) contour in this case differs from that described in § 2.1.1 in two ways. First, the parameters to be used for the unknown receiving earth station are those in Table 9. Second, and more significantly, the knowledge that the unknown earth stations operate with geostationary satellites can be used to calculate the worst-case value of the horizon antenna gain of the receiving earth station towards the transmitting earth station for each azimuth at the transmitting earth station. The propagation mode (1) required distance is that distance which will result in a value of propagation mode (1) predicted path loss which is equal to the propagation mode (1) minimum required loss, $L_b(p)$ (dB), as defined in § 1.3, and repeated here for convenience.

$$L_b(p) = P_t + G_t + G_r - P_r(p) \qquad \text{dB} \qquad (6)$$

where:

P_t and $P_r(p)$: as defined in § 1.3

G_t: gain of the coordinating (transmitting) earth station antenna (dBi) towards the horizon at the horizon elevation angle and the azimuth under consideration

G_r: the horizon antenna gain of the unknown receiving earth station towards the transmitting earth station on the specific azimuth from the coordinating earth station. Values are determined by the procedure in § 2.1 of Annex 5, based on parameters from Table 9.

To facilitate the determination of the values of G_r to be used at an azimuth from the transmitting earth station, several simplifying approximations must be made:

– that the horizon elevation of the receiving earth station is zero degrees on all azimuths;

– that the receiving earth station operates with a space station that has zero degrees orbital inclination and may be located anywhere on the geostationary orbit that is above the minimum elevation angle, given in Table 9, for the location of the receiving earth station;

– that the latitude of the receiving earth station is the same as that of the transmitting earth station;

– that plane geometry can be used to interrelate the azimuth angles at the respective earth stations, rather than using the great circle path.

The first three assumptions provide the basis for determining the horizon antenna gain of the receiving earth station on any azimuth. The assumption of 0° horizon elevation angle is conservative since the increase in horizon antenna gain due to a raised horizon would, in practice, be more than offset by any real site shielding[7]. The last two assumptions in the list simplify the calculation of the sum of G_t and G_r along any azimuth. Since the propagation mode (1) required distances are small, in global geometric terms these approximations may introduce a small error in the determination of the horizon antenna gain of the receiving earth station antenna that, in any case, will not exceed 2 dB. Because of

[7] While no site shielding can be assumed for the receiving earth station, any site shielding that may exist at the transmitting earth station is considered by taking into account the horizon elevation angle in accordance with § 1 of Annex 1.

the assumption of plane geometry, for a given azimuth at the transmitting earth station the appropriate value of the horizon antenna gain of the receiving earth station is the value on the reciprocal (i.e. ±180°, see § 2.1 of Annex 5) azimuth at the receiving earth station.

The propagation mode (1) required distance is then determined using the procedures described in § 4, and the detailed methods in Annex 1. Specific guidance relevant to the application of the propagation calculations is provided in § 4.4.

3.1.2 Determination of the coordinating earth station's propagation mode (2) contour

The procedure for the determination of the propagation mode (2) contour for a transmitting earth station operating with a geostationary space station uses the same simplifying approximations as made in § 3.1.1, but it is based on a geometrical construction that avoids the requirement for a complex propagation model (see § 3 of Annex 5). Auxiliary contours cannot be used in this method, as the calculations are not based on the propagation mode (2) required loss.

The propagation mode (2) contour is determined using the elevation angle and the azimuth from the coordinating transmitting earth station to the space station, together with the following two considerations:

– the minimum coordination distance (see § 4.2), which will be the required distance for some azimuths; and

– a worst-case required distance determined by the hydrometeor scatter geometry for a receiving earth station located in either of two 6° azimuth sectors. Within these sectors, the receiving earth station is assumed to be operating at the minimum elevation angle to a space station in the geostationary orbit and its main beam intersects the beam for the coordinating transmitting earth station at the point where the latter beam passes through the rain height, h_R. Although the scattering can occur anywhere between the coordinating earth station and this point, the intersection of the two beams at this point represents the worst-case interference scenario. Hence, it results in the worst-case distance requirement for receiving earth stations located in the two azimuth sectors.

For an earth station operating with a space station in an inclined orbit, the lowest expected operational antenna elevation angle and its associated azimuth are used in the calculations.

The propagation mode (2) contour is determined using the method in § 3 of Annex 5.

3.2 Coordinating or unknown earth stations operating with non-geostationary space stations

To determine the coordination area, the method described in § 2.2 is used. For the cases where a coordinating (transmitting) earth station operates with non-geostationary space stations, the following procedures assume that the earth station antenna is tracking the space station, otherwise see § 1.4.2. Table 9 provides values of horizon antenna gain to be used in the calculations.

One or more of the following three procedures may be needed to determine the required propagation mode (1) coordination contours of Table 2. Propagation mode (2) contours are not required for any of the cases where either of the earth stations operates with space stations in non-geostationary orbits.

3.2.1 A coordinating earth station operating with a geostationary space station with respect to unknown earth stations operating with non-geostationary space stations

When the coordinating earth station operates with a space station in the geostationary orbit and the unknown earth stations operate with space stations in non-geostationary orbits, the propagation mode (1) coordination area is determined using the procedures described in § 2.1.1. The only modification needed is to use the horizon antenna gain, G_r, of the unknown receiving earth station in place of the terrestrial station gain, G_x. The appropriate values for this gain and the appropriate system parameters are contained in Table 9.

3.2.2 A coordinating earth station operating with non-geostationary space stations with respect to unknown earth stations operating with geostationary space stations

When the coordinating earth station operates to space stations in non-geostationary orbits and the unknown earth stations operate with space stations in the geostationary orbit, the horizon antenna gain, G_r, for the unknown receiving earth station is determined in accordance with the simplifying approximations of § 3.1.1, as elaborated in § 2.1 of Annex 5, and the parameters of Table 9. Determination of the propagation mode (1) coordination area then follows the procedure of § 2.2 by using the appropriate horizon gain of the receiving earth station at each azimuth under consideration and the appropriate system parameters from Table 9.

3.2.3 Coordinating and unknown earth stations operating with non-geostationary space stations

When the coordinating earth station operates with space stations in non-geostationary orbits and the unknown earth stations operate with space stations in non-geostationary orbits, the propagation mode (1) coordination area is determined using the procedure described in § 2.2. The only modification is to use the horizon antenna gain, G_r, of the unknown receiving earth station in place of the terrestrial station antenna gain. The appropriate values for this gain and the appropriate system parameters are given in Table 9.

4 General considerations for the determination of the propagation mode (1) required distance

For the determination of the propagation mode (1) required distances, the applicable frequency range has been divided into three parts. The propagation calculations for the VHF/UHF frequencies between 100 MHz and 790 MHz are based upon propagation mode (1) predicted path loss curves. From 790 MHz to 60 GHz the propagation modelling uses tropospheric scatter, ducting and layer reflection/refraction models. At higher frequencies up to 105 GHz, the model is based on a free-space loss and a conservative assumption for gaseous absorption. The possible range of time percentages is different in the different propagation models.

After taking site shielding (see § 1 of Annex 1) into consideration, for the coordinating earth station only, the following methods are used to determine the propagation mode (1) required distances:

– For frequencies between 100 MHz and 790 MHz, the method described in § 2 of Annex 1.

– For frequencies between 790 MHz and 60 GHz, the method described in § 3 of Annex 1.

– For frequencies between 60 GHz and 105 GHz, the method described in § 4 of Annex 1.

The three methods referred to above rely on a value of propagation mode (1) minimum required loss, determined according to the appropriate system parameters in Tables 7, 8 and 9.

4.1 Radio-climatic information

For the calculation of the propagation mode (1) required distance, the world has been classified in terms of a radio-meteorological parameter representing clear-air anomalous propagation conditions. The percentage of time β_e for which these clear-air anomalous propagation conditions exist, is latitude dependent and is given by:

$$\beta_e = \begin{cases} 10^{1.67-0.015\,\zeta_r} & \text{for } \zeta_r \le 70° \quad (7) \\ 4.17 & \text{for } \zeta_r > 70° \quad (8) \end{cases}$$

with:

$$\zeta_r = \begin{cases} |\zeta| - 1.8 & \text{for } |\zeta| > 1.8° \quad (9) \\ 0 & \text{for } |\zeta| \le 1.8° \quad (10) \end{cases}$$

where ζ is the latitude of the earth station's location (degrees).

For frequencies between 790 MHz and 60 GHz, the path centre sea level surface refractivity, N_0, is used in the propagation mode (1) calculations. This can be calculated using:

$$N_0 = 330 + 62.6\ \mathrm{e}^{-\left(\frac{\zeta-2}{32.7}\right)^2} \quad (11)$$

4.2 Minimum coordination distance for propagation modes (1) and (2)

The minimum coordination distance can be calculated in two steps. First calculate distance d_x using:

$$d_x = 100 + \frac{(\beta_e - 40)}{2} \quad \text{km} \quad (12)$$

where β_e is given in § 4.1.

Then calculate the minimum coordination distance at any frequency, f (GHz) in the range 100 MHz to 105 GHz using:

$$d_{min} = \begin{cases} 100 + \dfrac{(\beta_e - f)}{2} & \text{km} \quad \text{for} \quad f < 40 \text{ GHz} \quad (13) \\[2ex] \dfrac{(54 - f)\, d_x + 10(f - 40)}{14} & \text{km} \quad \text{for} \quad 40 \text{ GHz} \le f < 54 \text{ GHz} \quad (14) \\[2ex] 10 & \text{km} \quad \text{for} \quad 54 \text{ GHz} \le f < 66 \text{ GHz} \quad (15) \\[2ex] \dfrac{10(75 - f) + 45(f - 66)}{9} & \text{km} \quad \text{for} \quad 66 \text{ GHz} \le f < 75 \text{ GHz} \quad (16) \\[2ex] 45 & \text{km} \quad \text{for} \quad 75 \text{ GHz} \le f < 90 \text{ GHz} \quad (17) \\[2ex] 45 - \dfrac{(f - 90)}{1.5} & \text{km} \quad \text{for} \quad 90 \text{ GHz} \le f \le 105 \text{ GHz} \quad (18) \end{cases}$$

The distance from which all iterative calculations start (for both propagation mode (1) and propagation mode (2)), is the minimum coordination distance, d_{min}, as given in equations (13) to (18).

4.3 Maximum coordination distance for propagation mode (1)

In the iterative calculation described in Annex 1, it is necessary to set an upper limit, d_{max1}, to the propagation mode (1) coordination distance.

For frequencies less than or equal to 60 GHz and propagation paths entirely within a single Zone, the distance shall not exceed the maximum coordination distance given in Table 3 for that Zone.

For mixed paths, the required distance can comprise one or more contributions from Zones A1, A2, B and C. The aggregate distance for any one zone must not exceed the value given in Table 3. The overall required distance must not exceed the value in Table 3 for the zone in the mixed path having the largest Table 3 value. Thus, a path comprising both Zones A1 and A2 must not exceed 500 km.

TABLE 3

Maximum coordination distances for propagation mode (1) for frequencies below 60 GHz

Zone	d_{max1} (km)
A1	500
A2	375
B	900
C	1 200

For frequencies above 60 GHz, the maximum coordination distance, d_{max1}, is given by:

$$d_{max1} = 80 - 10 \log \left(\frac{p}{50} \right) \tag{19}$$

where p is defined in § 1.3.

4.4 Guidance on application of propagation mode (1) procedures

As explained in § 1.3, for those cases where earth stations are sharing with terrestrial stations, it is appropriate to apply a correction factor, C_i (dB), to the worst-case assumptions on system parameters and interference path geometry. This correction factor takes into account the fact that the assumption that all the worst-case values will occur simultaneously is unrealistic when determining the propagation mode (1) required distances.

The characteristics of terrestrial systems depend on the frequency band, and the value of the correction factor to be applied follows the frequency dependence given in equation (20). At frequencies between 100 MHz and 400 MHz, and between 60 GHz and 105 GHz, sharing between earth stations and terrestrial systems is a recent development and there is little established practical experience, or opportunity to analyse operational systems. Hence, the value of the correction factor is 0 dB in these bands. Between 400 MHz and 790 MHz and between 4.2 GHz and 60 GHz, the value of the correction factor is reduced in proportion to the logarithm of the frequency, as indicated in equation (20).

The value of the nominal correction to be used at any frequency f (GHz) is therefore given by:

$$X(f) = \begin{cases} 0 & \text{dB} \quad \text{for} \quad f \le 0.4 \text{ GHz} \\ 3.3833 X(\log f + 0.3979) & \text{dB} \quad \text{for} \quad 0.4 \text{ GHz} < f \le 0.79 \text{ GHz} \\ X & \text{dB} \quad \text{for} \quad 0.79 \text{ GHz} < f \le 4.2 \text{ GHz} \\ -0.8659 X(\log f - 1.7781) & \text{dB} \quad \text{for} \quad 4.2 \text{ GHz} < f \le 60 \text{ GHz} \\ 0 & \text{dB} \quad \text{for} \quad f > 60 \text{ GHz} \end{cases} \tag{20}$$

where:

X: 15 dB for a transmitting earth station and 25 dB for a receiving earth station.

In principle, the value of the nominal correction factor, $X(f)$, is distance and path independent. However, there are a number of issues relating to interference potential at the shorter distances, and it is not appropriate to apply the full nominal correction at these distances. The correction factor C_i is therefore applied proportionally with distance along the azimuth under consideration, starting with 0 dB at d_{min}, such that the full value of $X(f)$ is achieved at a nominal distance of 375 km from the earth station.

Hence, the correction is applied using the correction constant $Z(f)$ (dB/km) where:

$$Z(f) = \frac{X(f)}{375 - d_{min}} \quad \text{dB/km} \tag{21}$$

The correction factor C_i (dB) is calculated in equations (28b) and (52) from the correction constant $Z(f)$ (dB/km).

At distances greater than 375 km, the correction factor C_i to be applied is the value of C_i at 375 km distance.

In addition, the correction factor is applied to its highest value only on land paths. The correction factor is 0 dB for wholly sea paths. A proportion of the correction factor is applied on mixed paths. The amount of correction to be applied to a particular path is determined by the path description parameters used for the propagation mode (1) calculation (correction factors C_i and C_{2i} in § 2 and § 3 respectively of Annex 1). As the correction factor is distance dependent, it is applied automatically within the iterative calculation used to determine the propagation mode (1) required distance (see Annex 1).

The correction factor does not apply to the bidirectional case and therefore in the determination of the bidirectional coordination contour:

$$Z(f) = 0 \qquad \text{dB/km}$$

For the determination of propagation mode (1) auxiliary contours, the propagation mode (1) minimum required loss $L_b(p)$ for p% of time in equation (1) (see § 1.3) is replaced by:

$$L_{bq}(p) = L_b(p) + Q \qquad \text{dB} \tag{22}$$

where:

Q: auxiliary contour value (dB).

Note that auxiliary contour values are assumed to be negative (i.e. −5, −10, −15, −20 dB, etc.).

5 General considerations for the determination of the propagation mode (2) required distance

The determination of the contour for scattering from hydrometeors (e.g. rain scatter) is predicted on a path geometry that is substantially different from that of the great-circle propagation mechanisms. Hydrometeor scatter can occur where the beams of the earth station and the terrestrial station intersect (partially or completely) at, or below, the rain height h_R (see § 3 of Annex 2). It is assumed that at heights above this rain height the effect of scattering will be suppressed by additional attenuation, and it will not, therefore, contribute significantly to the interference potential. For the determination of the propagation mode (2) contour, it is assumed that the main beam of any terrestrial station exactly intersects the main beam of the coordinating earth station. The mitigating effects of partial beam intersections can be determined using propagation mode (2) auxiliary contours.

Since, to a first approximation, microwave energy is scattered isotropically by rain, interference can be considered to propagate equally at all azimuths around the common volume centred at the beam intersection (see § 1.3). Generally, the beam intersection will not lie on the great-circle path between the two stations. A common volume can therefore result from terrestrial stations located anywhere around the earth station, including locations behind the earth station.

The propagation mode (2) contour is a circle with a radius equal to the propagation mode (2) required distance. Unlike the case for propagation mode (1), the propagation mode (2) contour is not centred on the earth station's physical location, instead it is centred on a point on the earth's surface immediately below the centre of the common volume.

A common volume can exist, with equal probability, at any point along the earth station beam between the earth station's location and the point at which the beam reaches the rain height. To provide appropriate protection for/from terrestrial stations[8], the centre of the common volume is assumed to be half way between the earth station and the point at which its beam intersects the rain height. The distance between the projection of this point on to the Earth's surface and the location of the earth station is known as Δd (see § 4 of Annex 2). The centre of the propagation mode (2) contour is therefore Δd (km) from the earth station on the azimuth of the earth station's main beam axis.

5.1 The required distance for propagation mode (2)

Propagation mode (2) required distances are measured along a radial originating at the centre of the rain scatter common volume. The calculation requires iteration for distance, starting at the same minimum distance as that defined for propagation mode (1) until either the required propagation mode (2) minimum required loss, or a latitude-dependent propagation mode (2) maximum calculation distance, is achieved. The propagation mode (2) calculations use the method described in Annex 2. The calculations only need to be performed in the frequency range 1 000 MHz to 40.5 GHz. Outside this frequency range, rain scatter interference can be neglected and the propagation mode (2) required distance is set to the minimum coordination distance given by equations (13) to (18).

ANNEX 1

Determination of the required distance for propagation mode (1)

1 Adjustments for earth station horizon elevation angle and distance

For propagation mode (1), the required distance depends on the characteristics of the physical horizon around the earth station. The horizon is characterized by the horizon distance d_h (see below), and the horizon elevation angle ε_h. The horizon elevation angle is defined here as the angle (degrees), viewed from the centre of the earth station antenna, between the horizontal plane and a ray that grazes the physical horizon in the direction concerned. The value of ε_h is positive when the physical horizon is above the horizontal plane and negative when it is below.

It is necessary to determine horizon elevation angles and distances for all azimuths around an earth station. In practice it will generally suffice to do this in azimuth increments of 5°. However, every attempt should be made to identify, and take into consideration, minimum horizon elevation angles that may occur between those azimuths examined in 5° increments.

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[8] This procedure does not apply for the case of an earth station sharing a frequency band with other earth stations operating in the opposite direction of transmission, as for that specific case the propagation mode (2) contour is based on a geometric construction.

For the purposes of the determination of the propagation mode (1) required distance it is useful to separate the propagation effects related to the local horizon around the earth station which, on some or all azimuths, may be determined by nearby hills or mountains, from the propagation effects on the remainder of the path. This is achieved by referencing the propagation model to a 0° horizon elevation angle for the coordinating earth station, and then to include a specific term A_h to deal with the known horizon characteristics of the earth station being coordinated. Where appropriate, A_h modifies the value of the path loss, on each azimuth, from which the propagation mode (1) required distance is derived.

There are two situations in which the level of attenuation for the propagation mode (1) path loss with respect to the reference 0° case can change:

– The first is where the coordinating earth station has a positive horizon elevation angle (on a particular azimuth). In this case, it will benefit from additional diffraction propagation losses over the horizon (generally referred to as site shielding). As a result, the attenuation A_h is positive and the value of the required path loss is reduced, with respect to the reference 0° horizon elevation angle case (see equations (27a) and (27b)).

– The second situation is where the coordinating earth station is at a location above the local foreground, and has a negative (downward) horizon elevation angle on a particular azimuth. In this case, a measure of additional protection is necessary because the path angular distance along the radial is reduced and hence the path loss for a given distance will be lower than for the zero degree elevation angle case. It is convenient to deal with this effect as part of the site shielding calculation. As a result, the attenuation A_h will be negative and the value of the required path loss is increased, with respect to the reference 0° horizon elevation angle case.

The contribution made by the attenuation arising from the coordinating earth station's horizon characteristics to the propagation mode (1) minimum required loss modifies the value of path loss that then needs to be determined in the three propagation mode (1) models. The attenuation A_h is calculated for each azimuth around the coordinating earth station as follows.

The distance of the horizon, d_h, from the earth station's location, is determined by:

$$d_h = \begin{cases} 0.5 \text{ km} & \text{if no information is available about the horizon distance, or} \\ & \text{if the distance is} < 0.5 \text{ km} \\ \text{horizon distance (km)} & \text{if this is within the range } 0.5 \text{ km} \le \text{ horizon distance } \le 5.0 \text{ km} \\ 5.0 \text{ km} & \text{if the horizon distance is} > 5.0 \text{ km} \end{cases}$$

The contribution made by the horizon distance, d_h, to the total site shielding attenuation is given by A_d (dB) for each azimuth using:

$$A_d = 15\left[1 - \exp\left(\frac{0.5 - d_h}{5}\right)\right]\left[1 - \exp\left(-\varepsilon_h f^{1/3}\right)\right] \quad \text{dB} \qquad (23)$$

where f is the frequency (GHz) throughout this Annex.

The total site shielding attenuation along each azimuth from the coordinating earth station is given by:

$$A_h = \begin{cases} 20 \log (1 + 4.5\varepsilon_h f^{1/2}) + \varepsilon_h f^{1/3} + A_d & \text{dB} \quad \text{for} \quad \varepsilon_h \geq 0° & (24a) \\ 3\left[(f+1)^{1/2} - 0.0001\, f - 1.0487\right] \varepsilon_h & \text{dB} \quad \text{for} \quad 0° > \varepsilon_h \geq -0.5° & (24b) \\ -1.5\left[(f+1)^{1/2} - 0.0001\, f - 1.0487\right] & \text{dB} \quad \text{for} \quad \varepsilon_h < -0.5° & (24c) \end{cases}$$

The value of A_h must be limited to satisfy the conditions:

$$-10 \leq A_h \leq (30 + \varepsilon_h) \tag{25}$$

In equations (23), (24) and (25) the value of ε_h must always be expressed in degrees. The limits defined in equation (25) are specified because protection outside these limits may not be realized in practical situations.

2 Frequencies between 100 MHz and 790 MHz

The propagation model given in this section is limited to an average annual time percentage, p, in the range 1% to 50%.

An iterative process is used to determine the propagation mode (1) required distance. First, equation (27) is evaluated. Then, commencing at the minimum coordination distance, d_{min}, given by the method described in § 1.5.3 of the main body of this Appendix, equations (28) to (31) are iterated for distances d_i (where i = 0, 1, 2,...) incremented in steps of s (km) as described in § 1.3 of the main body of this Appendix. In each iteration, d_i is the distance considered. This process is continued until either of the following expressions becomes true:

$$L_2(p) \geq \begin{cases} L_1(p) & \text{for the main or supplementary contour} \\ L_{1q}(p) & \text{for the auxiliary contour} \end{cases} \tag{26a}$$

or:

$$d_i \geq \begin{cases} d_{max1} & \text{for the main or supplementary contour} \\ d_1 & \text{for the auxiliary contour} \end{cases} \tag{26b}$$

The required distance, d_1, or the auxiliary contour distance, d_q, are then given by the distance for the last iteration: i.e.

$$d_1 = d_i \tag{26c}$$

or:

$$d_q = d_i \tag{26d}$$

As the eventual mix of zones along a path is unknown, all paths are treated as if they are potential land and sea paths. Parallel calculations are undertaken, the first assuming the path is all land and a second assuming it is all sea. A non-linear interpolation is then performed, the output of which depends upon the current mix of land and sea losses in the distance, d_i. Where the current mix along the path includes sections of both warm sea and cold sea zones, all the sea along that path is assumed to be warm sea.

For the main or supplementary contour:

$$L_1(p) = L_b(p) - A_h \tag{27a}$$

For an auxiliary contour:

$$L_{1q}(p) = L_{bq}(p) - A_h \tag{27b}$$

where:

$L_b(p)$ (dB) and $L_{bq}(p)$ (dB): minimum required loss required for p% of the time for the main or supplementary contour and the auxiliary contour with value Q (dB), respectively (see equation (22)).

Iterative calculations

At the start of each iteration calculate the current distance for i = 0, 1, 2,…:

$$d_i = d_{min} + i \cdot s \tag{28a}$$

The correction factor, C_i (dB), (see § 4.4 of the main body of this Appendix) for the distance, d_i, is given by:

$$C_i = \begin{cases} Z(f)(d_i - d_{min}) & \text{dB} \quad \text{for the main or supplementary contour} \\ 0 & \text{dB} \quad \text{for the auxiliary contour} \end{cases} \tag{28b}$$

where $Z(f)$ is given by equation (21) in § 4.4 of the main body of this Appendix.

At distances greater than 375 km, the value of the correction factor (C_i in equation (28b)) to be applied is the value of C_i at the 375 km distance.

The loss, $L_{bl}(p)$, where it is assumed that the path is wholly land (Zones A1 or A2), is evaluated successively using:

$$L_{bl}(p) = 142.8 + 20 \log f + 10 \log p + 0.1\, d_i + C_i \tag{29}$$

The loss, $L_{bs}(p)$, where it is assumed that the path is wholly cold sea (Zone B) or warm sea (Zone C), is evaluated successively using:

$$L_{bs}(p_1) = \begin{cases} \left.\begin{array}{l} 49.91 \log\left(d_i + 1840\, f^{1.76}\right) + 1.195 f^{0.393} (\log p)^{1.38} d_i^{0.597} \\ + (0.01\, d_i - 70)(f - 0.1581) + (0.02 - 2 \times 10^{-5}\, p^2)\, d_i \\ + 9.72 \times 10^{-9}\, d_i^2 p^2 + 20.2 \end{array}\right\} \text{for Zone B} & (30a) \\ \left.\begin{array}{l} 49.343 \log\left(d_i + 1840\, f^{1.58}\right) + 1.266 (\log p)^{(0.468 + 2.598 f)}\, d_i^{0.453} \\ + (0.037 d_i - 70)(f - 0.1581) + 1.95 \times 10^{-10}\, d_i^2 p^3 + 20.2 \end{array}\right\} \text{for Zone C} & (30b) \end{cases}$$

The predicted path loss at the distance considered is then given by:

$$L_2(p) = L_{bs}(p) + \left[1 - \exp\left(-5.5 \left(\frac{d_{tm}}{d_i}\right)^{1.1}\right)\right]\left(L_{bl}(p) - L_{bs}(p)\right) \tag{31}$$

where:

d_{tm} (km): longest continuous land (inland + coastal) distance, i.e. Zone A1 + Zone A2 along the current path.

3 Frequencies between 790 MHz and 60 GHz

The propagation model given in this section is limited to an average annual time percentage (p) in the range 0.001% to 50%.

An iterative process is used to determine the propagation mode (1) required distance. First, equations (33) to (42) are evaluated. Then, commencing at the minimum coordination distance, d_{min}, equations (43) to (53) are iterated for distances d_i, where i = 0, 1, 2, ..., incremented in steps of s (km) as described in § 1.3 of the main body of this Appendix. For each iteration, d_i is the distance considered. This process is continued until either of the following expressions becomes true:

$$\begin{array}{llll} (L_5(p) \geq L_3(p)) & \text{and} & (L_6(p) \geq L_4(p)) & \text{for the main or supplementary contour} \\ (L_5(p) \geq L_{3q}(p)) & \text{and} & (L_6(p) \geq L_{4q}(p)) & \text{for the auxiliary contour} \end{array} \tag{32a}$$

or:

$$d_i \geq \begin{cases} d_{max1} & \text{for the main or supplementary contour} \\ d_1 & \text{for the auxiliary contour} \end{cases} \tag{32b}$$

The required distance, d_1, or the auxiliary contour distance, d_q, is then given by the current distance for the last iteration, i.e.:

$$d_1 = d_i \tag{32c}$$

or:

$$d_q = d_i \tag{32d}$$

Specific attenuation due to gaseous absorption

Calculate the specific attenuation (dB/km) due to dry air:

$$\gamma_o = \begin{cases} \left[7.19 \times 10^{-3} + \dfrac{6.09}{f^2 + 0.227} + \dfrac{4.81}{(f-57)^2 + 1.50} \right] f^2 \times 10^{-3} & \text{for } f \leq 56.77 \text{ GHz} \quad (33a) \\ 10 & \text{for } f > 56.77 \text{ GHz} \quad (33b) \end{cases}$$

The specific attenuation due to water vapour is given as a function of ρ (the water vapour density (g/m^3)) by the following equation:

$$\gamma_w(\rho) = \left(0.050 + 0.0021\rho + \frac{3.6}{(f-22.2)^2 + 8.5} \right) f^2 \rho \times 10^{-4} \tag{34}$$

Calculate the specific attenuation (dB/km) due to water vapour for the troposcatter propagation model using a water vapour density of 3.0 g/m^3:

$$\gamma_{wt} = \gamma_w(3.0) \tag{35a}$$

Calculate the specific attenuation (dB/km) due to water vapour for the ducting propagation model using a water vapour density of 7.5 g/m^3 for paths over land, Zones A1 and A2, using:

$$\gamma_{wdl} = \gamma_w(7.5) \tag{35b}$$

Calculate the specific attenuation (dB/km) due to water vapour for the ducting propagation model using a water vapour density of 10.0 g/m^3 for paths over sea, Zones B and C, using:

$$\gamma_{wds} = \gamma_w\,(10.0) \tag{35c}$$

Note that the value of 10 g/m^3 is used for both Zones B and C in view of the lack of data on the variability of water vapour density on a global basis, particularly the minimum values.

Calculate the frequency-dependent ducting specific attenuation (dB/km):

$$\gamma_d = 0.05 f^{1/3} \tag{36}$$

For the ducting model

Calculate the reduction in attenuation arising from direct coupling into over-sea ducts (dB):

$$A_c = \frac{-6}{(1 + d_c)} \tag{37}$$

where d_c (km) is the distance from a land based earth station to the coast in the direction being considered.

d_c is zero in other circumstances.

Calculate the minimum loss to be achieved within the iterative calculations:

$$A_1 = 122.43 + 16.5 \log f + A_h + A_c \tag{38}$$

For the main or supplementary contour:

$$L_3(p) = L_b(p) - A_1 \tag{39a}$$

For an auxiliary contour:

$$L_{3q}(p) = L_{bq}(p) - A_1 \tag{39b}$$

where:

$L_b(p)$ (dB) and $L_{bq}(p)$ (dB): minimum required loss required for p% of the time for the main or supplementary contour and the auxiliary contour with value Q (dB) respectively (see equation (22)).

For the tropospheric scatter model

Calculate the frequency-dependent part of the losses (dB):

$$L_f = 25 \log(f) - 2.5 \left[\log\left(\frac{f}{2}\right) \right]^2 \tag{40}$$

Calculate the non-distance-dependent part of the losses (dB):

$$A_2 = 187.36 + 10\varepsilon_h + L_f - 0.15\,N_0 - 10.1\left(-\log\left(\frac{p}{50}\right)\right)^{0.7} \tag{41}$$

where:

ε_h: earth station horizon elevation angle (degrees)

N_0: path centre sea level surface refractivity (see equation (11), § 4.1 in the main body of this Appendix).

Calculate the minimum required value for the distance dependent losses (dB):

For the main, or supplementary, contour:

$$L_4(p) = L_b(p) - A_2 \tag{42a}$$

For an auxiliary contour:

$$L_{4q}(p) = L_{bq}(p) - A_2 \tag{42b}$$

where:

$L_b(p)$ (dB) and $L_{bq}(p)$ (dB): minimum required loss required for p% of the time for the main or supplementary contour and the auxiliary contour of value Q (dB) respectively (see equation (22)).

Iterative calculations

At the start of each iteration, calculate the distance considered for i = 0, 1, 2, ..:

$$d_i = d_{min} + i \cdot s \tag{43}$$

Calculate the specific attenuation due to gaseous absorption (dB/km):

$$\gamma_g = \gamma_o + \gamma_{wdl}\left(\frac{d_t}{d_i}\right) + \gamma_{wds}\left(1 - \frac{d_t}{d_i}\right) \tag{44}$$

where:

d_t (km): current aggregate land distance, Zone A1 + Zone A2, along the current path.

Calculate the following zone-dependent parameters:

$$\tau = 1 - \exp\left[-\left(4.12 \times 10^{-4}\,(d_{lm})^{2.41}\right)\right] \tag{45}$$

where:

d_{lm} (km): longest continuous inland distance, Zone A2, along the path considered;

$$\mu_1 = \left[10^{\frac{-d_{tm}}{16\ -\ 6.6\ \tau}} + \left[10^{-(0.496\ +\ 0.354\ \tau)}\right]^5\right]^{0.2} \tag{46}$$

where:

d_{tm} (km): longest continuous land (i.e. inland + coastal) distance, Zone A1 + Zone A2 along the path considered.

μ_1 shall be limited to $\mu_1 \leq 1$.

$$\sigma = -0.6 - 8.5 \times 10^{-9} \; d_i^{3.1} \; \tau \tag{47}$$

σ shall be limited to $\sigma \geq -3.4$.

$$\mu_2 = \left(2.48 \times 10^{-4} \; d_i^2\right)^{\sigma} \tag{48}$$

μ_2 shall be limited to $\mu_2 \leq 1$.

$$\mu_4 = \begin{cases} 10^{(-0.935 + 0.0176\,\zeta_r)\,\log \mu_1} & \text{for} \quad \zeta_r \leq 70° \quad (49a) \\ 10^{0.3 \log \mu_1} & \text{for} \quad \zeta_r \leq 70° \quad (49b) \end{cases}$$

where ζ_r is given in equations (9) and (10), § 4.1 in the main body of this Appendix.

Calculate the path-dependent incidence of ducting, β, and a related parameter, Γ_1 used to calculate the time dependency of the path loss:

$$\beta = \beta_e \cdot \mu_1 \cdot \mu_2 \cdot \mu_4 \tag{50}$$

where β_e is given in equations (7) and (8), § 4.1 in the main body of this Appendix.

$$\Gamma_1 = \frac{1.076}{(2.0058 - \log\beta)^{1.012}} \; \exp\left[-\left(9.51 - 4.8\log\beta + 0.198\,(\log\beta)^2\right) \times 10^{-6}\, d_i^{1.13}\right] \tag{51}$$

Calculate the correction factor, C_{2i} (dB) (see § 4.4 in the main body of this Appendix) using:

$$C_{2i} = \begin{cases} Z(f)(d_i - d_{min})\tau & \text{dB} \quad \text{for the main or supplementary contour} \\ 0 & \text{dB} \quad \text{for the auxiliary contour} \end{cases} \tag{52}$$

where $Z(f)$ is calculated using equation (21) in § 4.4 in the main body of this Appendix.

At distances greater than 375 km the value of the correction factor C_{2i} in equation (52) to be applied is the value of C_{2i} at the 375 km distance.

Calculate the distance-dependent part of the losses (dB) for ducting:

$$L_5(p) = (\gamma_d + \gamma_g)\ d_i + (1.2 + 3.7 \times 10^{-3}\, d_i) \log\left(\frac{p}{\beta}\right) + 12\left(\frac{p}{\beta}\right)^{\Gamma_1} + C_{2i} \tag{53}$$

and for tropospheric scatter:

$$L_6(p) = 20 \log\,(d_i) + 5.73 \times 10^{-4}\,\big(112 - 15 \cos\,(2\zeta)\big)\, d_i + (\gamma_o + \gamma_{wt})\, d_i + C_{2i} \tag{54}$$

For the determination of distances for auxiliary contours, C_{2i} = 0 dB.

4 Frequencies between 60 GHz and 105 GHz

This propagation model is valid for average annual percentage time (p) in the range from 0.001% to 50%.

An iterative process is used to determine the propagation mode (1) required distance. First, equations (55) to (59) are evaluated. Then commencing at the minimum coordination distance, d_{min}, equations (60) and (61) are iterated for distances d_i, where i = 0, 1, 2,..., incremented in steps of s (km) as described in § 1.3 of the main body of this Appendix. For each iteration, d_i is the distance considered.

This process is continued until either of the following expressions becomes true:

$$L_9(p) \geq \begin{cases} L_8(p) & \text{for the main or supplementary contour} \\ L_{8q}(p) & \text{for the auxiliary contour} \end{cases} \tag{54a}$$

or:

$$d_i \geq \begin{cases} d_{max1} & \text{for the main or supplementary contour} \\ d_1 & \text{for the auxiliary contour} \end{cases} \tag{54b}$$

The required distance, d_1, or the auxiliary contour distance d_q are then given by the current distance for the last iteration: i.e.

$$d_1 = d_i \tag{54c}$$

or:

$$d_q = d_i \tag{54d}$$

Calculate the specific attenuation (dB/km) for dry air in the frequency range 60 GHz to 105 GHz using:

$$\gamma_{om} = \begin{cases} \left[2 \times 10^{-4}\left(1 - 1.2 \times 10^{-5} f^{1.5}\right) + \dfrac{4}{(f - 63)^2 + 0.936} + \right. \\ \left. + \dfrac{0.28}{(f - 118.75)^2 + 1.771}\right] f^2\, 6.24 \times 10^{-4} \quad \text{dB/km} \quad \text{for} \quad f > 63.26\ \text{GHz} & (55a) \\ 10 \quad \text{dB/km} \quad \text{for} \quad f \leq 63.26\ \text{GHz} & (55b) \end{cases}$$

Calculate the specific attenuation (dB/km) for an atmospheric water vapour density of 3 g/m^3 using:

$$\gamma_{wm} = (0.039 + 7.7 \times 10^{-4} f^{0.5}) f^2 \; 2.369 \times 10^{-4} \tag{56}$$

Calculate a conservative estimate of the specific attenuation (dB/km) for gaseous absorption using:

$$\gamma_{gm} = \gamma_{om} + \gamma_{wm} \qquad \text{dB/km} \tag{57}$$

For the required frequency and the value of earth station site shielding, A_h (dB), as calculated using the method described in § 1 of this Annex, calculate the minimum loss to be achieved in the iterative calculations:

$$L_7(p) = 92.5 + 20 \log (f) + A_h \qquad \text{dB} \tag{58}$$

For the main or supplementary contour:

$$L_8(p) = L_b(p) - L_7 \qquad \text{dB} \tag{59a}$$

For an auxiliary contour:

$$L_{8q}(p) = L_{bq}(p) - L_7 \qquad \text{dB} \tag{59b}$$

where:

$L_b(p)$ (dB) and $L_{bq}(p)$ (dB): minimum required loss required for p% of the time for the main or supplementary contour and the auxiliary contour of value Q (dB) respectively (see equation (22)).

Iterative calculations

At the start of each iteration calculate the distance for i = 0, 1, 2, ...:

$$d_i = d_{min} + i \cdot s \tag{60}$$

Calculate the distance-dependent losses for the distance:

$$L_9(p) = \gamma_{gm} \, d_i + 20 \log (d_i) + 2.6 \left[1 - \exp\left(\frac{-d_i}{10} \right) \right] \log \left(\frac{p}{50} \right) \tag{61}$$

For frequencies above 60 GHz, the correction factor (see § 4.4 in the main body of this Appendix) is 0 dB. Therefore, no correction term has been added to equation (61).

ANNEX 2

Determination of the required distance for propagation mode (2)

1 Overview

The algorithm given below allows propagation mode (2) path loss, $L_r(p)$ (dB), to be obtained as a monotonic function of rainfall rate, $R(p)$ (mm/h), and with the hydrometeor scatter distance, r_i (km), as a parameter. The model is valid for average annual time percentage (p) in the range 0.001% to 10%. The procedure to determine the hydrometeor scatter contour is as follows:

a) The value of $R(p)$, is determined for the appropriate rain climatic Zones A to Q.

b) Values of $L_r(p)$, are then calculated for incremental values of r_i, starting at the minimum coordination distance d_{min}, in steps of s (km), as described in § 1.3 of the main body of this Appendix. The correct value of r_i is that for which the corresponding value of $L_r(p)$ equals or exceeds the propagation mode (2) minimum required loss $L(p)$. This value of r_i is the propagation mode (2) required distance and is denoted d_r.

c) If the iterative calculation results in r_i equalling or exceeding the appropriate maximum calculation distance (d_{max2}) given in § 2, then the calculation is terminated and d_r is assumed to be equal to d_{max2}. Hence the iteration stops when either of the following expressions becomes true:

$$L_r(p) \geq L(p) \tag{62a}$$

or:

$$r_i \geq d_{max2} \tag{62b}$$

d) The contour for propagation mode (2) is a circle of radius d_r (km) centred on a point along the azimuth of the earth station antenna main beam at a horizontal distance of Δd (km) from the earth station.

2 Maximum calculation distance

As discussed in § 1.5.3 of the main body of this Appendix, it is necessary to set upper limits to the maximum distance used in the iterative calculation of the required distance. The maximum calculation distance to be used for propagation mode (2) (d_{max2}) is latitude dependent and is given in the following equation:

$$d_{max2} = \sqrt{17\,000(h_R + 3)} \qquad \text{km}$$

where h_R is defined in equations (74) and (75).

3 Calculation of the propagation mode (2) contour

Determine $R(p)$, the rainfall rate (mm/h) exceeded on average for p% of a year. The world has been divided into a number of rain climatic zones (see Figs. 2, 3 and 4) which show different precipitation characteristics.

FIGURE 2

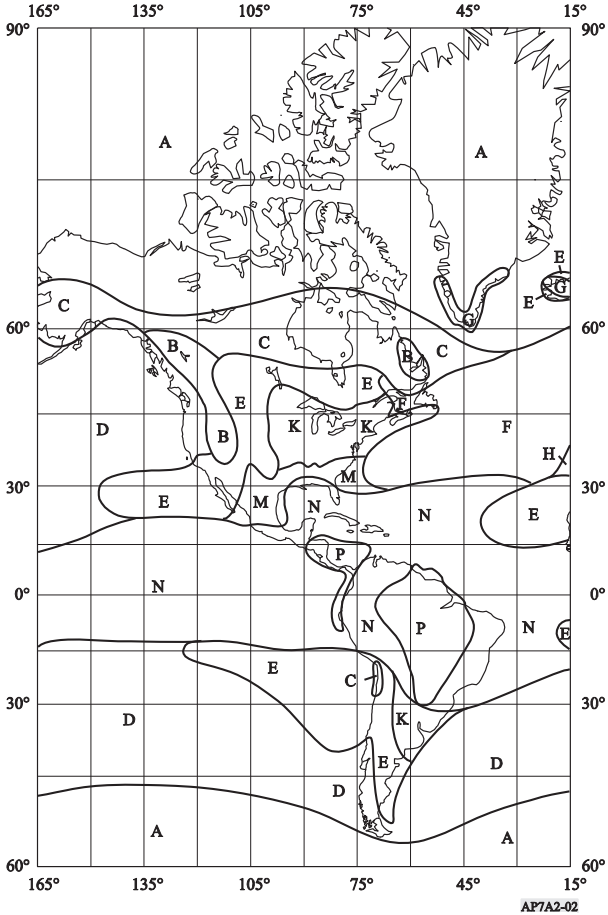


FIGURE 3

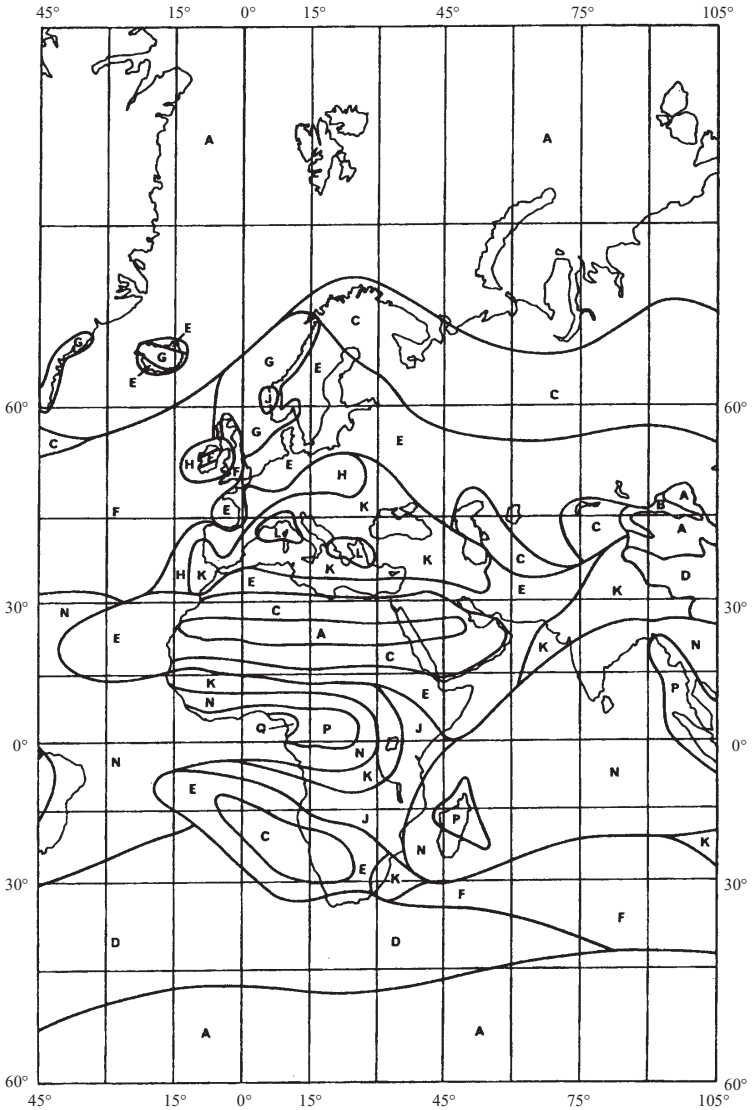
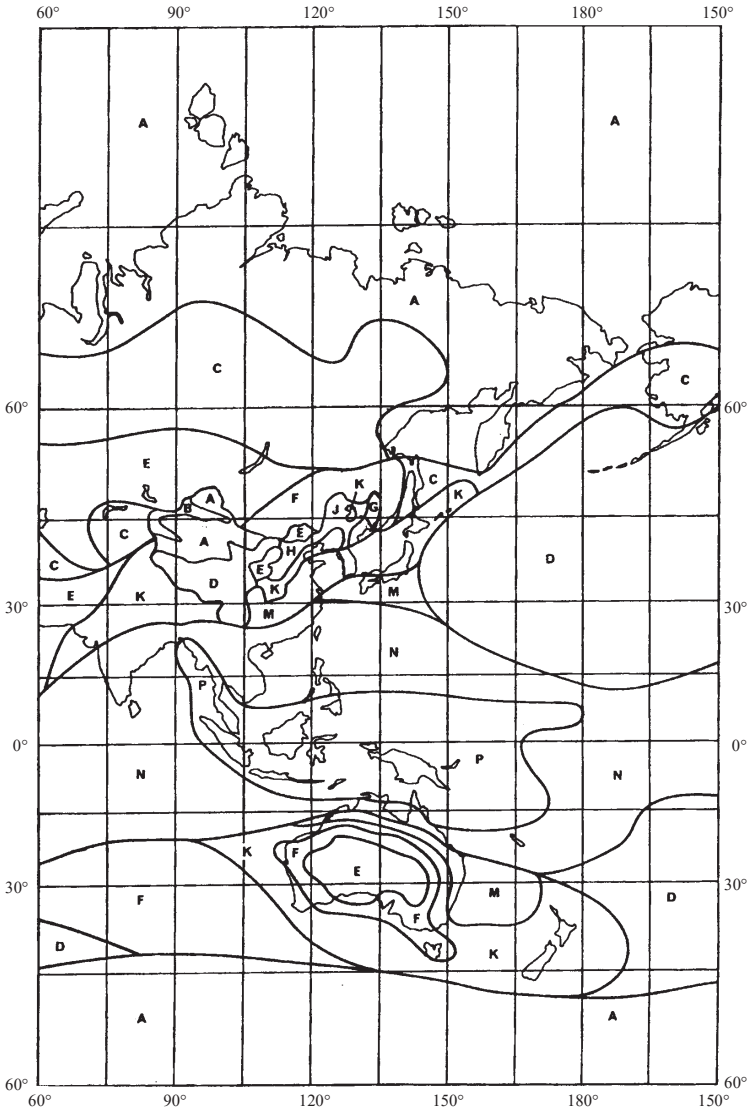


FIGURE 4



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The curves shown in Fig. 5 represent consolidated rainfall-rate distributions, each applicable to several of these rain climatic zones.

Determine which rain climatic zone is applicable to the location of the earth station:

– For 0.001% < p < 0.3% and the applicable rain climatic zone:

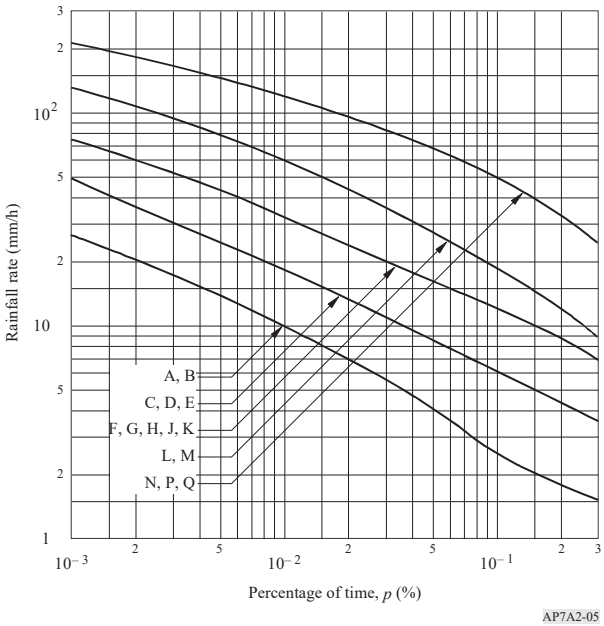
Determine $R(p)$ either from Fig. 5 or from equations (63) to (67).

– For $p \geq 0.3\%$:

Use equation (68) with values of $R(0.3\%)$ and p_c obtained from Table 4.

FIGURE 5

Consolidated cumulative distributions of rainfall rate for the rain climatic zones shown in Figs. 2, 3 and 4



Rain climatic Zones A, B

$$R(p) = 1.1\, p^{-0.465} + 0.25 \left[\log\left(p/0.001\right) \log^3\left(0.3/p\right) \right] - \left[\left| \log\left(p/0.1\right) \right| + 1.1 \right]^{-2} \quad \text{mm/h} \qquad (63)$$

Rain climatic Zones C, D, E

$$R(p) = 2\, p^{-0.466} + 0.5 \left[\log\left(p/0.001\right) \log^3\left(0.3/p\right) \right] \quad \text{mm/h} \qquad (64)$$

Rain climatic Zones F, G, H, J, K

$$R(p) = 4.17\, p^{-0.418} + 1.6\left[\log\left(p/0.001\right)\log^3\left(0.3/p\right)\right] \quad \text{mm/h} \qquad (65)$$

Rain climatic Zones L, M

$$R(p) = 4.9\, p^{-0.48} + 6.5\left[\log\left(p/0.001\right)\log^2\left(0.3/p\right)\right] \quad \text{mm/h} \qquad (66)$$

Rain climatic Zones N, P, Q

$$R(p) = 15.6\left(p^{-0.383} + \left[\log\left(p/0.001\right)\log^{1.5}\left(0.3/p\right)\right]\right) \quad \text{mm/h} \qquad (67)$$

TABLE 4

Values of *R* and p_c for the different rain climatic zones

Rain climatic zone	***R* (0.3%) (mm/h)**	**p_c (%)**
A, B	1.5	2
C, D, E	3.5	3
F, G, H, J, K	7.0	5
L, M	9.0	7.5
N, P, Q	25.0	10

where:

p_c (%): reference time percentage above which the rainfall rate $R(p)$ can be assumed to be zero.

$$R(p) = R(0.3\%)\left[\frac{\log(p_c/p)}{\log(p_c/0.3)}\right]^2 \qquad (68)$$

Determine the specific attenuation (dB/km) due to rain using values of k and α from Table 5 in equation (70). Values of k and α at frequencies other than those in Table 5 can be obtained by interpolation using a logarithmic scale for frequency, a logarithmic scale for k and a linear scale for α.

TABLE 5

Values of *k* and α for vertical polarization as a function of the frequency

Frequency (GHz)	*k*	α
1	0.0000352	0.880
4	0.000591	1.075
6	0.00155	1.265
8	0.00395	1.31
10	0.00887	1.264
12	0.0168	1.20
14	0.029	1.15
18	0.055	1.09
20	0.0691	1.065
22.4	0.090	1.05
25	0.113	1.03
28	0.150	1.01
30	0.167	1.00
35	0.233	0.963
40	0.310	0.929
40.5	0.318	0.926

Let:

$$R = R(p) \tag{69}$$

Then the specific attenuation (dB/km) due to rain is given by:

$$\gamma_R = k\ R^{\alpha} \tag{70}$$

Calculate the effective diameter of the rain cell:

$$d_s = 3.5\ R^{-0.08} \tag{71}$$

Then, calculate the effective scatter transfer function:

$$R_{cv} = \frac{2.17}{\gamma_R\ d_s}\left(1 - 10^{\frac{-\gamma_R\ d_s}{5}}\right) \tag{72}$$

Calculate the additional attenuation outside the common volume:

$$\Gamma_2 = 631\ k\ R^{(\alpha - 0.5)} \times 10^{-(R+1)^{0.19}} \tag{73}$$

Determine the rain height above ground, h_R (km):

For North America and Europe west of 60° E longitude:

$$h_R = 3.2 - 0.075\,(\zeta - 35) \qquad \text{for} \quad 35 \le \zeta \le 70 \tag{74}$$

where:

ζ: latitude of the coordinating earth station.

For all other areas of the world:

$$h_R = \begin{cases} 5 - 0.075\left(\zeta - 23\right) & \text{for} \quad \zeta > 23 & \text{Northern hemisphere} & (75a) \\ 5 & \text{for} \quad 0 \le \zeta \le 23 & \text{Northern hemisphere} & (75b) \\ 5 & \text{for} \quad 0 \ge \zeta \ge -21 & \text{Southern hemisphere} & (75c) \\ 5 + 0.1\left(\zeta + 21\right) & \text{for} \quad -71 \le \zeta < -21 & \text{Southern hemisphere} & (75d) \\ 0 & \text{for} \quad \zeta < -71 & \text{Southern hemisphere} & (75e) \end{cases}$$

Determine the specific attenuation due to water vapour absorption (a water vapour density of 7.5 g/m^3 is used):

$$\gamma_{wr} = \left[0.06575 + \frac{3.6}{\left(f - 22.2\right)^2 + 8.5} \right] f^2\, 7.5 \times 10^{-4} \tag{76}$$

3.1 Iterative calculations

Evaluate equations (77) to (82) inclusive for increasing values of r_i, where r_i is the current distance considered (km) between the region of maximum scattering and the possible location of a terrestrial station and i = 0, 1, 2, ... Continue this process until either of the conditions given in equations (62a) and (62b) is true. Then the rain-scatter required distance d_r is the current value of r_i.

$$r_i = d_{min} + i \cdot s \tag{77}$$

Determine the loss above the rain height, L_{ar} (dB), applicable to scatter coupling:

$$L_{ar} = \begin{cases} 6.5\left[6\,(r_i - 50)^2 \times 10^{-5} - h_R\right] & \text{for} \quad 6\,(r_i - 50)^2 \times 10^{-5} > h_R & (78a) \\ 0 & \text{for} \quad 6\,(r_i - 50)^2 \times 10^{-5} \le h_R & (78b) \end{cases}$$

Calculate the additional attenuation for the departure from Rayleigh scattering:

$$A_b = \begin{cases} 0.005\,(f - 10)^{1.7} R^{0.4} & \text{for } 10 \text{ GHz} < f < 40.5 \text{ GHz} & (79a) \\ 0 & \text{for} \quad f < 10 \text{ GHz or when } L_{ar} \ne 0 & (79b) \end{cases}$$

Calculate the effective path length for oxygen absorption:

$$d_O = \begin{cases} 0.7\, r_i + 32 & \text{for} \quad r_i < 340 \text{ km} \quad (80a) \\ 270 & \text{for} \quad r_i \geq 340 \text{ km} \quad (80b) \end{cases}$$

Calculate the effective path length for water vapour absorption:

$$d_v = \begin{cases} 0.7\, r_i + 32 & \text{for} \quad r_i < 240 \text{ km} \quad (81a) \\ 200 & \text{for} \quad r_i \geq 240 \text{ km} \quad (81b) \end{cases}$$

Determine the propagation mode (2) path loss, L_r (dB):

$$L_r = 168 + 20 \log r_i - 20 \log f - 13.2 \log R - G_x + A_b - 10 \log R_{cv} + \Gamma_2 + L_{ar} + \gamma_o\, d_o + \gamma_{wr}\, d_v \quad (82)$$

where:

γ_o: as given in equation (33)

G_x: terrestrial network antenna gain in Tables 7 or 8.

4 Construction of the propagation mode (2) contour

In order to determine the centre of the circular propagation mode (2) contour, it is necessary to calculate the horizontal distance to this point from the earth station, along the azimuth of the earth station antenna main beam axis. The distance, Δd (km), to the centre of the propagation mode (2) contour is given by:

$$\Delta d = \frac{h_R}{2 \tan \varepsilon_s} \quad (83)$$

where:

ε_s: earth station antenna main beam axis elevation angle

and

Δd: shall be limited to the distance (d_r – 50) km.

The propagation mode (2) required distance, d_r, must lie within the range between the minimum coordination distance, d_{min}, and the propagation mode (2) maximum calculation distance, d_{max2}.

Draw the propagation mode (2) contour as a circle of radius d_r (km) around the centre determined above. The propagation mode (2) contour is the locus of points on this circle. However, if any part of the propagation mode (2) contour falls within the contour defined by the minimum coordination distance, this arc of the propagation mode (2) contour is taken to be identical to the contour based on the minimum coordination distance and the propagation mode (2) contour is then no longer circular.

ANNEX 3

Antenna gain towards the horizon for an earth station operating with a geostationary space station

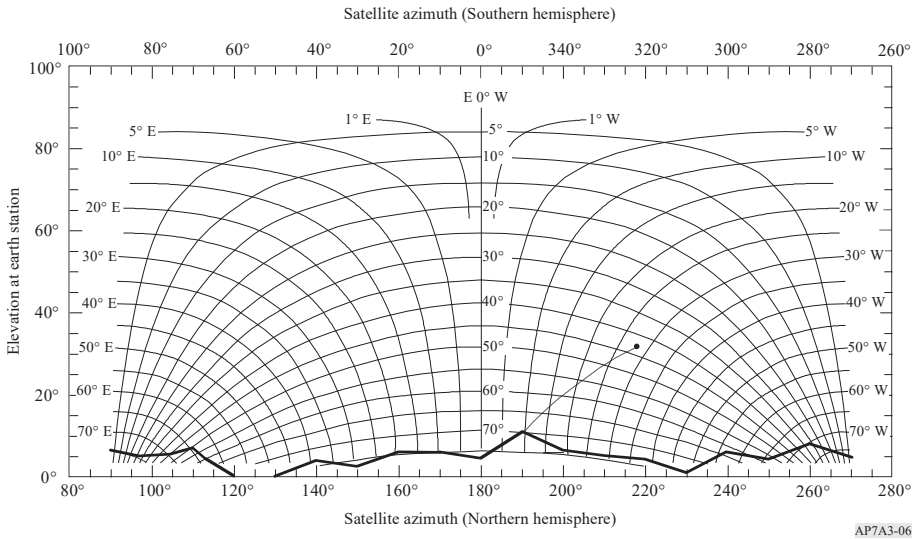
1 General

The gain component of the earth station antenna in the direction of the physical horizon around an earth station is a function of the angular separation between the antenna main beam axis and the horizon in the direction under consideration. When the earth station is used to transmit to a space station in a slightly inclined orbit, all possible pointing directions of the antenna main beam axis need to be considered. For earth station coordination, knowledge of $\varphi(\alpha)$, the minimum possible value of the angular separation that will occur during the operation of the space station, is required for each azimuth.

When a geostationary space station maintains its location close to its nominal orbital position, the earth station's main beam axis elevation angle, ε_s, and the azimuth angle, α_s, to the space station from the earth station's latitude, ζ, are uniquely related. Figure 6 shows the possible location arcs of positions of a space station on the geostationary orbit in a rectangular azimuth/elevation plot. It shows arcs corresponding to a set of earth station latitudes and the intersecting arcs correspond to points on the orbit with a fixed difference in longitude East or West of the earth station. Figure 6 also shows a portion of the horizon profile $\varepsilon_h(\alpha)$. The off-axis angle $\varphi(\alpha)$ between the horizon profile at an azimuth of 190° and a space station located 28° W of an earth station at 43° N latitude is indicated by the great-circle arc shown dashed on Fig. 6.

FIGURE 6

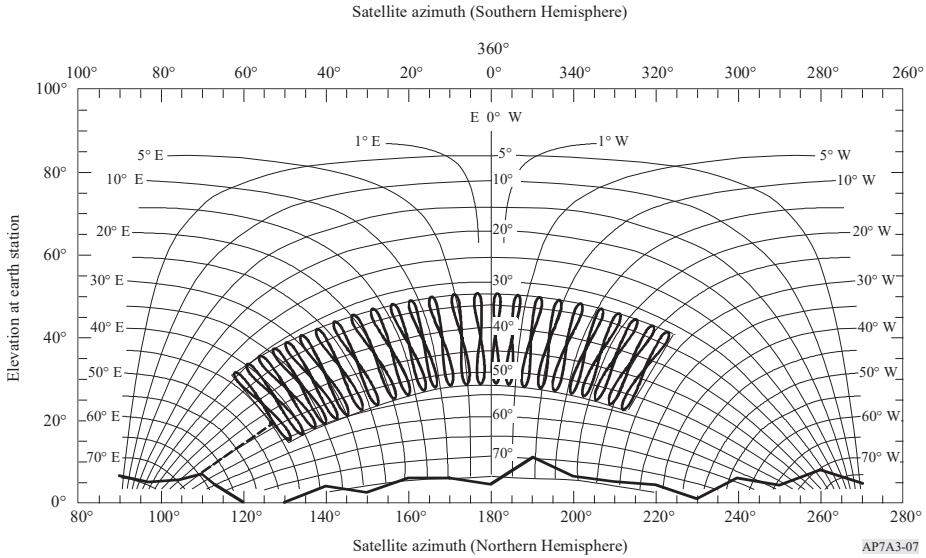
Position arcs of geostationary satellites with horizon and the arc from the horizon at azimuth 190° to a satellite 28° W of an earth station at 43° N latitude



When the north/south station-keeping of a geostationary satellite is relaxed, the orbit of the satellite becomes inclined, with an inclination that increases gradually with time. As viewed from the Earth, the position of the satellite traces a figure eight during each 24-hour period. Figure 7 shows the variations in the trajectories of a set of satellites, each with 10° inclination, spaced by 3° along the geostationary orbit from 28° W to 44° E, with respect to an earth station at 43° N latitude. Figure 7 also shows, with a dashed curve, the great-circle arc corresponding to the minimum off-axis angle φ(α) between a point on the trajectory of one of the satellites and the horizon profile at an azimuth of 110°.

FIGURE 7

Position arcs of geostationary satellites with horizon and the arc from the horizon at azimuth 110° to satellites with 10° inclination on the geostationary orbital arc from 28° W to 44° E of an earth station at 43° N latitude



For a transmitting earth station operating in a frequency band that is also allocated for bidirectional use by receiving earth stations operating with geostationary space stations, refer to § 2.1 of Annex 5.

2 Determination of the angular separation φ(α)

For the determination of the off-axis angle φ(α), two cases are distinguished. These depend on whether the orbit of the space station has no inclination, or is slightly inclined. The following equations may be used in both of these cases:

$$\psi_s(i,\delta) = \arccos\,(\sin\zeta \sin i + \cos\zeta \cos i \cos\delta) \tag{84}$$

$$\varepsilon_s(i,\delta) = \arcsin\left(\frac{K\cos\psi_s(i,\delta)-1}{\left(1+K^2-2K\cos\psi_s(i,\delta)\right)^{1/2}}\right) \tag{85}$$

$$\alpha_{0s}(i,\delta)=\arccos\left[\frac{\sin i-\cos\psi_s\sin\zeta}{\sin\psi_s\ \cos\zeta}\right] \tag{86}$$

$$\alpha_s(i,\delta)=\alpha_{0s}(i,\delta) \quad \text{for a space station located east of the earth station } (\delta \geq 0) \tag{87}$$

$$\alpha_s(i,\delta)=360°-\alpha_{0s}(i,\delta) \quad \text{for a space station located west of the earth station } (\delta \leq 0) \tag{88}$$

$$\varphi(\alpha,i,\delta)=\arccos\left[\cos\varepsilon_h(\alpha)\cos\varepsilon_s(i,\delta)\cos\left(\alpha-\alpha_s(i,\delta)\right)+\sin\varepsilon_h(\alpha)\sin\varepsilon_s(i,\delta)\right] \tag{89}$$

where:

ζ: latitude of the earth station (positive for north; negative for south)

δ: difference in longitude between the earth station and a space station

i: latitude of a sub-satellite point (positive for north; negative for south)

$\psi_s(i, \delta)$: great-circle arc between the earth station and a sub-satellite point

$\alpha_s(i, \delta)$: space station azimuth as seen from the earth station

$\varepsilon_s(i, \delta)$: space station elevation angle as seen from the earth station

$\varphi\lambda\alpha, i, \delta)$: angle between the main beam and the horizon direction corresponding to the azimuth, α, under consideration when the main beam is steered towards a space station with a sub-satellite point at latitude, i, and longitude difference, δ

α: azimuth of the direction under consideration

ε_h: elevation angle of the horizon at the azimuth under consideration, α

$\varphi(\alpha)$: angle to be used for horizon gain calculation at the azimuth under consideration, α

K: orbit radius/Earth radius, which for the geostationary orbit is assumed to be 6.62.

All arcs mentioned above are in degrees.

***Case 1*: Single space station, no orbital inclination**

For a space station operating with no orbital inclination at an orbital position with difference in longitude δ_0, equations (84) to (89) may be applied directly using $i = 0$ to determine $\varphi(\alpha)$ for each azimuth α. Thus:

$$\varphi(\alpha) = \varphi(\alpha, 0, \delta_0) \tag{90}$$

where:

δ_0: difference in longitude between the earth station and the space station.

***Case 2*: Single space station, slightly inclined orbit**

For a space station operating in a slightly inclined orbit on a portion of the geostationary arc with a nominal longitude difference of δ_0, the maximum orbital inclination over its lifetime, i_s, must be considered. Equations (84) to (89) may be applied to develop the minimum off-axis angle to each of four arcs in azimuth/elevation that bound the trajectory of the space station in angle and elevation. The bounding arcs correspond to the maximum and minimum latitudes of the sub-satellite points and the extremes of the difference in longitude between the earth and space stations when the space station is operating at its maximum inclination.

The determination of the minimum off-axis angles in equations (91) to (95) may be made by taking increments along a bounding contour. The step size in inclination i or longitude δ should be between 0.5° and 1.0° and the end points of the respective ranges should be included in the calculation.

The horizon profile $\varepsilon_h(\alpha)$ used in the determination of $\varphi(\alpha)$ is specified at increments in azimuth α that do not exceed 5°.

Thus:

$$\varphi(\alpha) = \min_{n = 1 \text{ to } 4} \varphi_n(\alpha) \tag{91}$$

with:

$$\varphi_1(\alpha) = \min_{\delta_0 - \delta_s \le \delta \le \delta_0 + \delta_s} \varphi(\alpha, -i_s, \delta) \tag{92}$$

$$\varphi_2(\alpha) = \min_{\delta_0 - \delta_s \le \delta \le \delta_0 + \delta_s} \varphi(\alpha, i_s, \delta) \tag{93}$$

$$\varphi_3(\alpha) = \min_{-i_s \le i \le i_s} \varphi(\alpha, i, \delta_0 - \delta_s) \tag{94}$$

$$\varphi_4(\alpha) = \min_{-i_s \le i \le i_s} \varphi(\alpha, i, \delta_0 + \delta_s) \tag{95}$$

$$\delta_s = \left({}^{i_s}\!/_{15} \right)^2 \tag{96}$$

where:

i_s: maximum operational inclination angle of the satellite orbit

δ_s: maximum longitude change from nominal value of the sub-satellite point of a satellite with orbital inclination i_s.

3 Determination of antenna gain

The relationship $\varphi(\alpha)$ is used to derive a function for the horizon antenna gain (dBi), $G(\varphi)$ as a function of the azimuth α, by using the actual earth station antenna pattern, or a formula giving a good approximation. For example, in cases where the ratio between the antenna diameter and the wavelength is equal to or greater than 35, the following equation is used:

$$G(\varphi) = \begin{cases} G_{amax} - 2.5 \times 10^{-3} \left(\dfrac{D}{\lambda} \varphi \right)^2 & \text{for } 0 < \varphi < \varphi_m \\ G_1 & \text{for } \varphi_m \le \varphi < \varphi_r \\ 29 - 25 \log \varphi & \text{for } \varphi_r \le \varphi < 36° \\ -10 & \text{for } 36° \le \varphi \le 180° \end{cases} \tag{97}$$

$$G_1 = \begin{cases} -1 + 15 \log \left(D/\lambda \right) \quad \text{dBi} & \text{for } D/\lambda \ge 100 \\ -21 + 25 \log \left(D/\lambda \right) \quad \text{dBi} & \text{for } 35 \le D/\lambda < 100 \end{cases}$$

$$\varphi_m = \frac{20\,\lambda}{D}\sqrt{G_{amax} - G_1} \qquad \text{degrees}$$

$$\varphi_r = \begin{cases} 15.85\left(D/\lambda\right)^{-0.6} & \text{degrees} \quad \text{for} \quad D/\lambda \geq 100 \\ 100\left(\lambda/D\right) & \text{degrees} \quad \text{for} \quad 35 \leq D/\lambda < 100 \end{cases}$$

Where a better representation of the actual antenna pattern is available, it may be used.

In cases where D/λ is not given, it may be estimated from the expression:

$$20\log\frac{D}{\lambda} \approx G_{amax} - 7.7$$

where:

G_{amax}: main beam axis antenna gain (dBi)

D: antenna diameter (m)

λ: wavelength (m)

G_1: gain of the first side lobe (dBi).

ANNEX 4

Antenna gain toward the horizon for an earth station operating with non-geostationary space stations

This Annex presents methods which may be used to determine the antenna gain towards the horizon for an earth station operating to non-geostationary satellites using the TIG method described in § 2.2 of the main body of this Appendix.

1 Determination of the horizon antenna gain

In its simplest implementation, the TIG method depends on the minimum elevation angle of the beam axis of the earth station antenna (ε_{sys}), which is a system parameter that has the same value on all azimuths from the earth station. If the horizon elevation angle at an azimuth under consideration is ε_h (degrees), the minimum separation angle from the horizon at this azimuth to any possible pointing angle for the main beam axis of the antenna (φ_{min}) is equal to the difference between these two angles ($\varepsilon_{sys} - \varepsilon_h$), but it is not less than zero degrees. The maximum separation angle from the horizon at this azimuth to any possible pointing angle for the main beam axis of the antenna (φ_{max}) is equal to the difference between the sum of these two angles and 180° ($180 - \varepsilon_{sys} - \varepsilon_h$). The maximum and minimum values of horizon gain for the azimuth under consideration are obtained from the gain pattern of the earth station antenna at these off-axis angles. Where no pattern is available the pattern of § 3 of Annex 3 may be used.

Additional constraints may be included in the determination of the maximum and minimum values of horizon antenna gain where an earth station operates with a constellation of non-geostationary satellites that are not in near-polar orbit. In this case, depending on the latitude of the earth station, there may be portions of the hemisphere above the horizontal plane at the earth station in which no satellite will appear. To include these visibility limitations within this method, it is first necessary to determine, for a closely spaced set of azimuth angles around the earth station, the minimum elevation angle at which a satellite may be visible. This minimum satellite visibility elevation angle (ε_v) may be determined from consideration of the visibility of the edge of the shell formed by all possible orbits having the orbital inclination and altitude of the satellites in the constellation.

The lowest elevation angle towards which the main-beam axis of the earth station antenna will point on any azimuth is the minimum composite elevation angle (ε_c), which is equal to the greater of the minimum satellite visibility elevation angle (ε_v) and the minimum elevation angle of the earth station (ε_{sys}). After the minimum composite elevation angle has been determined for all azimuths by the procedure of § 1.1 of this Annex, the resulting profile of the minimum composite elevation angles can be used, in the procedure of § 1.2 of this Annex, to determine the maximum and minimum values of horizon gain at any azimuth.

Further information and an example of this method may be found in the most recent version of Recommendation ITU-R SM.1448. (WRC-15)

1.1 Determination of satellite visibility limits

The visibility limits of a constellation of satellites can be determined from the inclination angle of the most inclined satellite and the altitude of the lowest satellite in the constellation. For this determination, six cases may be distinguished, but not all of these may be applicable for a given constellation and a given earth station latitude. The azimuth and the corresponding lower limit on the elevation angle are developed by a parametric method using a set of points on the edge of the orbital shell of the constellation. The approach is to develop this relationship for azimuths to the east of a station in the northern hemisphere. Elevation angles for azimuths to the west of the station and for all azimuths for stations in the southern hemisphere are obtained by symmetry. The following equations, which are applicable to circular orbits only, may be used for the complete determination of the horizon antenna gain in all practical cases:

$$\psi(\delta) = \arccos\,(\sin \zeta_e \sin i_s + \cos \zeta_e \cos i_s \cos \delta) \tag{98}$$

$$\varepsilon_v(\delta) = \arcsin\left[\frac{K_1 \cos[\psi(\delta)] - 1}{\left(1 + K_1^2 - 2K_1 \cos[\psi(\delta)]\right)^{1/2}}\right] \tag{99}$$

$$\alpha_0(\delta) = \arccos\left[\frac{\sin i_s - \cos[\psi(\delta)] \sin \zeta_e}{\sin[\psi(\delta)] \cos \zeta_e}\right] \tag{100}$$

with:

$$\alpha(\delta)=\begin{cases}\alpha_0(\delta) \text{ and} & \\ 360°-\alpha_0(\delta) & \text{for earth stations north of the Equator} \\ 180°-\alpha_0(\delta) \text{ and} & \\ 180°+\alpha_0(\delta) & \text{for earth stations south of the Equator}\end{cases} \quad (101)$$

where:

i_s: orbital inclination of the satellites in the constellation assumed to be positive and between 0° and 90°

ζ_e: modulus of the latitude of the earth station

δ: difference in longitude from the earth station to a point on the edge of the orbital shell of the constellation

$\psi(\delta)$: great-circle arc between the earth station and a point on the surface of the Earth directly below the point on the edge of the orbital shell of the constellation

$\alpha(\delta)$: azimuth from the earth station to a point on the edge of the orbital shell

$\alpha_0(\delta)$: principal azimuth, an azimuth between 0° and 180°, from an earth station to a point on the edge of the orbital shell

$\varepsilon_v(\delta)$: elevation angle from the earth station to a point on the edge of the orbital shell

K_1: orbit radius/Earth radius for the lowest altitude satellite in the constellation (Earth radius = 6 378.14 km)

ψ_m = arccos $(1/K_1)$.

All arcs mentioned above are in degrees.

For any latitude on the surface of the Earth, the azimuth for which the minimum elevation angle to a satellite can be greater than zero, and the corresponding elevation angles, may be determined by implementing the calculations under the following case(s). No more than two of these cases will be applicable for any latitude. For situations not specifically addressed in the following cases, no satellite is visible at elevation angles at or below 90° on any azimuth.

Case 1: For: $\zeta_e \leq i_s - \psi_m$

For this case, a satellite may be visible to the horizon for all azimuths about the earth station ($\varepsilon_v = 0$).

Case 2: For: $i_s - \psi_m < \zeta_e \leq \arcsin(\sin i_s \cos \psi_m)$

For this case, the azimuth angles and elevation are developed parametrically by choosing a set of values of δ, uniformly spaced on the interval 0 to δ_1, and applying equations (98) to (101). For this purpose the spacing between values is not to exceed 1.0°, and the end points are to be included.

$$\delta_1 = \arccos\left[\frac{\cos\psi_m - \sin\zeta_e \sin i_s}{\cos\zeta_e \cos i_s}\right]$$

At any principal azimuth ($\alpha_0(\delta)$) that is not included in the set, the minimum elevation angle is zero ($\varepsilon_v = 0$), except for azimuths where Case 6 additionally applies.

Case 3: For: $\arcsin(\sin i_s \cos \psi_m) < \zeta_e < i_s$ and $\zeta_e < 180° - \psi_m - i_s$

For this case, the azimuth angles and elevation are developed parametrically by choosing a set of values of δ, uniformly spaced on the interval 0 to δ_2, and applying equations (98) to (101). For this purpose the spacing between values is not to exceed 1.0°, and the end points are to be included.

$$\delta_2 = 2\arctan\left[\frac{\sqrt{\sin^2\psi_m - \cos^2 i_s \sin^2\delta_1}}{\sin\zeta_e \cos i_s \sin\delta_1}\right] - \delta_1$$

At any principal azimuth ($\alpha_0(\delta)$) that is not included in the set, the minimum elevation angle is zero ($\varepsilon_v = 0$), except for azimuths where Case 6 additionally applies.

Case 4: For: $i_s \leq \zeta_e < i_s + \psi_m$ and $\zeta_e < 180° - i_s - \psi_m$

For this case, the minimum elevation angle is given explicitly in terms of the principal azimuth angle α_0, as follows:

$$\varepsilon_v = \begin{cases} 90° & \text{for} \quad 0 \leq \alpha_0 < \alpha_2 \\ 0 & \text{for} \quad \alpha_2 \leq \alpha_0 \leq 180° \end{cases}$$

where:

$$\alpha_2 = \arccos\left[\frac{\sin i_s - \cos\psi_m \sin\zeta_e}{\sin\psi_m \cos\zeta_e}\right]$$

Note that a minimum elevation angle of 90° in this formulation indicates that no satellite is visible at elevation angles at or below 90° on these azimuths. Furthermore, within the range of principal azimuths where the minimum elevation angle is zero, Case 6 may additionally apply.

Case 5: For $180° - i_s - \psi_m \leq \zeta_e \leq 90°$

For this case, a satellite may be visible to the horizon for all azimuths about the earth station ($\varepsilon_v = 0$).

Case 6: For $\zeta_e < \psi_m - i_s$

This case may occur additionally with Case 2, Case 3 or Case 4 and a satellite may be visible only above a minimum elevation angle for other principal azimuths.

For this case, the other principal azimuths and the corresponding elevation angles are developed parametrically by choosing a set of values of δ, uniformly spaced on the interval 0 to δ_3, and applying equations (98) to (101) with i_s replaced by $-i_s$. For this purpose the spacing between values is not to exceed 1.0° and the end points are to be included.

$$\delta_3 = \arccos\left[\frac{\cos\psi_m + \sin\zeta_e \sin i_s}{\cos\zeta_e \cos i_s}\right]$$

1.2 Determination of minimum and maximum horizon gain from the minimum visible elevation angle profile

The horizon gain of the earth station antenna is determined from the profile of values of the minimum composite elevation angle (ε_c). At any azimuth, the minimum composite elevation angle is the greater of the minimum satellite visibility elevation angle at that azimuth (ε_v) and the minimum elevation angle for the earth station (ε_{sys}). The following procedure may be used to determine the maximum and minimum values of horizon antenna gain for each azimuth under consideration.

The following equation may be used to determine the angular separation between the horizon profile, at an azimuth angle α and horizon elevation angle ε_h, and a point on the profile of the minimum composite elevation angle, where the minimum composite elevation angle is ε_c at an azimuth angle of α_c:

$$\varphi(\alpha,\alpha_c) = \arccos\left[\sin\varepsilon_h(\alpha)\sin\left(\varepsilon_c(\alpha_c)\right) + \cos\varepsilon_h(\alpha)\cos\left(\varepsilon_c(\alpha_c)\right)\cos(\alpha-\alpha_c)\right] \qquad (102)$$

where:

α: azimuth of the direction under consideration

$\varepsilon_h(\alpha)$: elevation angle of the horizon at the azimuth under consideration, α

$\varepsilon_c(\alpha_c)$: minimum composite elevation angle at the azimuth, α_c

α_c: azimuth corresponding to ε_c.

The minimum value of the separation angle φ_{min}, for the azimuth under consideration, is determined by finding the minimum value of $\varphi(\alpha, \alpha_c)$ for any azimuth α_c, and the maximum value, φ_{max}, is determined by finding the maximum value of $\varphi(\alpha, \alpha_c)$ for any azimuth α_c. The azimuth angles (α) are usually taken in increments of 5°; however, to accurately determine the minimum separation angle, the values of the minimum composite elevation angle, ε_c, need to be determined for a spacing of 1° or less in the azimuth α_c. Where the procedures in § 1.1 of this Annex do not provide a profile of minimum composite elevation angle with a close enough spacing in azimuth angles, linear interpolation may be used to develop the necessary intermediate values. The maximum and minimum horizon antenna gains, G_{max} and G_{min}, to be used in the equations of § 2.2 of the main body of this Appendix for the azimuth under consideration are obtained by applying the off-axis angles, φ_{min} and φ_{max}, respectively, in the earth station antenna pattern. If the earth station antenna pattern is not known then the antenna pattern in § 3 of Annex 3 is used. In many cases, φ_{max} will be large enough on all azimuths so that G_{min} will be equal to the minimum gain of the antenna pattern at all azimuths.

ANNEX 5

Determination of the coordination area for a transmitting earth station with respect to receiving earth stations operating with geostationary space stations in bidirectionally allocated frequency bands

1 Introduction

The propagation mode (1) contour of a transmitting earth station with respect to unknown receiving earth stations operating with geostationary space stations requires the determination of the horizon gain of the antenna of the receiving earth station at each azimuth of the transmitting earth station. Different methods then need to be applied to determine the coordination area of the coordinating earth station, depending on whether it operates with geostationary or non-geostationary space stations. When both the coordinating earth station and the unknown receiving earth stations operate with geostationary space stations, it is also necessary to determine a propagation mode (2) contour.

The coordination area of a transmitting earth station, with respect to unknown receiving earth stations that operate to non-geostationary space stations, can be determined by minor modifications to the methods applicable to the determination of coordination area of transmitting earth stations with respect to terrestrial stations. (See § 3.2.1 and § 3.2.3 of the main body of the Appendix.)

2 Determination of the bidirectional contour for propagation mode (1)

For a transmitting earth station operating in a frequency band that is also allocated for bidirectional use by receiving earth stations operating with geostationary space stations, further development of the procedures in Annex 3 is needed. It is necessary to determine the horizon gain of the unknown receiving earth station, the horizon gain to be used at each azimuth at the coordinating (transmitting) earth station, for the determination of the bidirectional contour.

2.1 Calculation of horizon gain for unknown receiving earth stations operating with geostationary space stations

The value of G_r, the horizon gain of the receiving earth station, for each azimuth, α, at the transmitting earth station is found by the following steps:

Step 1: The receiving earth station may be operating with any satellite in the geostationary orbit above a minimum elevation angle, ε_{min}, contained in Table 9. The maximum difference in longitude (δ_b (degrees)) between the receiving earth station and its associated space station occurs at this minimum elevation angle, ε_{min}, and is given by:

$$\delta_b = \arccos\left(\frac{\sin\left(\varepsilon_{min} + \arcsin\left(\frac{\cos(\varepsilon_{min})}{K}\right)\right)}{\cos(\zeta)}\right) \tag{103}$$

where:

ζ: latitude of the receiving earth station, which is assumed to be the same as the transmitting earth station

K: ratio of the radius of the satellite orbit to the radius of the Earth, equal to 6.62.

Step 2: For each azimuth, α, at the transmitting earth station:

– determine the azimuth α_r from the receiving earth station to the transmitting earth station:

$$\alpha_r = \alpha + 180° \qquad \text{for } \alpha < 180°$$

$$\alpha_r = \alpha - 180° \qquad \text{for } \alpha \geq 180°$$

– for each azimuth α_r, determine the minimum angular separation, $\varphi(\alpha_r)$, between the receiving earth station main beam axis and the horizon at this azimuth using Case 1 in § 2 of Annex 3. For this evaluation, $\varphi(\alpha_r)$ is the minimum value of $\varphi(\alpha_r, 0, \delta_0)$, where the values of δ_0 are between $-\delta_b$ and $+\delta_b$ in steps of 1° or less, making sure to include the end points.

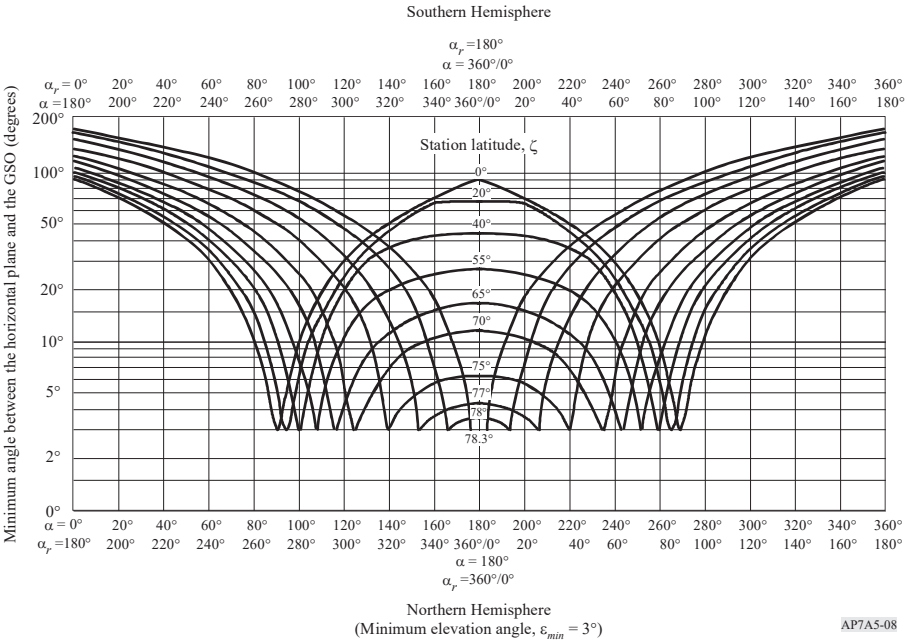
The minimum angular separation, $\varphi(\alpha_r)$, may be used with the gain pattern in § 3 of Annex 3 to determine the horizon gain for this azimuth, α, unless a different gain pattern is referenced in Table 9.

Figure 8 shows plots of the minimum angular separation between the horizon at zero degrees elevation on an azimuth α_r and a satellite on the geostationary orbit at an elevation above 3°. Plots are shown for a set of values of the station latitude, ζ, which is assumed to be the same for both transmitting and receiving earth stations. Figure 8 also provides a scale showing the corresponding azimuth, α, of the transmitting earth station.

Further information and an example may be found in the most recent version of Recommendation ITU-R SM.1448. (WRC-15)

FIGURE 8

Illustration of minimum angular distance between points on the geostationary-satellite orbit (GSO) and the horizontal plane



3 Determination of the bidirectional rain scatter contour

The procedure for the determination of the bidirectional rain scatter area, as described in § 3.1.2 of the main body of this Appendix, is as follows:

The horizontal distance d_s (km) from the coordinating earth station to the point at which the main beam axis attains the rain height h_R is calculated by:

$$d_s = 8\,500\left(\sqrt{\tan^2\varepsilon_s + h_R/4\,250} - \tan\,\varepsilon_s\right) \qquad \text{km} \qquad (104)$$

where the rain height, h_R, can be determined from equations (74) or (75) in Annex 2 and ε_s is the minimum elevation angle of the transmitting earth station.

The maximum calculation distance, d_{emax}, to be used in the determination of the propagation mode (2) contour, for the case of a coordinating earth station operating in bidirectionally allocated frequency bands, is dependent on the rain height. It is the greater distance determined from:

$$d_{emax} = 130.4\sqrt{h_R} \qquad \text{km} \qquad \text{or } d_{min}$$

where the minimum coordination distance, d_{min}, is given in § 4.2 of the main body of this Appendix.

The point, at the distance d_s from the earth station, on the azimuth α_s of the coordinating earth station's main beam axis, is the geographic point immediately below the main beam axis intersection with the rain height, and is the reference point from which the maximum calculation distance d_{emax} is determined (see Fig. 9).

If the maximum calculation distance, d_{emax}, is greater than the minimum coordination distance, d_{min}, then calculate the maximum latitude at which a receiving earth station may operate with a geostationary satellite with a minimum elevation angle ε_{min}:

$$\zeta_{max} = \arccos\left[\frac{\cos(\varepsilon_{min})}{K}\right] - \varepsilon_{min} \tag{105}$$

where:

ε_{min}: given in Table 9

K: ratio of the radius of the satellite orbit to the radius of the Earth, equal to 6.62.

If the coordinating earth station latitude in the northern hemisphere is greater than ζ_{max}, or if the coordinating earth station latitude in the southern hemisphere is less than $-\zeta_{max}$ or $-71°$, then the rain scatter contour is a circle of radius d_{min}, centred on the transmitting earth station.

For all other cases, the coordination area is developed by the following procedure:

Step 1: The unknown receiving earth station is assumed to be operating with a satellite at the minimum elevation angle ε_{min}. It is also assumed that the receiving earth station is relatively close to the coordinating earth station in geometric terms and hence a plane geometry approximation can be applied within the coordination area. If the receiving earth station's main beam axis passes through the intersection of the coordinating earth station's main beam axis with the rain height, the azimuths from the point on the ground immediately below this intersection to the possible locations of a receiving earth station are given by:

$$\alpha_{w1} = \arccos\left[\frac{\tan\zeta}{\tan\zeta_{max}}\right]$$

and

$$\alpha_{w2} = 360° - \alpha_{w1}$$

where ζ is the latitude of the transmitting earth station.

Step 2: Mark on a map of an appropriate scale the coordinating earth station's location and draw from this location a line of distance, d_s, along the azimuth, α_s, to the point below the coordinating earth station's main beam axis intersection with the rain height.

Step 3: From the main beam axis intersection point in Step 2, mark on the map the distance, d_{emax}, along the two azimuths, α_{w2} and α_{w1}, and on each azimuth at the distance, d_{emax}, draw two equal distance arcs of width 3° clockwise and counter-clockwise. The two arcs, each having a total width of 6°, are the first boundary elements of the bidirectional rain scatter area.

Step 4: Mark a circle of radius equal to the minimum coordination distance, d_{min}, around the coordinating earth station's location, and then draw straight lines from the northern edges of the two arc segments tangential to the northern rim of the circle, and from the southern edges of the two arc segments tangential to the southern rim of the circle.

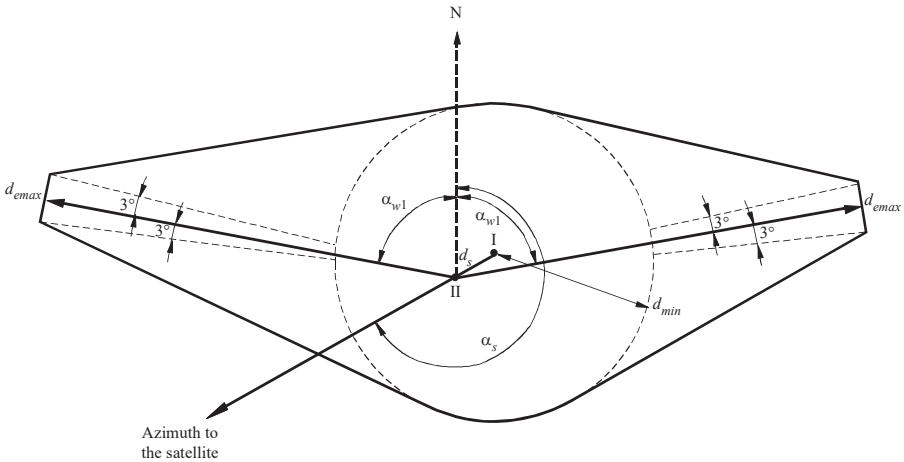
The area bounded by the two 6° wide arcs, the four straight lines, and the circular sections (of which there is always at least one) between the two northern and the two southern tangent points with the straight lines, constitutes the bidirectional rain scatter area.

Figure 9 illustrates the construction of the bidirectional rain scatter area for a coordinating earth station. (The resulting rain scatter area contains the possible loci of all receiving earth station locations from which a beam path towards the geostationary-satellite orbit will intersect the main beam of the transmitting earth station antenna.)

FIGURE 9

Example of the bidirectionnal rain scatter area

(Not to scale)



I: location of the transmitting earth station

II: point where the earth station antenna main-beam axis reaches the altitude h_R

Assumptions:

ζ = 40° N
ε_s = 10°
α_s = 254°

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ANNEX 6

Supplementary and auxiliary contours

1 Introduction

The material found in this Annex is intended to assist administrations in bilateral discussions.

2 Supplementary contours

The coordination area is determined with respect to the type of terrestrial station (or, in a frequency band with a bidirectional space allocation, an earth station operating in the opposite direction of transmission) that would yield the largest coordination distances. Therefore, in the case of terrestrial services, fixed stations using tropospheric scatter have been assumed to be operating in frequency bands that may typically be used by such radiocommunication systems; and fixed stations operating in line-of-sight configurations and using analogue modulation have been assumed to be operating in other frequency bands. However, other radiocommunication systems (e.g. other terrestrial stations), that typically have lower antenna gains, or otherwise less stringent system parameters, than those on which the coordination area is based, may also operate in the same frequency range. Therefore, it is possible for the administration seeking coordination to identify a supplementary contour using either the methods in § 2 or 3 of the main body of this Appendix, where they are applicable, or other agreed methods. Subject to bilateral agreement between administrations, these supplementary contours can assume the role of the coordination contour for an alternative type of radio system in the same service or another radiocommunication service.

When a supplementary contour is to be developed for other types of systems, for example digital fixed systems, the necessary system parameters may be found in one of the adjacent columns in Tables 7, 8 and 9. If no suitable system parameters are available then the value of the permissible interference power ($P_r(p)$) may be calculated using equation (127) of § 2 in Annex 7.

In addition, supplementary contours may be prepared by the administration seeking coordination in order to define smaller areas, based on more detailed methods, for consideration when agreed bilaterally between the concerned administrations. These contours can be a useful aid for the rapid exclusion of terrestrial stations or earth stations from further consideration. For earth stations operating with non-geostationary space stations, supplementary contours may be generated using the method in § 4 of this Annex.

Supplementary contours may comprise propagation mode (1) interference paths and, depending on the sharing scenario, propagation mode (2) interference paths. In addition, the propagation mode (1) element of a supplementary contour may, if appropriate for the radiocommunication service, utilize the same level of correction factor (see § 4.4 of the main body of this Appendix) that was applied in the determination of the coordination contour. However, all parts of each supplementary contour must fall on or between the contour defined by the minimum coordination distance and the corresponding propagation mode (1) or propagation mode (2) main contour.

3 Auxiliary contours

Practical experience has shown that, in many cases, the separation distance required for the coordinating earth station, on any azimuth, can in fact be substantially less than the coordination distance, since the worst-case assumptions do not apply to every terrestrial station or earth station. There are two main mechanisms that contribute to such a difference between the separation distance and the coordination distance:

– the terrestrial station antenna gain (or e.i.r.p.), or receiving earth station antenna gain, in the direction of the coordinating earth station is less than that assumed in calculating the coordination contour;

– appropriate allowance can be made, for example, for the effects of site shielding not included in the coordination distance calculations.

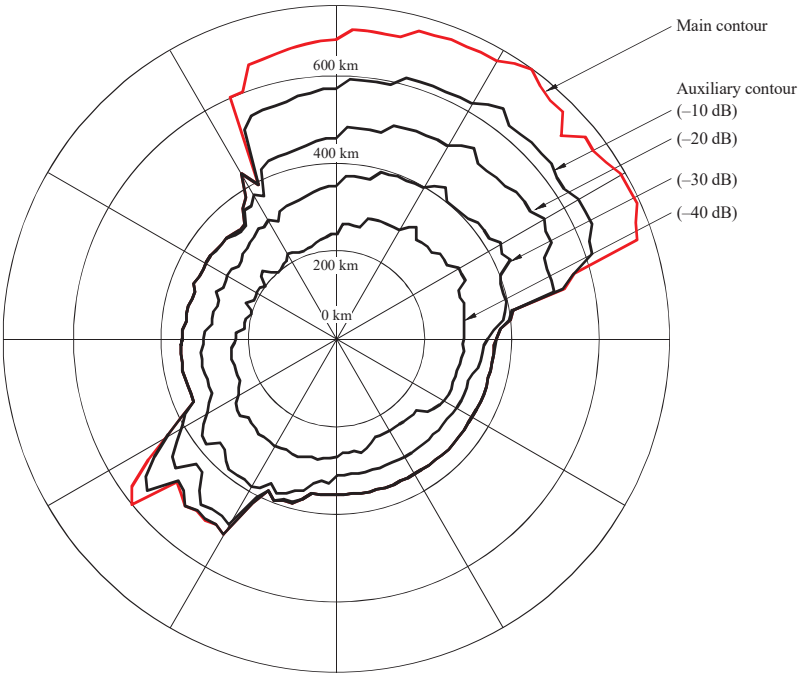
Auxiliary contours must use the same method as that used to determine the corresponding main or supplementary contour. In addition, all parts of each auxiliary contour must fall on or between the contour defined by the minimum coordination distance and the corresponding main or supplementary contour. Auxiliary contours may assist in eliminating from detailed coordination terrestrial stations or earth stations that are located in the coordination area and hence have been identified as potentially affected by the coordinating earth station. Any terrestrial station or earth station that lies outside an auxiliary contour and has an antenna gain towards the coordinating earth station that is less than the gain represented by the relevant auxiliary contour need not be considered further as a significant source, or subject, of interference.

3.1 Auxiliary contours for propagation mode (1)

Propagation mode (1) auxiliary contours are calculated with values for the propagation mode (1) minimum required loss in equation (22) in § 4.4 of the main body of this Appendix that are progressively reduced by, for example, 5, 10, 15, 20 dB, etc., below the value derived from the parameters assumed in Tables 7, 8 and 9 for the corresponding main or supplementary propagation mode (1) contour, until the minimum coordination distance is reached. Propagation mode (1) auxiliary contour distances are calculated without the correction factor (see § 4.4 of the main body of this Appendix), and hence could be larger, on any azimuth, than the corresponding main, or supplementary, propagation mode (1) distance. To prevent this, in those cases where a correction factor applies to the main or supplementary contour, the maximum propagation mode (1) auxiliary contour distance on any azimuth is limited to the corresponding main or supplementary propagation mode (1) distance. In effect this means that the correction factor will limit the possible range of auxiliary contour values so that only those auxiliary contours with values greater than the applied correction factor will be shown within the main or supplementary contour (see Fig. 10). For example, if the value of correction factor applicable to the propagation mode (1) main or supplementary contour is 10 dB, then the first auxiliary contour drawn would be for a reduction in minimum required loss of 5 dB and hence the auxiliary contour value would be −15 dB (by convention, auxiliary contours are shown as negative quantities as they represent a reduction in the terrestrial, or receiving earth station, antenna gain, or the terrestrial station e.i.r.p.).

FIGURE 10 (WRC-03)

Propagation mode (1) main contour and auxiliary contours



The propagation mode (1) auxiliary contours are shown for –10, –20, –30 and –40 dB adjustments in the minimum required loss.

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Propagation mode (2) interference effects may still need to be considered even if propagation mode (1) interference effects have been eliminated from detailed coordination, as the propagation models are based on different interference mechanisms.

3.2 Auxiliary contours for propagation mode (2)

The propagation mode (2) contour around an earth station is calculated assuming the main beams of the coordinating earth station and the terrestrial station intersect exactly (see § 1.3 of the main body of this Appendix). However, it is unlikely that these antenna main beams will intersect exactly. It is therefore possible to generate propagation mode (2) auxiliary contours that take account of any offset in the pointing of the terrestrial station antenna beam from the direction of the coordinating earth station. This offset would result in partial beam intersections and hence a reduced interference potential. These propagation mode (2) auxiliary contours are calculated according to the method described in § 3.2.1 of this Annex.

Propagation mode (2) auxiliary contours are not generated for different values of antenna gain or e.i.r.p. but for different values of beam avoidance angle. Hence, if there is a need to consider both a lower value of antenna gain, or e.i.r.p., for the terrestrial station and propagation mode (2) auxiliary contours, it is first essential to consider the impact of the reduction in antenna gain, or e.i.r.p., on the propagation mode (2) contour. This is achieved by generating a supplementary contour (see § 2) corresponding to the lower value of antenna gain or e.i.r.p. for the terrestrial station, which is drawn on a separate map. Auxiliary mode (2) contours can then be generated inside this propagation mode (2) supplementary contour for different values of the beam avoidance angle. Hence, propagation mode (2) auxiliary contours may be most frequently applied in conjunction with a supplementary contour rather than with the coordination contour.

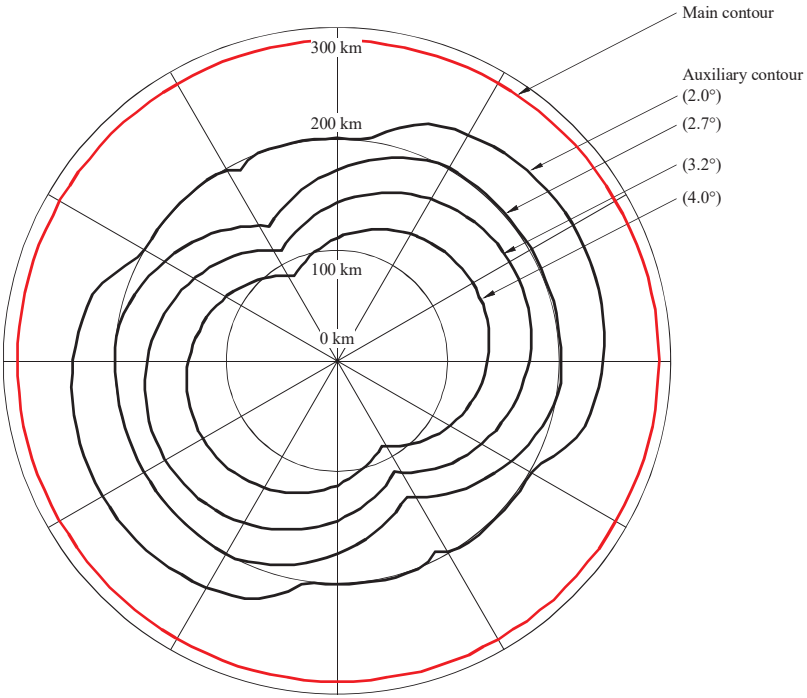
The correction factor discussed in § 1.3 of the main body of this Appendix does not apply to propagation mode (2) interference paths and hence is also not applicable to propagation mode (2) auxiliary contours. In addition propagation mode (2) auxiliary contours cannot be developed for the bidirectional case.

Propagation mode (2) auxiliary contours are prepared for appropriate values of terrestrial station main beam avoidance angle (see Fig. 11). When the antenna characteristics of the terrestrial stations are known, the appropriate antenna pattern[9] should be used when determining the propagation mode (2) auxiliary contours. If this is not available, the reference antenna pattern given in § 3.2.3 may be used.

[9] The method requires the antenna pattern to be monotonic in terms of the reduction in gain either side of the main beam axis.

FIGURE 11 (WRC-03)

Propagation mode (2) main contour and auxiliary contours



The propagation mode (2) auxiliary contours are shown for terrestrial station main beam avoidance angles of 2.0º, 2.7º, 3.2º and 4.0º, respectively

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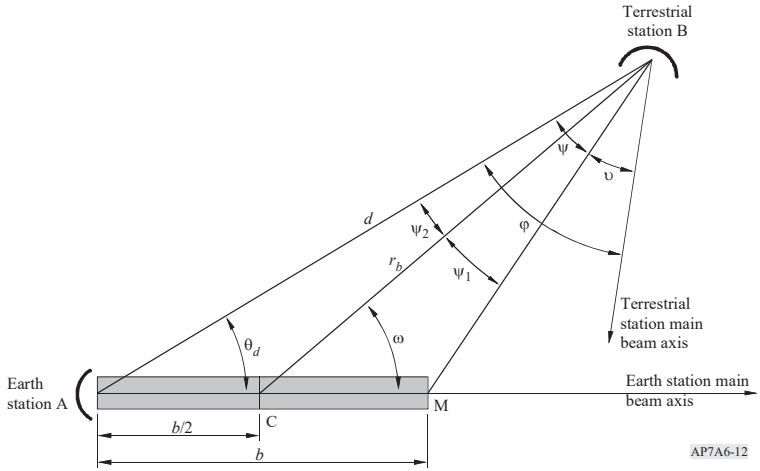
3.2.1 Determination of auxiliary contours for propagation mode (2)

Propagation mode (2) auxiliary contours allow the azimuthal offset of a terrestrial station antenna beam from the coordinating earth station's location to be taken into consideration. Figure 12 shows the hydrometeor scatter region projected on to the horizontal plane. In this Figure, the earth station and the terrestrial station are located at the points A and B, respectively, where the terrestrial station is on a radial defined by the angle ω from the point C at the centre of the propagation mode (2) main, or supplementary, contour. Point C is also the centre of the auxiliary contour.

FIGURE 12

Propagation geometry in the horizontal plane



The shaded area in Fig. 12 represents the critical region, along the earth station's main beam axis, between the earth station and the rain height. Within this critical region a common volume can be formed between the earth station beam and the beam of any terrestrial stations within the propagation mode (2) main, or supplementary, contour. This critical region's length is b and its maximum horizontal extent is at point M. Intersection of this critical region by the terrestrial station main beam axis would result in significant hydrometeor scatter interference via main lobe-to-main lobe coupling.

For a given point within the propagation mode (2) main, or supplementary, contour, the angle subtended by the critical region is termed the critical angle, ψ. The protection angle, υ, represents the angle of the terrestrial station main beam axis away from the critical region. The beam avoidance angle between the terrestrial station's main beam axis and the earth station's location is φ. It is the sum of the two angles ψ and υ and it is this quantity that has a fixed value for a specific auxiliary contour. Each auxiliary contour is generated by varying the angle, ω, and deriving the distance, r_b, from point C to the auxiliary contour. As the angle ω increases from 0° to 360°, the angles ψ and υ change, but their sum remains the same.

The algorithm in § 3.2.2 of this Annex can be used to calculate the auxiliary propagation mode (2) contour for a given value of beam avoidance angle φ.

The method is based on iteratively decrementing the distance, r_b, between terrestrial station and the centre of the common volume, and starting at the main contour distance d_r, until either the shortest value of r_b is found for which the required minimum loss is achieved, or the minimum coordination distance is reached. For each value of r_b, the critical angle ψ is determined and then the protection angle υ is calculated. The terrestrial station antenna gain corresponding to υ and the current distance r_b are used to obtain the propagation mode (2) path loss in equation (82) in Annex 2.

The above process is repeated for each angle ω, to generate a complete auxiliary contour for a given value of beam avoidance angle φ. For some combinations of beam avoidance angle and angle ω, an auxiliary contour may coincide with the main, or supplementary, propagation mode (2) contour.

3.2.2 The step-by-step algorithm

Auxiliary propagation mode (2) contours are constructed by calculating distances along radials from the centre of the circular mode (2) main, or supplementary, contour, which is the point C, at the distance $b/2$ from the earth station along the azimuth of its main beam axis. The distance $b/2$ is equal to Δd, where Δd is given by equation (83) in Annex 2.

For the selected value of beam avoidance angle, φ, generate the auxiliary contour for values of angle, ω, ranging from 0° to 180° in steps of 1°, as follows:

a) Set r_b to the main, or supplementary, mode (2) contour distance d_r calculated as described in § 3.1 of Annex 2.

b) Compute ψ from:

$$\psi_1 = \arctan\left(\frac{b \sin \omega}{2r_b - b \cos \omega}\right) \tag{106}$$

$$\psi_2 = \arctan\left(\frac{b \sin \omega}{2r_b + b \cos \omega}\right) \tag{107}$$

$$\psi = \psi_1 + \psi_2 \tag{108}$$

c) If $\psi > \varphi$ then the auxiliary mode (2) contour coincides with the main or supplementary mode (2) contour for the current value of ω, and the calculation for that value of ω is completed, and go to step j). Otherwise proceed through the following steps d) to i) until one of the terminating conditions described in step f) and step i) is satisfied.

d) Decrement r_b by subtracting 0.2 km from its value.

e) Recalculate the critical angle ψ using equations (106), (107) and (108).

f) If $(0.5\, b \sin \omega / \sin \psi_2) < d_{min}$, the auxiliary mode (2) contour coincides with the minimum coordination distance d_{min} and the calculation for the current value of ω is completed – go to step j). Otherwise, proceed to step g).

g) Compute the protection angle $\upsilon = \varphi - \psi$.

h) Calculate $G(\upsilon)$, the terrestrial station antenna gain at the angle υ relative to the beam axis, using the reference antenna pattern given in this Annex.

i) In equation (82) in Annex 2, use the gain calculated in step h) in place of G_x and the value considered of r_b in place of r_i, and calculate the corresponding propagation mode (2) path loss L_r. If $L_r < L(p)$, then increment r_b by adding 0.2 km to its value and take this as the distance for the current radial. Otherwise, repeat from step d).

j) Once the value of r_b has been found for the current value of angle ω, calculate the angle θ_d from the location of the earth station, and if appropriate the distance, d, to that contour point using:

$$d = 0.5\, b \sin \omega / \sin \psi_2 \tag{109}$$

$$\theta_d = \omega - \psi_2 \tag{110}$$

An auxiliary propagation mode (2) contour is symmetrical about the earth station main beam axis. Thus, values of d and θ_d corresponding to the values of ω from 181° to 359° can be found by noting that results for a given value of ω are the same as for (−ω) or (360° − ω).

The step size for incrementing r_b used above, 0.2 km, is suitable for most situations. It controls the granularity of the result when viewed as a set of r_b values. For low values of earth station beam elevation, the granularity becomes more noticeable in the values of d and θ_d, and a smaller step size may be used.

3.2.3 Reference radiation patterns for line-of-sight radio-relay system antennas

The reference radiation pattern for line-of-sight radio-relay system antennas in this section is used for the unknown terrestrial station antenna in the propagation mode (2) auxiliary contour calculations when the actual antenna pattern is not available.

a) In cases where the ratio between the antenna diameter and the wavelength is greater than 100, the following equation is used:

$$G(\varphi) = G_{amax} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda} \varphi \right)^2 \quad \text{for} \quad 0 < \varphi < \varphi_m \tag{111}$$

$$G(\varphi) = G_1 \quad \text{for} \quad \varphi_m \le \varphi < \varphi_r \tag{112}$$

$$G(\varphi) = 32 - 25 \log \varphi \quad \text{for} \quad \varphi_r \le \varphi < 48° \tag{113}$$

$$G(\varphi) = -10 \quad \text{for} \quad 48° \le \varphi \le 180° \tag{114}$$

$$G_1 = 2 + 15 \log \frac{D}{\lambda} \tag{115}$$

$$\varphi_m = \frac{20\,\lambda}{D} \sqrt{G_{amax} - G_1} \tag{116}$$

$$\varphi_r = 15.85 \left(\frac{D}{\lambda} \right)^{-0.6} \tag{117}$$

b) In cases where the ratio between the antenna diameter and the wavelength is less than or equal to 100, the following equation is used:

$$G(\varphi) = G_{amax} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda} \varphi \right)^2 \quad \text{for} \quad 0 < \varphi < \varphi_m \tag{118}$$

$$G(\varphi) = G_1 \quad \text{for} \quad \varphi_m \le \varphi < 100 \frac{\lambda}{D} \tag{119}$$

$$G(\varphi) = 52 - 10 \log \frac{D}{\lambda} - 25 \log \varphi \qquad \text{for} \quad 100 \frac{\lambda}{D} \leq \varphi < 48° \tag{120}$$

$$G(\varphi) = 10 - 10 \log \frac{D}{\lambda} \qquad \text{for} \quad 48° \leq \varphi \leq 180° \tag{121}$$

c) In cases where only the maximum antenna gain is known, D/λ can be estimated from the following expression:

$$20 \log \frac{D}{\lambda} \approx G_{amax} - 7.7 \tag{122}$$

where:

G_{amax}: main beam axis antenna gain (dBi)

D: antenna diameter (m)

λ: wavelength (m)

G_1: gain of the first side lobe (dBi).

4 Determination of a supplementary contour using the time-variant gain (TVG) method

The TVG method requires the cumulative distribution of the time-varying horizon antenna gain of an earth station operating with a non-geostationary space station. In comparison to the TIG method, the TVG method usually produces smaller distances, but requires greater effort in determining the cumulative distribution of the horizon gain of the earth station antenna for each azimuth to be considered.

The TVG method closely approximates the convolution of the distribution of the horizon gain of the earth station antenna and the propagation mode (1) path loss. This method may produce slightly smaller distances than those obtained by an ideal convolution. An ideal convolution cannot be implemented due to the limitations of the current model for propagation mode (1). The propagation mode (1) required distance, at the azimuth under consideration, is taken as the largest distance developed from a set of calculations, each of which is based on equation (4) of the main body of this Appendix. For convenience, in these calculations, this equation may be rewritten for the n-th calculation in the following form:

$$L_b(p_v) - G_e(p_n) = P_t + G_x - P_r(p) \qquad \text{dB} \tag{123}$$

with the constraint:

$$p_v = \begin{cases} 100\, p / p_n & \text{for } p_n \geq 2\, p \\ 50 & \text{for } p_n < 2\, p \end{cases} \qquad \%$$

where:

P_t, $P_r(p)$: as defined in equations in § 1.3 of the main body of this Appendix where p is the percentage of time associated with permissible interference power $P_r(p)$

G_x: maximum antenna gain assumed for the terrestrial station (dBi). Tables 7 and 8 give values for G_x for the various frequency bands

$G_e(p_n)$: the horizon gain of the coordinating earth station antenna (dBi) that is exceeded for p_n% of the time on the azimuth under consideration

$L_b(p_v)$: the propagation mode (1) minimum required loss (dB) for p_v% of the time; this loss must be exceeded by the propagation mode (1) predicted path loss for all but p_v% of the time.

The values of the percentages of time, p_n, to be used in equation (123) are determined in the context of the cumulative distribution of the horizon antenna gain. This distribution needs to be developed for a predetermined set of values of horizon antenna gain spanning the range from the minimum to the maximum values for the azimuth under consideration. The notation $G_e(p_n)$ denotes the value of horizon antenna gain for which the complement of the cumulative distribution of the horizon antenna gain has the value corresponding to the percentage of time p_n. The p_n value is the percentage of time that the horizon antenna gain exceeds the n-th horizon antenna gain value. The procedure in § 4.1 may be used to develop this distribution.

For each value of p_n, the value of horizon antenna gain for this time percentage, $G_e(p_n)$, is used in equation (123) to determine a propagation mode (1) minimum required loss. The propagation mode (1) predicted path loss is to exceed this propagation mode (1) required loss for no more than p_v% of the time, as specified by the constraint associated with equation (123). A series of propagation mode (1) distances are then determined using the procedures described in § 4 of the main body of this Appendix.

The propagation mode (1) required distance is then the maximum distance in the series of propagation mode (1) distances that are obtained for any value of p_n, subject to the constraint associated with equation (123). A detailed description of the method for using equation (123) to determine the propagation mode (1) required distance is provided in § 4.2.

Further information, including examples, may be found in the most recent version of Recommendation ITU-R SM.1448. (WRC-15)

4.1 Determination of the horizon antenna gain distribution for the TVG method

The TVG method for the determination of an earth station's supplementary contour requires the determination of the horizon antenna gain statistics for all azimuths (in suitable increments, e.g. 5°) around the earth station. In considering the horizon antenna gain of the antenna for either a transmitting or a receiving earth station, only the horizon antenna gain values during the operational time are to be considered. In developing the cumulative distributions of horizon antenna gain, the percentages of time are percentages of operational time. Thus, there may be periods of time for which no horizon antenna gain is specified.

The determination of the horizon antenna gain distribution requires both earth station and orbital information including whether or not station keeping is used to maintain a single orbital path (repeating/non-repeating ground track system). The cumulative distribution of the time-varying horizon gain of a transmitting or a receiving earth station antenna operating with non-geostationary space stations is calculated as follows:

Step 1: Simulate the constellation of non-geostationary space stations over a sufficiently long period, with a time step appropriate for orbit altitude, to obtain a valid representation of the antenna gain variations. For repeating ground track constellations, simulate the orbital path for each satellite visible from the earth station over a period of the ground track. For non-repeating ground track constellations, simulate the orbit of each satellite in the constellation over a period long enough to get a stable representation of the distribution.

Step 2: At each time step, determine the azimuth and elevation angle of each satellite that is both visible at the earth station and above the minimum elevation angle at which the earth station operates. In addition to the minimum elevation angle, other criteria could be used to avoid certain geometric configurations, e.g. geostationary orbit arc avoidance (no transmission between an earth station and a non-geostationary satellite that is within $\pm X°$ from the geostationary orbit arc).

Step 3: At each step, and for each satellite in communication with the earth station, use the actual earth station antenna pattern, or a formula giving a good approximation of it, to calculate the gain towards the horizon at each azimuth and elevation angle around the earth station.

Step 4: Choose a gain increment g (dB) and partition the gain range by a number of gain levels between G_{min} and G_{max}, i.e. $G = \{G_{min}, G_{min} + g, G_{min} + 2g,..., G_{max}\}$.

These gain levels determine a set of gain intervals so that the n-th gain interval (n = 1, 2, 3, …) includes gain values equal to, or greater than, $G_{min} + (n - 2)$g and less than $G_{min} + (n - 1)g$.

A value of g = 0.1 to 0.5 dB is recommended.

For each azimuth on the horizon around the earth station, accumulate the time that the horizon gain takes a value in each gain interval of width g (dB).

Step 5: The probability density function (pdf) on each azimuth is determined by dividing the time in each gain interval by the total simulation time.

Step 6: Determine the cumulative distribution function (cdf) of horizon antenna gain at each azimuth by accumulating the gain density function at that azimuth. The value of the required cdf at any specific gain value is the percentage of time that the gain is less than, or equal to, that gain value.

4.2 Determination of the supplementary contour distance using the TVG method

This calculation is based on a cumulative distribution of the horizon gain of the earth station antenna for each azimuth to be considered (in suitable angular increments e.g. 5°). Appropriate distributions for this purpose may be developed by the method in § 4.1. The process for calculating the supplementary contour distance for each azimuth is described in the following procedure.

Step 1: From the complementary cumulative distribution of the horizon antenna gain, for the azimuth under consideration, determine the percentage of time p_n that the horizon gain exceeds the level G_{en}, where:

$$G_{en} = G_{min} + (n - 1)g \qquad (n = 1, 2, 3,...) \qquad (124)$$

with:

G_{min}: minimum value of horizon gain, and

g: gain increment.

Step 2: For each percentage p_n that is equal to or greater than $2p$%, the percentage of time to be used in determining the propagation mode (1) path loss is p_v.

$$p_v = 100\, p / p_n \qquad \% \qquad \text{for } p_n \geq 2p\% \tag{125}$$

For each percentage of time, determine the distance, d_n (km), for which the propagation mode (1) predicted path loss is equal to the propagation mode (1) minimum required loss, using the propagation model in accordance with § 4 of the main body of this Appendix and the equation:

$$L_{bn}(p_v) = P_t + G_{en} + G_x - P_r(p) \qquad \text{dB} \tag{126}$$

The values of p_v must be within the range of percentage of time of the propagation mode (1) model (see § 1.5.1 of the main body of this Appendix).

Step 3: The propagation mode (1) required distance for the azimuth under consideration is the largest of the distances, d_n (km), calculated in Step 2, except when this largest distance is attained for the smallest value of p_n that is equal to or greater than $2p$ in accordance with equation (125) in Annex 6. In such cases, the propagation mode (1) required distance for the azimuth under consideration is the distance determined from equation (126) in Annex 6 with $G_{en} = G_{max}$ and $p_v = 50$% where G_{max} is the maximum value of horizon antenna gain.

Step 4: The propagation mode (1) supplementary contour distance for the azimuth under consideration is the required distance as determined in Step 3, except that the distance must be between the minimum coordination distance, d_{min}, and the maximum coordination distance, d_{max1}. These limits are given in § 4.2 and § 4.3 of the main body of this Appendix, respectively.

ANNEX 7

System parameters and predetermined coordination distances for determination of the coordination area around an earth station

1 Introduction

Tables 7 to 9 contain the system parameter values required by the methods in the main body of this Appendix to determine the coordination area around an earth station when the band is shared with terrestrial radiocommunication services or other earth stations operating in the opposite direction of transmission.

Table 7 is limited to those system parameter values required for the case of a transmitting earth station sharing with terrestrial services; Table 8 is limited to those parameter values required for the case of a receiving earth station sharing with terrestrial services; Table 9 is limited to those parameter values required for the case of a transmitting earth station which is sharing in a bidirectionally allocated band with other earth stations operating in the opposite direction of transmission.

These system parameter tables include primary allocations to the space and terrestrial services in Article **5** in all bands between 100 MHz and 105 GHz. Some of the columns have incomplete information. In some cases, this is because there is no requirement to calculate coordination distances as pre-determined coordination distances apply. In other cases, the service allocations are new and the systems may not be introduced for some years. Hence, the system parameters are the subject of ongoing development within the Radiocommunication Study Groups.

Parameters specific to the earth station, for which coordination is being sought, are provided to the Radiocommunication Bureau in the format specified in Appendix **4** as part of the notification and coordination procedures.

The row in each table entitled "method to be used" directs the user to the appropriate section of the main body of this Appendix which describes the methods to be followed for the determination of the coordination area.

Note that the earth station for which the coordination area is to be determined is identified by the service designation given in the first row of each table.

When a supplementary contour is to be developed, for example for digital fixed systems, the necessary system parameters may be found in one of the adjacent columns in Tables 7, 8 and 9. If no suitable system parameters are available, then the value of the permissible interference power ($P_r(p)$) may be calculated using equation (127) in § 2.

The predetermined coordination distances specified in Table 10 are used for transmitting and receiving earth stations, in cases defined by the corresponding frequency sharing situation.

2 Calculation of the permissible interference power of an interfering emission

Tables 7, 8 and 9 contain values for the parameters which are required for the calculation of the permissible interference power of the interfering emission (dBW), in the reference bandwidth, to be exceeded for no more than p% of the time at the receiving antenna terminal of a station subject to interference, from a single source of interference, using the general formula:

$$P_r(p) = 10 \log (k\, T_e\, B) + N_L + 10 \log (10^{M_s/10} - 1) - W \qquad \text{dBW} \qquad (127)$$

where:

k: Boltzmann's constant (1.38×10^{-23} J/K)

T_e: thermal noise temperature of the receiving system (K), at the terminal of the receiving antenna (see § 2.1 of this Annex)

N_L: link noise contribution (see § 2.2 of this Annex)

B: reference bandwidth (Hz), i.e. the bandwidth in the receiving station that is subject to the interference and over which the power of the interfering emission can be averaged

p: percentage of the time during which the interference from one source may exceed the permissible interference power value; since the entries of interference are not likely to occur simultaneously, $p = p_0/n$

p_0: percentage of the time during which the interference from all sources may exceed the threshold value

n: number of equivalent, equal level, equal probability entries of interference, assumed to be uncorrelated for small percentages of the time

M_s: link performance margin (dB) (see § 2.3 of this Annex)

W: a thermal noise equivalence factor (dB) for interfering emissions in the reference bandwidth; it is positive when the interfering emissions would cause more degradation than thermal noise (see § 2.4 of this Annex).

In certain cases, an administration may have reason to believe that, for its receiving earth station, a departure from the values associated with the earth station, as listed in Table 8, may be justified. Attention is drawn to the fact that for specific systems the bandwidths B or, for example in the case of demand assignment systems, the percentages of the time p and p_0 may have to be changed from the values given in Table 8.

2.1 Calculation of the noise temperature of the receiving system

The noise temperature (K) of the receiving system, referred to the output terminals of the receiving antenna, may be determined (unless specifically given in Table 7) from:

$$T_e = T_a + \left(\ell_{t1} - 1\right) 290 + \ell_{t1}\ T_r \qquad \text{K} \qquad (128)$$

where:

T_a: noise temperature (K) contributed by the receiving antenna

ℓ_{t1}: numerical loss in the transmission line (e.g. a waveguide) between the antenna terminal and the receiver front end

T_r: noise temperature (K) of the receiver front end, including all successive stages at the front end input.

For radio-relay receivers and where the waveguide loss of a receiving earth station is not known, a value of $\ell_{t1} = 1.0$ is used.

In case of determination of the coordination contours between two earth stations operating in the opposite direction of transmission, the following earth station receiving system noise temperatures should be used if the value is not provided in Table 9. This assumption is necessary because the receiving earth station takes the place of a receiving terrestrial station in the calculations.

TABLE 6

Frequency range (GHz)	**T_e (K)**
$f < 10$	75
$10 < f < 17$	150
$f > 17$	300

2.2 Determination of the factor N_L

The factor N_L is the noise contribution to the link. In the case of a satellite transponder, it includes the uplink noise, intermodulation, etc. In the absence of table entries, it is assumed:

$$N_L = 1 \text{ dB} \quad \text{for fixed-satellite links}$$

$$= 0 \text{ dB} \quad \text{for terrestrial links}$$

2.3 Determination of the factor M_S

The factor M_s is the factor by which the link noise under clear-sky conditions would have to be raised in order to equal the permissible interference power.

2.4 Determination of the factor W

The factor W (dB) is the level of the radio-frequency thermal noise power relative to the received power of an interfering emission which, in the place of the former and contained in the same (reference) bandwidth, would produce the same interference (e.g. an increase in the voice or video channel noise power, or in the bit error ratio). The factor W generally depends on the characteristics of both the wanted and the interfering signals.

When the wanted signal is digital, W is usually equal to or less than 0 dB, regardless of the characteristics of the interfering signal.

3 Horizon antenna gain for a receiving earth station with respect to a transmitting earth station

For the determination of the coordination area of a transmitting earth station with respect to a receiving earth station in a bidirectionally allocated band, it is necessary to calculate the horizon antenna gain of the unknown earth station. In cases where the unknown receiving earth stations operate with geostationary satellites, Table 9 provides the necessary receiving earth station parameters for the calculation procedure, which is described in § 2.1 of Annex 5.

In the case where the unknown receiving earth station operates with non-geostationary satellites, the horizon antenna gain to be used for all azimuths is provided in Table 9. The tabulated values were determined by using the method described in § 2.2 of the main body of this Appendix, which uses the maximum and minimum values of horizon antenna gain. For this purpose the maximum horizon antenna gain is the gain of the antenna for an off-axis angle equal to the minimum operating elevation angle. The minimum horizon antenna gain is the gain at large off-axis angles, usually more than 36° or 48°.

In determining the TIG horizon antenna gain entries in Table 9, the difference between the maximum and minimum horizon antenna gain did not exceed 30 dB. Consequently, the TIG horizon antenna gain was taken as the lesser of the maximum horizon antenna gain or 20 dB more than the minimum horizon antenna gain. For the purpose of determining the TIG horizon antenna gain, the reference antenna pattern of § 3 of Annex 3 was used, except in cases noted in the Tables where a different pattern was deemed to be more appropriate.

TABLE 7a (Rev.WRC-12)

Parameters required for the determination of coordination distance for a transmitting earth station

Transmitting space radiocommunication service designation		**Mobile-satellite, space operation**	**Earth exploration-satellite, meteorological satellite**		**Space operation**	**Space research, space operation**	**Mobile-satellite**	**Space operation**		**Mobile-satellite, radio-determination-satellite**	**Mobile-satellite**		**Space operation, space research**		**Mobile-satellite**		**Space research, space operation, Earth exploration-satellite**
Frequency bands (MHz)		148.0-149.9	401-403		433.75-434.25	449.75-450.25	806-840	1 427-1 429		1 610-1 626.5	1 668.4-1 675		1 750-1 850		1 980-2 025		2 025-2 110 2 110-2 120 (Deep space)
Receiving terrestrial service designations		Fixed, mobile	Meteorological aids		Amateur, radiolocation fixed, mobile	Fixed, mobile, radio-location	Fixed, mobile broadcasting, aeronautical radionavigation	Fixed, mobile		Aeronautical radionavigation	Fixed, mobile		Fixed, mobile		Fixed, mobile		Fixed, mobile
Method to be used		§ 2.1, § 2.2	§ 2.1, § 2.2		§ 2.1, § 2.2	§ 2.1, § 2.2	§ 1.4.6	§ 2.1, § 2.2		§ 1.4.6	§ 1.4.6		§ 2.1, § 2.2		§ 1.4.6		§ 2.1, § 2.2
Modulation at terrestrial station [1]		A	A	N		A and N	A and N	A	N		A	N	A	N	A	N	A
Terrestrial station interference parameters and criteria	p_0 (%)	1.0				0.01	0.01	0.01	0.01		0.01	0.01	0.01	0.01	0.01		0.01
	N	1				2	2	2	2		2	2	2	2	2		2
	p (%)	1.0				0.005	0.005	0.005	0.005		0.005	0.005	0.005	0.005	0.005		0.005
	N_L (dB)	–				0	0	0	0		0	0	0	0	0		0
	M_s (dB)	–				20	20	33	33		33	33	33	33	26 [2]		26 [2]
	W (dB)	–				0	0	0	0		0	0	0	0	0		0
Terrestrial station parameters	G_x (dBi) [3]	8				16	16	33	33		35	35	35	35	49 [2]		49 [2]
	T_e (K)	–				750	750	750	750		750	750	750	750	500 [2]		500 [2]
Reference bandwidth	B (Hz)	4×10^3				12.5×10^3	12.5×10^3	4×10^3	10^6		4×10^3	10^6	4×10^3	10^6	4×10^3		4×10^3
Permissible interference power	$P_r(p)$ (dBW) in B	−153				−139	−139	−131	−107		−131	−107	−131	−107	−140		−140

1 A: analogue modulation; N: digital modulation.

2 The parameters for the terrestrial station associated with transhorizon systems have been used. Line-of-sight radio-relay parameters associated with the frequency band 1 668.4-1 675 MHz may also be used to determine a supplementary contour. (WRC-03)

3 Feeder losses are not included.

TABLE 7b (Rev.WRC-23)

Parameters required for the determination of coordination distance for a transmitting earth station

Transmitting space radiocommunication service designation		**Fixed-satellite, mobile-satellite**	**Aero-nautical mobile-satellite (R) service**	**Aero-nautical mobile-satellite (R) service**	**Fixed-satellite**	**Fixed-satellite**	**Fixed-satellite**	**Fixed-satellite**		**Earth exploration-satellite, space operation, space research**		**Fixed-satellite, mobile-satellite, meteorological-satellite**		**Fixed-satellite**		**Fixed-satellite**		**Fixed-satellite**	**Space research**		**Fixed-satellite [3]**	**Fixed-satellite**	**Fixed-satellite [3]**
Frequency bands (GHz)		2.655-2.690	5.030-5.091	5.030-5.091	5.091-5.150	5.091-5.150	5.725-5.850	5.725-7.075		7.100-7.250 [5]		7.900-8.400		10.7-11.7		12.5-14.8		13.75-14.3	14.8-15.35		15.43-15.65	17.7-18.4	19.3-19.7
Receiving terrestrial service designations		Fixed, mobile	Aeronautical radio-navigation	Aeronautical mobile (R)	Aeronautical radio-navigation	Aeronautical mobile (R)	Radiolocation	Fixed, mobile		Fixed, mobile		Fixed, mobile		Fixed, mobile		Fixed, mobile		Radiolocation radionavigation (land only)	Fixed, mobile		Aeronautical radionavigation	Fixed, mobile	Fixed, mobile
Method to be used		§ 2.1	§ 2.1, § 2.2	§ 2.1, § 2.2			§ 2.1	§ 2.1		§ 2.1, § 2.2		§ 2.1		§ 2.1		§ 2.1, § 2.2		§ 2.1	§ 2.1, § 2.2			§ 2.1, § 2.2	§ 2.2
Modulation at terrestrial station [1]		A						A	N	A	N	A	N	A	N	A	N	–	A	N		N	N
Terrestrial station interference parameters and criteria	p_0 (%)	0.01						0.01	0.005	0.01	0.005	0.01	0.005	0.01	0.005	0.01	0.005	0.01	0,01	0,005		0.005	0.005
	n	2						2	2	2	2	2	2	2	2	2	2	1	2	2		2	2
	p (%)	0.005						0.005	0.0025	0.005	0.0025	0.005	0.0025	0.005	0.0025	0.005	0.0025	0.01	0,005	0,0025		0.0025	0.0025
	N_L (dB)	0						0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
	M_s (dB)	26 [2]						33	37	33	37	33	37	33	40	33	40	1	33	40		25	25
	W (dB)	0						0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
Terrestrial station parameters	G_x (dBi) [4]	49 [2]	6	10	6	6		46	46	46	46	46	46	50	50	52	52	36	52	52		48	48
	T_e (K)	500 [2]						750	750	750	750	750	750	1 500	1 100	1 500	1 100	2 636	1 500	1 100		1 100	1 100
Reference bandwidth	B (Hz)	4×10^3	150×10^3	37.5×10^3	150×10^3	10^6		4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	10^7	4×10^3	10^6		10^6	10^6
Permissible interference power	$P_r(p)$ (dBW) in B	−140	−160	−157	−160	−143		−131	−103	−131	−103	−131	−103	−128	−98	−128	−98	−131	−128	−98		−113	−113

1 A: analogue modulation; N: digital modulation.

2 The parameters for the terrestrial station associated with transhorizon systems have been used. Line-of-sight radio-relay parameters associated with the frequency band 5 725-7 075 MHz may also be used to determine a supplementary contour with the exception that G_x = 37 dBi.

3 Feeder links of non-geostationary satellite systems in the mobile-satellite service.

4 Feeder losses are not included.

5 Actual frequency bands are 7 190-7 250 MHz for the Earth exploration-satellite service, 7 100-7 155 MHz and 7 190-7 235 MHz for the space operation service and 7 145-7 235 MHz for the space research service.

TABLE 7c (Rev.WRC-19)

Parameters required for the determination of coordination distance for a transmitting earth station

Transmitting space radiocommunication service designation		**Fixed-satellite**	**Fixed-satellite**	**Fixed-satellite** [2]	**Fixed-satellite**	**Space research**	**Earth exploration-satellite, space research**	**Fixed-satellite, mobile-satellite, radionavigation-satellite**	**Fixed-satellite** [2]	**Fixed-satellite**
Frequency bands (GHz)		24.65-25.25 27.0-29.5	24.65-25.25 27-27.5	28.6-29.1	27.5-28.6 29.1-29.5[3]	34.2-34.7	40.0-40.5	42.5-47 47.2-50.2 50.4-51.4	47.2-50.2	51.4-52.4
Receiving terrestrial service designations		Fixed (except HAPS), mobile	Fixed (HAPS ground station)	Fixed, mobile	Fixed, mobile	Fixed, mobile, radiolocation	Fixed, mobile	Fixed, mobile, radionavigation	Fixed, mobile	Fixed, mobile
Method to be used		§ 2.1	§ 2.1	§ 2.2	§ 2.2		§ 2.1, § 2.2	§ 2.1, § 2.2	§ 2.2	§ 2.1
Modulation at terrestrial station [1]		N	N	N	N		N	N	N	N
Terrestrial station interference parameters and criteria	p_0 (%)	0.005	0.01	0.005	0.005		0.005	0.005	0.001	0.005
	n	1	1	2	1		1	1	1	1
	p (%)	0.005	0.005	0.0025	0.005		0.005	0.005	0.001	0.005
	N_L (dB)	0	0	0	0		0	0	0	0
	M_s (dB)	25	10	25	25		25	25	25	25
	W (dB)	0	0	0	0		0	0	0	0
Terrestrial station parameters	G_x (dBi) [4]	50	0[5]	50	50		42	42	46	42
	T_e (K)	2 000	350	2 000	2 000		2 600	2 600	2 000	2 600
Reference bandwidth	B (Hz)	10^6	10^6	10^6	10^6		10^6	10^6	10^6	10^6
Permissible interference power	$P_r(p)$ (dBW) in B	−111	−134	−111	−111		−110	−110	−111	−110

1 A: analogue modulation; N: digital modulation.

2 Non-geostationary satellites in the fixed-satellite service.

3 Feeder links to non-geostationary-satellite systems in the mobile-satellite service.

4 Feeder losses are not included.

5 Maximum HAPS ground station antenna gain toward the horizon.

TABLE 8a (Rev.WRC-23)

Parameters required for the determination of coordination distance for a receiving earth station

Receiving space radiocommunication service designation			Space operation, space research	Meteoro-logical-satellite, mobile-satellite	Space research	Space research, space operation	Space operation	Mobile-satellite	Meteoro-logical-satellite	Mobile-satellite	Space research	Space operation	Meteoro-logical-satellite	Mobile-satellite	Broadcasting-satellite (DAB)	Mobile-satellite, land-mobile satellite, maritime mobile-satellite
Frequency bands (MHz)			137-138	137-138	143.6-143.65	174-184	163-167 272-273 [5]	335.4-399.9	400.15-401	400.15-401	400.15-401	401-402	460-470	856-890	1 452-1 492	1 518-1 530 1 555-1 559 2 160-2 200 [1]
Transmitting terrestrial service designations			Fixed, mobile	Fixed, mobile	Fixed, mobile, radio-location	Fixed, mobile, broad-casting	Fixed, mobile	Fixed, mobile	Meteoro-logical aids	Meteoro-logical aids	Meteoro-logical aids	Meteoro-logical aids, fixed, mobile	Fixed, mobile	Fixed, mobile, broad casting	Fixed, mobile, broadcasting	Fixed, mobile
Method to be used			§ 2.1	§ 2.1	§ 2.1	§ 2.1	§ 2.1	§ 1.4.6	§ 1.4.6	§ 1.4.6	–	§ 2.1	§ 2.1	§ 1.4.6	§ 1.4.5	§ 1.4.6
Modulation at earth station [2]			N		N		N				N	N			N	N
Earth station interference parameters and criteria	p_0 (%)		0.1		0.1		1.0		0.012		0.1	0.1	0.012			10
	n		2		2		1		1		2	2	1			1
	p (%)		0.05		0.05		1.0		0.012		0.05	0.05	0.012			10
	N_L (dB)		0		0		0		0		0	0				0
	M_s (dB)		1		1		1		4.3		1	1				1
	W (dB)		0		0		0		0		0	0				0
Terrestrial station parameters	E (dBW) in B [3]	A	–		–		15				–	–	5		38	37 [4]
		N	–		–		15				–	–	5		38	37
	P_t (dBW) in B	A	–		–		–1				–	–	–11		3	0
		N	–		–		–1				–	–	–11		3	0
	G_x (dBi)		–		–		16				–	–	16		35	37
Reference bandwidth	B (Hz)		1		1		10^3		177.5×10^3		1	1	85		25×10^3	4×10^3
Permissible interference power	$P_r(p)$ (dBW) in B		−199		−199		−173		−148		−208	−208	−178			−176

1 In the band 2 160-2 200 MHz, the terrestrial station parameters of line-of-sight radio-relay systems have been used. If an administration believes that, in this band transhorizon systems need to be considered, the parameters associated with the frequency band 2 500-2 690 MHz may be used to determine the coordination area.

2 A: analogue modulation; N: digital modulation.

3 E is defined as the equivalent isotropically radiated power of the interfering terrestrial station in the reference bandwidth.

4 This value is reduced from the nominal value of 50 dBW for the purposes of determination of coordination area, recognizing the low probability of high power emissions falling fully within the relatively narrow bandwidth of the earth station.

5 The fixed-service parameters provided in the column for 163-167 MHz and 272-273 MHz are only applicable to the band 163-167 MHz.

TABLE 8b (Rev.WRC-12)

Parameters required for the determination of coordination distance for a receiving earth station

Receiving space radiocommunication service designation			Space operation (GSO and non-GSO)	Meteoro-logical-satellite (non-GSO)	Meteoro-logical-satellite (GSO)	Space research near-Earth (non-GSO and GSO)		Space research deep space (non-GSO)	Space operation (non-GSO and GSO)	Earth exploration-satellite (GSO)	Broadcasting-satellite	Mobile-satellite, radio-determination-satellite	Fixed-satellite, broadcasting satellite		Fixed-satellite	
						Unmanned	Manned									
Frequency bands (GHz)			1.525-1.535	1.670-1.710	1.670-1.710	1.700-1.710 2.200-2.290		2.290-2.300	2.200-2.290	2.200-2.290	2.310-2.360	2.4835-2.500 [6]	2.500-2.690		3.400-4.200	
Transmitting terrestrial service designations			Fixed	Fixed, mobile, meteoro-logical aids	Fixed, mobile, meteoro-logical aids	Fixed, mobile		Fixed, mobile	Fixed, mobile	Fixed, mobile	Fixed, mobile, radiolocation	Fixed, mobile, radiolocation	Fixed, mobile radiolocation		Fixed, mobile	
Method to be used			§ 2.1, § 2.2	§ 2.2 and [1]	§ 2.1 and [1]	§ 2.1, § 2.2		§ 2.2	§ 2.1, § 2.2	§ 2.1	§ 1.4.5	§ 1.4.6	§ 1.4.5 and § 2.1		§ 2.1	
Modulation at earth station [2]			N	N	N	N		N	N	N		N	A	N	A	N
Earth station interference parameters and criteria	p_0 (%)		1.0	0.006	0.011	0.1	0.001	0.001	1.0	1.0		10	0.03	0.003	0.03	0.005
	n		1	3	2	2	1	1	2	2		1	3	3	3	3
	p (%)		1.0	0.002	0.0055	0.05	0.001	0.001	0.5	0.5		10	0.01	0.001	0.01	0.0017
	N_L (dB)		0	0	0	0		0	0			0	1	1	1	1
	M_s (dB)		1	2.8	0.9	1		0.5	1			1	7	2	7	2
	W (dB)		0	0	0	0		0	0			0	4	0	4	0
Terrestrial station parameters	E (dBW) in B [3]	A	50	92 [4]	92 [4]	−27 [4,5]		−27 [5]	72	72 [4]		37	72 [4]	72 [4]	55	55
		N	37	–	–	−27		−27	76	76		37	76	76	42	42
	P_t (dBW) in B	A	13	40 [4]	40 [4]	−71 [4,5]		−71 [5]	28	28 [4]		0	28 [4]	28 [4]	13	13
		N	0	–	–	−71		−71	32	32		0	32	32	0	0
	G_x (dBi)		37	52	52	44		44	44	44		37	44	44	42	42
Reference bandwidth	B (Hz)		10^3	10^6	4×10^3	1		1	10^6	10^6		4×10^3	10^6	10^6	10^6	10^6
Permissible interference power	$P_r(p)$ (dBW) in B		−184	−142	−177	−216		−222	−154	−154		−176				

1 See Table 10.

2 A: analogue modulation; N: digital modulation.

3 E is defined as the equivalent isotropically radiated power of the interfering terrestrial station in the reference bandwidth.

4 In this band, the parameters for the terrestrial stations associated with transhorizon systems have been used. If an administration believes that transhorizon systems do not need to be considered, the line-of-sight radio-relay parameters associated with the frequency band 3.4-4.2 GHz may be used to determine the coordination area, with the exception that $E = 50$ dBW for analogue terrestrial stations; and $G_x = 37$ dBi. However, for the space research service only, noting footnote 5 when transhorizon systems are not considered, $E = 20$ dBW and $P_t = -17$ dBW for analogue terrestrial stations, $E = -23$ dBW and $P_t = -60$ dBW for digital terrestrial stations; and $G_x = 37$ dBi.

5 These values are estimated for 1 Hz bandwidth and are 30 dB below the total power assumed for emission.

6 In the band 2.4835-2.5 GHz the terrestrial station parameters of line-of-sight radio-relay systems have been used. If an administration believes that, in this band, transhorizon systems need to be considered, the parameters associated with the frequency band 2 500-2 690 MHz may be used to determine the coordination area.

TABLE 8c (Rev.WRC-23)

Parameters required for the determination of coordination distance for a receiving earth station

Receiving space radiocommunication service designation			**Fixed-satellite**		**Fixed-satellite, radio-determination satellite**	**Fixed-satellite**	**Fixed-satellite**		**Meteoro-logical-satellite [7, 8]**	**Meteoro-logical-satellite [9]**	**Earth exploration-satellite [7]**	**Earth exploration-satellite [9]**	**Space research [10]**		**Fixed-satellite**		**Broadcasting-satellite**		**Space research**	**Broadcasting-satellite**	**Fixed-satellite [7]**
													Deep space								
Frequency bands (GHz)			4.500-4.800		5.150-5.216	6.700-7.075	7.250-7.750		7.450-7.550	7.750-7.900	8.025-8.400	8.025-8.400	8.400-8.450	8.450-8.500	10.7-12.75 13.4-13.65 [7]		12.5-12.75 [12]		14.8-15.35	17.7-17.8	17.7-18.8 19.3-19.7
Transmitting terrestrial service designations			Fixed, mobile		Aeronautical radionavigation	Fixed, mobile	Fixed, mobile		Fixed, mobile	Fixed, mobile	Fixed, mobile	Fixed, mobile	Fixed, mobile		Fixed, mobile		Fixed, mobile		Fixed, mobile	Fixed	Fixed, mobile
Method to be used			§ 2.1		§ 2.1	§ 2.2	§ 2.1		§ 2.1, § 2.2	§ 2.2	§ 2.1	§ 2.2	§ 2.2		§ 2.1, § 2.2		§ 1.4.5		§ 2.1, § 2.2	§ 1.4.5	§ 2.1
Modulation at earth station [1]			A	N		N	A	N	N	N	N	N	N	N	A	N	A	N	N		N
Earth station interference parameters and criteria	p_0 (%)		0.03	0.005		0.005	0.03	0.005	0.002	0.001	0.083	0.011	0.001	0.1	0.03	0.003	0.03	0.003	0.1		0.003
	n		3	3		3	3	3	2	2	2	2	1	2	2	2	1	1	2		2
	p (%)		0.01	0.0017		0.0017	0.01	0.0017	0.001	0.0005	0.0415	0.0055	0.001	0.05	0.015	0.0015	0.03	0.003	0.05		0.0015
	N_L (dB)		1	1		1	1	1	–	–	1	0	0	0	1	1	1	1	0		1
	M_s (dB)		7	2		2	7	2	–	–	2	4.7	0.5	1	7	4	7	4	1		6
	W (dB)		4	0		0	4	0	–	–	0	0	0	0	4	0	4	0	0		0
Terrestrial station parameters	E (dBW) in B [2]	A	92 [3]	92 [3]		55	55	55	55	55	55	55	25 [5]	25 [5]	40	40	55	55	32		35
		N	42 [4]	42 [4]		42	42	42	42	42	42	42	−18	−18	43	43	42	42	40	40	40
	P_t (dBW) in B	A	40 [3]	40 [3]		13	13	13	13	13	13	13	−17 [5]	−17 [5]	−5	−5	10	10	−5		−10
		N	0	0		0	0	0	0	0	0	0	−60	−60	−2	−2	−3	−3	−5	−7	−5
	G_x (dBi)		52 [3, 4]	52 [3, 4]		42	42	42	42	42	42	42	42	42	45	45	45	45	35	47	45
Reference band-width [6]	B (Hz)		10^6	10^6		10^6	10^6	10^6	10^7	10^7	10^6	10^6	1	1	10^6	10^6	27×10^6	27×10^6	10^6		10^6
Permissible interference power	$P_r(p)$ (dBW) in B					−151.2			−125	−125	−154 [11]	−142	−220	−216			−131	−131	−156		

Notes to Table 8c:

1 A: analogue modulation; N: digital modulation.

2 E is defined as the equivalent isotropically radiated power of the interfering terrestrial station in the reference bandwidth.

3 In this band, the parameters for the terrestrial stations associated with transhorizon systems have been used. If an administration believes that transhorizon systems do not need to be considered, the line-of-sight radio-relay parameters associated with the frequency band 3.4-4.2 GHz may be used to determine the coordination area.

4 Digital systems assumed to be non-transhorizon. Therefore G_x = 42.0 dBi. For digital transhorizon systems, parameters for analogue transhorizon systems above have been used.

5 These values are estimated for 1 Hz bandwidth and are 30 dB below the total power assumed for emission.

6 In certain systems in the fixed-satellite service it may be desirable to choose a greater reference bandwidth B. However, a greater bandwidth will result in smaller coordination distances and a later decision to reduce the reference bandwidth may require recoordination of the earth station.

7 Geostationary-satellite systems.

8 Non-geostationary satellites in the meteorological-satellite service notified in accordance with No. **5.461A** may use the same coordination parameters.

9 Non-geostationary satellite systems.

10 Space research earth stations in the frequency band 8.4-8.5 GHz operate with non-geostationary satellites.

11

For large earth stations:	$P_t(p) = (G - 180)$	dBW	
For small earth stations:	$P_t(20\%) = 2\,(G - 26) - 140$	dBW	for $26 < G \leq 29$ dBi
	$P_t(20\%) = G - 163$	dBW	for $G > 29$ dBi
	$P_t(p)\% = G - 163$	dBW	for $G \leq 26$ dBi

12 Applies to the broadcasting-satellite service in unplanned bands in Region 3.

TABLE 8d (Rev.WRC-19)

Parameters required for the determination of coordination distance for a receiving earth station

Receiving space radiocommunication service designation			Meteoro-logical-satellite	Fixed-satellite	Fixed-satellite [3]	Broad-casting-satellite	Earth exploration-satellite [4]	Earth exploration-satellite [5]	Space research (deep space)	Space research		Fixed-satellite [6]	Fixed-satellite [5]	Mobile-satellite	Broadcasting-satellite, fixed-satellite	Mobile-satellite	Radio-navigation-satellite
										Unmanned	Manned						
Frequency bands (GHz)			18.0-18.4	17.8-18.6 [4] 18.8-19.3	19.3-19.7	21.4-22.0	25.5-27.0	25.5-27.0	31.8-32.3	37.0-38.0		37.5-40.5	37.5-40.5	39.5-40.5	40.5-42.5	43.5-47.0	43.5-47.0
Transmitting terrestrial service designations			Fixed, mobile	Fixed, mobile	Fixed, mobile	Fixed, mobile	Fixed, mobile	Fixed, mobile	Fixed, radio-navigation	Fixed, mobile		Fixed, mobile	Fixed, mobile	Fixed, mobile	Broadcasting, fixed	Mobile	Mobile
Method to be used			§ 2.1	§ 2.1, § 2.2	§ 2.2	§ 1.4.5	§ 2.2	§ 2.1	§ 2.1, § 2.2	§ 2.1, § 2.2		§ 2.2	§ 2.1	§ 1.4.6	§ 1.4.5, § 2.1	§ 1.4.6	–
Modulation at earth station [1]			N	N	N		N	N	N	N		N	N	N	–	N	
Earth station interference parameters and criteria	p_0 (%)		0.05	0.003	0.01		0.25	0.25	0.001	0.1	0.001	0.02	0.003				
	n		2	2	1		2	2	1	1	1		2				
	p (%)		0.025	0.0015	0.01		0.125	0.125	0.001	0.1	0.001		0.0015				
	N_L (dB)		0	0	0		0	0	0	0		1	1				
	M_S (dB)		18.8	5	5		11.4	14	1	1		6.8	6				
	W (dB)		0	0	0		0	0	0	0		0	0				
Terrestrial station parameters	E (dBW) in B [2]	A		–	–		–	–	–	–		–	–	–	–		
		N	40	40	40	40	42	42	−28	−28		35	35	35	44	40	40
	P_t (dBW) in B	A		–	–		–	–	–	–		–	–	–	–		
		N	−7	−7	−7	−7	−3	−3	−81	−73		−10	−10	−10	−1	−7	−7
	G_x (dBi)		47	47	47	47	45	45	53	45		45	45	45	45	47	47
Reference bandwidth [7]	B (Hz)		10^7	10^6	10^6		10^7	10^7	1	1		10^6	10^6	10^6	10^6		
Permissible interference power	$P_r(p)$ (dBW) in B		−115	−140	−137		−120	−116	−216	−217		−140					

[1] A: analogue modulation; N: digital modulation.

[2] E is defined as the equivalent isotropically radiated power of the interfering terrestrial station in the reference bandwidth.

[3] Non-geostationary mobile-satellite service feeder links.

[4] Non-geostationary-satellite systems.

[5] Geostationary-satellite systems.

[6] Non-geostationary fixed-satellite service systems.

[7] In certain systems in the fixed-satellite service it may be desirable to choose a greater reference bandwidth B. However, a greater bandwidth will result in smaller coordination distances, and a later decision to reduce the reference bandwidth may require recoordination of the earth station.

TABLE 9a (Rev.WRC-19)

Parameters required for the determination of coordination distance for a transmitting earth station in bands shared bidirectionally with receiving earth stations

Space service designation in which the transmitting earth station operates		**Mobile-satellite**	**Earth exploration-satellite, meteorological-satellite**	**Mobile-satellite**		**Fixed-satellite, mobile-satellite**	**Aeronautical mobile-satellite (R) service**		**Fixed-satellite [3]**		**Fixed-satellite**	**Fixed-satellite, meteorological-satellite**	**Fixed-satellite**
Frequency bands (GHz)		0.272-0.273	0.401-0.402	1.670-1.675		2.655-2.690	5.030-5.091		5.150-5.216		6.700-7.075	8.025-8.400	8.025-8.400
Space service designation in which the *receiving* earth station operates		Space operation	Space operation	Meteorological-satellite		Fixed-satellite, broadcasting-satellite	Aeronautical mobile-satellite (R) service		Fixed-satellite	Radiodetermination-satellite	Fixed-satellite	Earth exploration-satellite	Earth exploration-satellite
Orbit [6]		Non-GSO	Non-GSO	Non-GSO	GSO		Non-GSO	GSO	Non-GSO		Non-GSO	Non-GSO	GSO
Modulation at *receiving* earth station [1]		N	N	N	N						N	N	N
Receiving earth station interference parameters and criteria	p_0 (%)	1.0	0.1	0.006	0.011						0.005	0.011	0.083
	n	1	2	3	2						3	2	2
	p (%)	1.0	0.05	0.002	0.0055						0.0017	0.0055	0.0415
	N_L (dB)	0	0	0	0						1	0	1
	M_s (dB)	1	1	2.8	0.9	2			2	2	2	4.7	2
	W (dB)	0	0	0	0						0	0	0
Receiving earth station parameters	G_m (dBi) [2]	20	20	30	45		45	45	48.5		50.7		
	G_r (dBi) [4]	19	19	19 [9]	8		8	8	10		10	10	8
	ε_{min} [5]	10°	10°	5°	3°	3°	10°	10°	3°	3°	3°	5°	3°
	T_e (K) [7]	500	500	370	118	75	340	340	75	75	75		
Reference bandwidth	B (Hz)	10^3	1	10^6	4×10^3		37.5×10^3	37.5×10^3			10^6	10^6	10^6
Permissible interference power	$P_r(p)$ (dBW) in B	−177	−208	−145	−178		−163.5	−163.5			−151	−142	−154

Notes to Table 9a:

1 A: analogue modulation; N: digital modulation.

2 On-axis gain of the receive earth station antenna.

3 Feeder links of non-geostationary-satellite systems in the mobile-satellite service.

4 Horizon antenna gain for the receive earth station (refer to § 3 of the main body of this Appendix and to § 3 of this Annex).

5 Minimum elevation angle of operation in degrees (non-geostationary or geostationary).

6 Orbit of the space service in which the receiving earth station operates (non-geostationary or geostationary).

7 The thermal noise temperature of the receiving system at the terminal of the receiving antenna (under clear-sky conditions). Refer to § 2.1 of this Annex for missing values.

8 Horizon antenna gain is calculated using the procedure of Annex 5. Where no value of G_m is specified, a value of 42 dBi is to be used.

9 Non-geostationary horizon antenna gain, $G_e = G_{min} + 20$ dB (see § 2.2), with $G_{min} = 10 - 10 \log (D/\lambda)$, $D/\lambda = 13$ (refer to Annex 3 for definition of symbols).

TABLE 9b (Rev.WRC-19)

Parameters required for the determination of coordination distance for a transmitting earth station in bands shared bidirectionally with receiving earth stations

Space service designation in which the transmitting earth station operates		**Fixed-satellite**			**Fixed-satellite**			**Fixed-satellite**	**Fixed-satellite**	**Fixed-satellite** [3]	**Fixed-satellite** [3]	**Earth exploration-satellite, space research**	
Frequency bands (GHz)		10.7-11.7			12.5-12.75			17.3-17.8	17.7-18.4	19.3-19.6	19.3-19.6	40.0-40.5	
Space service designation in which the *receiving* earth station operates		Fixed-satellite			Fixed-satellite			Broadcasting-satellite	Fixed-satellite, meteorological-satellite	Fixed-satellite [3]	Fixed-satellite [4]	Fixed-satellite, mobile-satellite	
Orbit [7]		GSO		Non-GSO	GSO		Non-GSO		GSO	Non-GSO	GSO	GSO	Non-GSO
Modulation at *receiving* earth station [1]		A	N	N	A	N			N	N			
Receiving earth station interference parameters and criteria	p_0 (%)	0.03	0.003		0.03	0.003			0.003	0.01	0.003	0.003	
	N	2	2		2	2			2	1	2	2	
	p (%)	0.015	0.0015		0.015	0.0015			0.0015	0.01	0.0015	0.0015	
	N_L (dB)	1	1		1	1			1	0	1	1	
	M_s (dB)	7	4		7	4			6	5	6	6	
	W (dB)	4	0		4	0			0	0	0	0	
Receiving earth station parameters	G_m (dBi) [2]			51.9			31.2		58.6	53.2	49.5	50.8	54.4
	G_r (dBi) [5]	9	9	10	9	9	11 [11]		9	10	10	9	7 [12]
	ε_{min} [6]	5°	5°	6°	5°	5°	10°		5°	5°	10°	10°	10°
	T_e (K) [8]	150	150		150	150			300	300	300	300	
Reference bandwidth	B (Hz)	10^6	10^6		10^6	10^6			10^6	10^6			
Permissible interference power	$P_r(p)$ (dBW) in B	−144	−144	−144	−144	−144	−144		−138	−141			

Notes to Table 9b:

1 A: analogue modulation; N: digital modulation.

2 On-axis gain of the receive earth station antenna.

3 Feeder links of non-geostationary-satellite systems in the mobile-satellite service.

4 Geostationary-satellite systems.

5 Horizon antenna gain for the receive earth station (refer to § 3 of the main body of the Appendix and to § 3 of this Annex).

6 Minimum elevation angle of operation in degrees (non-GSO or GSO).

7 Orbit of the space service in which the receiving earth station operates (GSO or non-GSO).

8 The thermal noise temperature of the receiving system at the terminal of the receiving antenna (under clear-sky conditions). Refer to § 2.1 of this Annex for missing values.

9 Horizon antenna gain is calculated using the procedure of Annex 5. Where no value of G_m is specified, a value of 42 dBi is to be used.

10 Horizon antenna gain is calculated using the procedure of Annex 5, except that the following antenna pattern may be used in place of that given in § 3 of Annex 3: $G = 32 - 25 \log \varphi$ for $1° \leq \varphi < 48°$; and $G = -10$ for $48° \leq \varphi < 180°$ (refer to Annex 3 for definition of symbols).

11 Non-geostationary horizon antenna gain. $G_e = G_{max}$ (see § 2.2 of the main body of this Appendix) with the antenna pattern modelled by the equation $G = 36 - 25 \log (\varphi)$ (refer to Annex 3 for definition of symbols).

12 Non-geostationary horizon antenna gain. $G_e = G_{max}$ (see § 2.2 of the main body of this Appendix) with the antenna pattern modelled by the equation $G = 32 - 25 \log (\varphi)$ (refer to Annex 3 for definition of symbols).

TABLE 10 (Rev.WRC-19)

Predetermined coordination distances

Frequency sharing situation		**Coordination distance (in sharing situations involving services allocated with equal rights) (km)**
Type of earth station	**Type of terrestrial station**	
Ground-based in the bands below 1 GHz to which No. **9.11A** applies. Ground-based mobile in the bands within the range 1-3 GHz to which No. **9.11A** applies	Mobile (aircraft)	500
Aircraft (all bands)	Ground-based	500
Aircraft (all bands)	Mobile (aircraft)	1 000
Ground-based in the bands: 400.15-401 MHz 1 668.4-1 675 MHz	Station in the meteorological aids service (radiosonde)	580
Aircraft in the bands: 400.15-401 MHz 1 668.4-1 675 MHz	Station in the meteorological aids service (radiosonde)	1 080
Ground-based in the radiodetermination-satellite service (RDSS) in the bands: 1 610-1 626.5 MHz 2 483.5-2 500 MHz 2 500-2 516.5 MHz	Ground-based	100
Airborne earth station in the radiodetermination-satellite service (RDSS) in the bands: 1 610-1 626.5 MHz 2 483.5-2 500 MHz 2 500-2 516.5 MHz	Ground-based	400
Receiving earth stations in the meteorological-satellite service	Station in the meteorological aids service	The coordination distance is considered to be the visibility distance as a function of the earth station horizon elevation angle for a radiosonde at an altitude of 20 km above mean sea level, assuming 4/3 Earth radius (see Note 1)
Non-GSO MSS feeder-link earth stations (all bands)	Mobile (aircraft)	500
Non-GSO MSS feeder-link earth stations in the band 5 091-5 150 MHz	Station in the aeronautical radionavigation service	Note 2
Receiving earth stations in the space research service in the band: 2 200-2 290 MHz	Mobile (aircraft)	880
Ground-based in the bands in which the frequency sharing situation is not covered in the rows above	Mobile (aircraft)	500

Notes to Table 10:

NOTE 1 – The coordination distance, d (km), for fixed earth stations in the meteorological-satellite service vis-à-vis stations in the meteorological aids service assumes a radiosonde altitude of 20 km and is determined as a function of the physical horizon elevation angle ε_h (degrees) for each azimuth, as follows:

$$d = 100 \quad \text{for} \quad \varepsilon_h \geq 11°$$

$$d = 582\left(\sqrt{1 + (0.254\ \varepsilon_h)^2} - 0.254\ \varepsilon_h\right) \quad \text{for} \quad 0° < \varepsilon_h < 11°$$

$$d = 582 \quad \text{for} \quad \varepsilon_h \leq 0°$$

The minimum and maximum coordination distances are 100 km and 582 km, and correspond to physical horizon angles greater than 11° and less than 0°. (WRC-2000)

NOTE 2 – For the coordination distance in the frequency band 5 091-5 150 MHz vis-à-vis stations in the aeronautical radionavigation service, see No. **5.444A**. (WRC-15)

APPENDIX 8 (REV.WRC-15)

Method of calculation for determining if coordination is required between geostationary-satellite networks sharing the same frequency bands

1 Introduction

The method of calculation for determining if coordination is required under provision No. **9.7** is based on the concept that the noise temperature of a system subject to interference increases as the level of the interfering emission increases. It can, therefore, be applied irrespective of the modulation characteristics of these satellite networks, and of the precise frequencies used.

In this method, the apparent increase in the equivalent satellite link noise temperature resulting from an interfering emission of a given system is calculated (see § 2 below) and the ratio of this increase to the equivalent satellite link noise temperature, expressed as a percentage, is compared to a threshold value (see § 3 below).

2 Calculation of the apparent increase in equivalent noise temperature of the satellite link subject to an interfering emission

Two possible cases are considered:

Case I: wanted and interfering networks share one or more frequency bands, each in the same direction of transmission;

Case II: wanted and interfering networks share one or more frequency bands, each in opposite directions of transmission (bidirectional use).

These two cases cover all relative satellite positions from closely-spaced to near-antipodal positions.

2.1 Parameters

Let A be a satellite link of network R associated with satellite S and A′ be a satellite link of network R′ associated with satellite S′. The symbols relating to satellite link A′ bear primes, those relating to satellite link A do not bear primes.

The parameters are defined as follows (for satellite link A):

T : the equivalent satellite link noise temperature, referred to the output of the receiving antenna of the earth station (K);

T_s : the receiving system noise temperature of the space station, referred to the output of the receiving antenna of the space station (K);

T_e : the receiving system noise temperature of the earth station, referred to the output of the receiving antenna of the earth station (K);

ΔT_s : apparent increase in the receiving system noise temperature of the satellite S, caused by an interfering emission, referred to the output of the receiving antenna of this satellite (K);

ΔT_e : apparent increase in the receiving system noise temperature of the earth station e_R, caused by an interfering emission, referred to the output of the receiving antenna of this station (K);

p_s : maximum power density per Hz delivered to the antenna of satellite S (averaged over the worst 4 kHz band for a carrier frequency below 15 GHz or over the worst 1 MHz band above 15 GHz) (W/Hz);

$g_3(\eta)$: transmitting antenna gain of satellite S in the direction η (numerical power ratio);

η_A : direction, from satellite S, of the receiving earth station e_R of satellite link A;

η_e' : direction, from satellite S, of the receiving earth station e'_R of satellite link A′;

NOTE – The product $p_s\, g_3\, (\eta_e')$ is the maximum e.i.r.p. per Hz of satellite S in the direction of the receiving earth station e'_R of satellite link A′.

η_s' : direction, from satellite S, of satellite S′;

p_e : maximum power density per Hz delivered to the antenna of the transmitting earth station e_T (averaged over the worst 4 kHz band for a carrier frequency below 15 GHz or over the worst 1 MHz band above 15 GHz) (W/Hz);

$g_2(\delta)$: receiving antenna gain of satellite S in the direction δ (numerical power ratio);

δ_A : direction, from satellite S, of the transmitting earth station e_T of satellite link A;

δ_e' : direction, from satellite S, of the transmitting earth station e'_T of satellite link A′;

δ_s' : direction, from satellite S, of satellite S′;

θ_t : topocentric angular separation in degrees between the two satellites[1], taking the longitudinal station-keeping tolerances into account;

NOTE – Only the topocentric angle θ_t should be used in dealing with Case I.

θ_g : geocentric angular separation in degrees between the two satellites, taking the longitudinal station-keeping tolerances into account;

NOTE – Only the geocentric angle θ_g should be used in dealing with Case II.

$g_1(\theta_t)$: transmitting antenna gain of the earth station e_T in the direction of satellite S′ (numerical power ratio);

$g_4(\theta_t)$: receiving antenna gain of the earth station e_R in the direction of satellite S′ (numerical power ratio);

k : Boltzmann's constant (1.38×10^{-23} J/K);

---

1 A method for calculation of the topocentric angular separation is given in Annex I.

l_d : free-space transmission loss[2] on the downlink (numerical power ratio), evaluated from satellite S to the receiving earth station e_R for satellite link A;

NOTE – The free-space transmission loss on any downlink evaluated from the satellites S or S′ to the receiving earth stations e_R or e'_R is considered to be equal to l_d.

l_u : free-space transmission loss[2] on the uplink (numerical power ratio), evaluated from the earth station e_T, to satellite S for satellite link A;

NOTE – The free-space loss on any uplink evaluated from the earth stations e_T or e'_T to the satellite S or S′ is considered to be equal to l_u.

l_s : free-space transmission loss[2] on the inter-satellite link (numerical power ratio), evaluated from satellite S′ to satellite S;

γ : transmission gain of a specific satellite link subject to interference evaluated from the output of the receiving antenna of satellite S to the output of the receiving antenna of the earth station e_R (numerical power ratio, usually less than 1).

2.2 General method

In the following equations, the frequency to be used for the calculation of l_d, l_u, and l_s is the average frequency of the band common to both networks in the direction considered. If, in a given direction, there is no overlap of the assigned frequency bands of the two networks, the corresponding value (ΔT_s or ΔT_e) is taken to be equal to zero. For cases where the Appendix **4** data have not been published, the assigned frequency band for that network shall be considered as being the frequency range as provided for in Appendix **4**.

2.2.1 Case I – Wanted and interfering networks sharing the same frequency band in the same direction of transmission

The gains $g_1(\theta_t)$ and $g_4(\theta_t)$ are those of the earth stations concerned. When neither measured data nor a relevant ITU-R Recommendation accepted by the administrations concerned are available the radiation patterns set out in Annex III should be used.

2.2.1.1 Simple frequency-changing transponder on board the satellite

The parameters ΔT_s and ΔT_e are given by the following equations:

$$\Delta T_s = \frac{p'_e g'_1(\theta_t) g_2(\delta_{e'})}{k l_u} \tag{1}$$

$$\Delta T_e = \frac{p'_s g'_3(\eta_e) g_4(\theta_t)}{k l_d} \tag{2}$$

The symbol ΔT will be used to denote the apparent increase in the equivalent noise temperature for the entire satellite link referred to the output of the receiving antenna of the receiving earth station e_R due to the interfering emission from link A′.

This increase is the result of the interfering emissions entering at both the satellite and the earth station receiver of link A and can accordingly be expressed as:

$$\Delta T = \gamma \Delta T_s + \Delta T_e \tag{3}$$

[2] A method for calculation of the free-space transmission loss is given in Annex II.

Hence,

$$\Delta T = \gamma \frac{p'_e g'_1(\theta_t) g_2(\delta_{e'})}{kl_u} + \frac{p'_s g'_3(\eta_e) g_4(\theta_t)}{kl_d} \tag{4}$$

An example calculation for the application of the method of this Appendix in Case I is given in Annex IV.

In the same way, the increase $\Delta T'$ in the equivalent noise temperature for the entire satellite link, referred to the output of the receiving antenna of the receiving earth station e'_R, under the effect of the interference caused by satellite link A, is given by the following equations:

$$\Delta T'_{s'} = \frac{p_e g_1(\theta_t) g'_2(\delta_e)}{kl_u} \tag{5}$$

$$\Delta T'_{e'} = \frac{p_s g_3(\eta_{e'}) g'_4(\theta_t)}{kl_d} \tag{6}$$

$$\Delta T' = \gamma \frac{p_e g_1(\theta_t) g'_2(\delta_e)}{kl_u} + \frac{p_s g_3(\eta_{e'}) g'_4(\theta_t)}{kl_d} \tag{7}$$

2.2.1.2 Cases requiring independent treatment of the uplink and the downlink

If there is a change of modulation in the satellite, if the transmission gain for the satellite network being considered has not been supplied, or if the transmission originates on board the satellite, then the apparent increase in the noise temperature must be related to the total receiving system noise temperature of the specific link being examined (the space station or the earth station, whichever is applicable). In this case, the equivalent noise temperature of the entire satellite link and the transmission gain are not used and equations (1) and (2) above are used separately as required (see § 3.2). (WRC-03)

2.2.2 Case II – Wanted and interfering networks sharing the same frequency band in opposite directions of transmission (bidirectional use)

The calculation method below only applies to interfering emissions between satellites.

Interference between earth stations using the same frequency band in opposite directions of transmission (bidirectional use) is to be dealt with by coordination procedures analogous to those used for coordination between earth and terrestrial stations.

All the equations relating to Case II shall use the geocentric angle θ_g.

2.2.2.1 Simple frequency-changing transponder on board the satellite

The noise temperature increase ΔT_s referred to the output of the receiving antenna of the satellite of link A is given by:

$$\Delta T_s = \frac{p'_s g'_3(\eta_s) g_2(\delta_{s'})}{kl_s} \tag{8}$$

The apparent increase in equivalent link noise temperature is then given by:

$$\Delta T = \gamma \Delta T_s \tag{9}$$

The increase $\Delta T'$ in the equivalent noise temperature of the link A′ caused by interfering emissions from the satellite associated with the link A is given by:

$$\Delta T' = \gamma' \Delta T'_s = \frac{\gamma' p_s g_3(\eta_{s'}) g'_2(\delta_s)}{k l_s} \tag{10}$$

2.2.2.2 Cases requiring independent treatment of the uplink and downlink

In this case equation (8) is used directly with T_s to obtain the percentage increase. The increase $\Delta T'_s$ in the noise temperature of link A′ caused by interfering emissions from the satellite associated with link A is obtained in a similar manner.

2.2.3 Consideration of polarization isolation

The polarization isolation factor described in this paragraph shall be considered only if the administration responsible for each network has consented to such a course and has notified its polarization or published it for coordination under No. **9.7**. In this case, the apparent increase in the equivalent satellite link noise temperature shall be determined by the following expressions:

Case I $$\Delta T = \frac{\gamma \Delta T_s}{Y_u} + \frac{\Delta T_e}{Y_d}$$

Case II $$\Delta T = \frac{\gamma \Delta T_s}{Y_{ss}}$$

where the values of ΔT_s and ΔT_e are those given in § 2.2.1 and § 2.2.2 and the values of the factors of polarization isolation Y_u, Y_d and Y_{ss} are those given in the Table below.

Polarization		Factor of polarization isolation (numerical ratio) *Y*
Network R	**Network R′**	
LHC	RHC	4
LHC	L	1.4
RHC	L	1.4
LHC	LHC	1
RHC	RHC	1
L	L	1

Where:
LHC: left-hand circular (anti-clockwise)
RHC: right-hand circular (clockwise)
L: linear

2.3 Determination of the satellite links to be considered in calculating the increase in equivalent satellite link noise temperature (Case I only)

The greatest increase in equivalent satellite link noise temperature caused to any link of another satellite network, existing or planned, by interfering emissions of the proposed satellite network must be determined.

The most unfavourably sited transmitting earth station of the interfering satellite network should be determined for each satellite receiving antenna of the network subject to interference by superimposing the "Earth-to-space" service areas of the interfering network on the space station receiving antenna gain contours plotted on a map of the Earth's surface. The most unfavourably sited transmitting earth station is the one in the direction of which the satellite receiving antenna gain of the network subject to interference is the greatest.

The most unfavourably sited receiving earth station of the network subject to interference should be determined in an analogous manner for each "space-to-Earth" service area of that network. The most unfavourably sited receiving earth station is the one in the direction of which the satellite transmitting antenna gain of the interfering network is the greatest.

2.4 Use of information furnished under Appendix 4

When an administration elects to use information furnished under Appendix **4** with the calculation procedures of § 2.2.1.1 and § 2.2.2.1 in order to formulate comments, the calculations need to be made for both sets of values of γ and T furnished. The greater of the two values of $\Delta T/T$ resulting from these calculations is the one to be used. (WRC-15)

3 Comparison between calculated percentage increase in noise temperature and the threshold value

3.1 Simple frequency-changing transponder on board the satellite

The calculated values of the $\Delta T/T$ and $\Delta T'/T'$, expressed as percentages, shall be compared with the threshold value of 6%[3].

– If the calculated value of $\Delta T/T$, expressed as a percentage, due to any interfering emission from satellite link A′ to satellite link A, is no greater than the threshold value, coordination is not required with respect to interference from link A′ to link A.

– If the calculated value of $\Delta T/T$, expressed as a percentage, is greater than the threshold value, coordination is required.

The comparison of $\Delta T'/T'$, with the threshold value, expressed as a percentage, shall be carried out in a similar manner.

3.2 Cases requiring independent treatment of the uplink and the downlink

a) In the case of interference into only one link, the uplink or the downlink, the value $\Delta T_e/T_e$ or $\Delta T_s/T_s$, expressed as a percentage, shall be compared with the threshold value of 6%[3].

b) In the case of interference into both the uplink and the downlink, between which there is a change of modulation on board the satellite, or in cases where the optional values for transmission gain and equivalent link noise temperature have not been supplied, the values of $\Delta T_e/T_e$ and $\Delta T_s/T_s$, expressed as a percentage, shall each be compared with the threshold value of 6%[3]. (WRC-03)

[3] Values other than 6% are used in the application of Appendix **30** and Appendix **30A**.

4 Consideration of narrow-band and FM-TV carriers

The method of calculation described in this Appendix may underestimate the interference from slow swept TV carriers into certain narrow-band (single channel per carrier (SCPC)) carriers.

In order to facilitate coordination between the satellite systems and to reduce the number of administrations involved in this procedure, the administrations whose SCPC assignments are either recorded in the Master International Frequency Register or are under coordination may inform an administration notifying its new assignment of the radio frequency channels used in their systems for SCPC transmission, so that the notifying administration may be able to avoid using these channels for FM-TV transmissions.

For this special case, administrations are referred to relevant ITU-R texts for guidance in facilitating subsequent coordination.

Conversely, administrations introducing new systems using SCPC transmissions may seek appropriate information from other administrations on their FM-TV transmissions.

ANNEX 1

Calculation of the topocentric angular separation between two geostationary satellites

The topocentric angular separation θ_t between two geostationary satellites from a given earth station can be determined by using the equation:

$$\theta_t = \text{arc cos}\left(\frac{d_1^2 + d_2^2 - \left(84\ 332 \sin\frac{\theta_g}{2}\right)^2}{2d_1 \cdot d_2}\right)$$

where d_1 and d_2 are the distances (km), from the earth station to the two satellites respectively, and evaluated as d by the method described in Annex II, and θ_g is as defined in § 2.1.

ANNEX 2

Calculation of the free-space transmission loss

The free-space transmission loss L can be determined by using the following equation:

$$L = 20\ (\log f + \log d) + 32.45 \qquad \text{dB}$$

where:

f : frequency (MHz)

d : distance (km).

a) The distance d between an earth station and a geostationary satellite is given by the equation:

$$d = 42\ 644 \sqrt{1 - 0.2954 \cos\psi} \qquad \text{km}$$

where:

$$\cos\psi = \cos\zeta \times \cos\beta$$

where:

ζ : latitude of the earth station

β : difference in longitude between the satellite and the earth station.

NOTE – If $\cos\psi < 0.151$, the satellite is below the horizontal plane.

b) The distance d_s between two geostationary satellites is determined as follows:

$$d_s = 84\ 332 \sin\frac{\theta_g}{2} \qquad \text{km}$$

where:

θ_g: geocentric angular separation as defined in § 2.1.

ANNEX 3

Radiation patterns for earth station antennas to be used when they are not published

When neither measured data nor relevant ITU-R Recommendations accepted by the administrations concerned are available then administrations should use the reference patterns as described below (dBi):

a) for values of $\frac{D}{\lambda} \geq 100$ [4] (maximum gain ≥ 48 dBi approximately):

$$G(\varphi) = G_{max} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda}\varphi\right)^2 \qquad \text{for } 0 < \varphi < \varphi_m$$

$$G(\varphi) = G_1 \qquad \text{for } \varphi_m \leq \varphi < \varphi_r$$

$$G(\varphi) = 32 - 25 \log \varphi \qquad \text{for } \varphi_r \leq \varphi < 48°$$

$$G(\varphi) = -10 \qquad \text{for } 48° \leq \varphi < 180°$$

[4] In cases where $\frac{D}{\lambda}$ is not given, it may be estimated from the expression $20 \log \frac{D}{\lambda} \approx G_{max} - 7.7$, where G_{max} is the main lobe antenna gain (dBi).

where:

D: antenna diameter
λ : wavelength
} expressed in the same unit

φ: off-axis angle of the antenna, in degrees, equal to θ_t or θ_g, as applicable

G_1: gain of the first sidelobe = 2 + 15 log $\frac{D}{\lambda}$

$$\varphi_m = \frac{20\,\lambda}{D}\sqrt{G_{max} - G_1} \quad \text{degrees}$$

$$\varphi_r = 15.85\left(\frac{D}{\lambda}\right)^{-0.6} \quad \text{degrees}$$

b) for values of $\frac{D}{\lambda} < 100$ [4] (maximum gain < 48 dBi approximately):

$G(\varphi) = G_{max} - 2.5 \times 10^{-3}\left(\frac{D}{\lambda}\varphi\right)^2$ for $0 < \varphi < \varphi_m$

$G(\varphi) = G_1$ for $\varphi_m \le \varphi < 100\,\frac{\lambda}{D}$

$G(\varphi) = 52 - 10 \log \frac{D}{\lambda} - 25 \log \varphi$ for $100\,\frac{\lambda}{D} \le \varphi < 48°$

$G(\varphi) = 10 - 10 \log \frac{D}{\lambda}$ for $48° \le \varphi \le 180°$

The above patterns may be modified as appropriate to achieve a better representation of the actual antenna pattern.

ANNEX 4

Example of an application of Appendix 8

1 General

In this example of Case I (see § 2.2.1), two identical satellite networks each with a simple frequency-changing transponder and a global coverage antenna are assumed.

All topocentric angles θ_t are assumed to be equal to 5°.

For this angular separation and for an earth station antenna with D/λ greater than 100, the reference radiation pattern (32 − 25 log θ_t) gives a gain of 14.5 dBi in the direction of the satellite of the other network.

The input data are furnished in § 2 below and are expressed in decibels except for the parameters T and θ_t. In § 3 the calculations are performed in decibels.

It may be noted that since both satellites use global beams there is practically no antenna discrimination between wanted and unwanted signals at the satellite, and that this constitutes a worst case.

2 Input data

The values of the network parameters given in the table below are derived from those published in accordance with Appendix **4**.

	Symbol*	Value	Unit
Uplink at 6 175 MHz	P'_e	−37	dB(W/Hz)
	$G'_1(\theta_t)$	14.5	dBi
	$G_2(\delta_{e'})$	15.5	dBi
	L_u	200	dB
Downlink at 3 950 MHz	P'_s	−57	dB(W/Hz)
	$G'_3(\eta_e)$	15.5	dBi
	$G_4(\theta_t)$	14.5	dBi
	L_d	196	dB
	$10 \log \gamma$	−15	dB
	T	105	K
	θ_t	5	degrees

* All capital symbols, except T, refer to parameters given in logarithmic units.

3 Calculation of $\frac{\Delta T}{T}$

From equation (1)

$$\begin{aligned} 10 \log \Delta T_s &= P'_e + G'_1(\theta_t) + G_2(\delta_{e'}) + 228.6 - L_u \\ &= -37 + 14.5 + 15.5 + 228.6 - 200 = 21.6 \end{aligned} \quad \text{dBK}$$

Therefore,

$$\Delta T_s = 145 \quad \text{K}$$

From equation (2)

$$\begin{aligned} 10 \log \Delta T_e &= P'_s + G'_3(\eta_e) + G_4(\theta_t) + 228.6 - L_d \\ &= -57 + 15.5 + 14.5 + 228.6 - 196 = 5.6 \end{aligned} \quad \text{dBK}$$

Therefore;

$$\Delta T_e = 3.6 \quad \text{K}$$

From equation (3)

$$\begin{aligned} \Delta T &= \gamma\, \Delta T_s + \Delta T_e \\ &= 0.032 \times 145 + 3.6 = 8.2 \end{aligned} \qquad \text{K}$$

Thus

$$\frac{\Delta T}{T} \times 100 = \frac{8.2 \times 100}{105} = 7.8 \qquad \%$$

4 Conclusion

In the example shown, the percentage increase in equivalent satellite link noise temperature is 7.8%. Since it exceeds the threshold value of 6%, coordination between the two networks is required.

APPENDIX 9

Report of an irregularity or infringement

(See Article **15**, Section V)

Particulars concerning the station infringing the Radio Regulations:

1	Name[1] if known (in BLOCK letters)	.....
2	Call sign or other identification (in BLOCK letters)	.....
3	Nationality, if known	.....
4	Frequency used (kHz, MHz, GHz or THz)	.....
5	Class of emission[2]	.....
6	Class of station and nature of service, if known	.....
7	Location[3, 4, 5]	.....

Particulars concerning the station, the centralizing office or inspection service reporting the irregularity or infringement:

8	Name (in BLOCK letters)	.....
9	Call sign or other identification (in BLOCK letters)	.....
10	Nationality	.....
11	Location[3, 4]	.....

Particulars of the irregularity or infringement:

12	Name[6] of the station (in BLOCK letters) in communication with the station committing the irregularity or infringement	.....
13	Call sign or other identification (in BLOCK letters) of the station in communication with the station committing the irregularity or infringement	.....
14	Date and time[7]	.....
15	Nature of the irregularity or infringement[8]	.....
16	Extracts from ship log or other information supporting the report	.....

Particulars concerning the transmitting station interfered with[9]:

17	Name of the station (in BLOCK letters)	.....
18	Call sign or other identification (in BLOCK letters)	.....
19	Frequency assigned (kHz, MHz, GHz or THz)	.....
20	Frequency measured at the time of the interference	.....
21	Class of emission[2] and bandwidth (indicate whether measured or estimated, or indicate the necessary bandwidth notified to the Radiocommunication Bureau)	.....
22	Receiving location[3, 4] (in BLOCK letters) where the interference was experienced	.....
23	Certificate:	
	I certify that the foregoing report represents, to the best of my knowledge, a complete and accurate account of what took place.	.....

Signatures[10] ..... Date: .....

Instructions for filling in this form

1 Each report shall refer to only one station (see Note 6). If it is forwarded as a letter, it shall be in duplicate, and whenever practicable should be typewritten. It may also be forwarded as a telegram.

2 The class of emission shall contain the basic characteristics listed in Appendix **1**. If any characteristic cannot be determined, indicate the unknown symbol with a dash. However, if a station is not able to identify unambiguously whether the modulation is frequency or phase modulation, indicate frequency modulation (F).

3 In the case of land, fixed, or earth stations, the position shall be expressed in latitude and longitude (Greenwich). If the position cannot be furnished, the area of operation should be indicated.

4 In the case of ship or aircraft stations, the position shall be expressed either in latitude and longitude (Greenwich) or by a true bearing in degrees and distance in nautical miles, or in kilometres, from some well known place. If the position cannot be furnished, the area of operation should be indicated.

5 Where space stations are concerned, information shall be furnished on the orbit.

6 If both communicating stations infringe the Regulations, a separate report shall be made for each of these stations.

7 The time must be expressed as Coordinated Universal Time (UTC) by a group of four figures (0000 to 2359). If the infringement is prolonged or repeated, the dates and times shall be shown.

8 A separate report is required for each irregularity or infringement, unless they are repeated within a short time.

9 This information is to be given only in case of a complaint about interference.

10 This report shall be signed by the operator who has reported the infringement and countersigned by the Master of the ship or person responsible for the aircraft, or the officer in charge of the station in the case of an infringement reported by a station of the mobile service. When the report originates from a centralizing office or from an inspection service, it shall be signed by the head of that office or service and countersigned by an official of the administration sending it.

For the use of the administration only

1 Company controlling the installation of the station against which complaint is made .....

2 Name of the operator of the station held responsible for the irregularity or infringement of the Regulations .....

3 Action taken .....

APPENDIX 10 (REV.WRC-07)

Report of harmful interference

(See Article 15, Section VI)

Particulars concerning the station causing the interference:

a	Name, call sign or other means of identification	.....
b	Frequency measured	.....
	Date:	.....
	Time (UTC):	.....
c	Class of emission[1]	.....
d	Bandwidth (indicate whether measured or estimated)	.....
e	Measured field strength or power flux-density[2]	.....
	Date:	.....
	Time (UTC):	.....
f	Observed polarization	.....
g	Class of station and nature of service	.....
h	Location/position/area/bearing (QTE[3]) (WRC-07)	.....
i	Location of the facility which made the above measurements	.....

Particulars concerning the transmitting station interfered with:

j	Name, call sign or other means of identification	.....
k	Frequency assigned	.....
l	Frequency measured	.....
	Date:	.....
	Time (UTC):	.....
m	Class of emission[4]	.....

---

1 The class of emission shall contain the basic characteristics listed in Appendix **1**. If any characteristic cannot be determined, indicate the unknown symbol with a dash. However, if a station is not able to identify unambiguously whether the modulation is frequency or phase modulation, indicate frequency modulation (F).

2 When measurements are not available, signal strengths according to the QSA scale should be provided.

3 See the most recent version of Recommendation ITU-R M.1172. (WRC-07)

4 See footnote 1.

n	Bandwidth (indicate whether measured or estimated, or indicate the necessary bandwidth notified to the Radiocommunication Bureau)	.....
o	Location/position/area	.....
p	Location of the facility which made the above measurements	.....

Particulars furnished by the receiving station experiencing the interference:

q	Name of station	.....
r	Location/position/area	.....
s	Dates and times (UTC) of occurrence of harmful interference	.....
t	Bearings (QTE[5]) or other particulars (WRC-07)	.....
u	Nature of interference	.....
v	Field strength or power flux-density of the wanted emission at the receiving station experiencing the interference[6]	.....
	Date:	.....
	Time (UTC):	.....
w	Polarization of the receiving antenna or observed polarization	.....
x	Action requested	.....

NOTE – For convenience and brevity, telegraphic reports shall be in the format above, using the letters in the order listed in lieu of the explanatory titles, but only those letters for which information is provided should be used. However, sufficient information shall be provided to the administration receiving the report, so that an appropriate investigation can be conducted.

[5] See footnote 3.

[6] See footnote 2.

APPENDIX 11 (REV.WRC-19)

System specifications for double-sideband (DSB), single-sideband (SSB) and digitally modulated emissions in the HF broadcasting service

PART A – Double-sideband (DSB) system

1 System parameters

1.1 Channel spacing

The nominal spacing for DSB shall be 10 kHz. However, the interleaved channels with a separation of 5 kHz may be used in accordance with the relative protection criteria, provided that the interleaved emission is not to the same geographical area as either of the emissions between which it is interleaved.

2 Emission characteristics

2.1 Nominal carrier frequencies

Nominal carrier frequencies shall be integral multiples of 5 kHz.

2.2 Audio-frequency band

The upper limit of the audio-frequency band (at −3 dB) of the transmitter shall not exceed 4.5 kHz and the lower limit shall be 150 Hz, with lower frequencies attenuated at a slope of 6 dB per octave.

2.3 Modulation processing

If audio-frequency signal processing is used, the dynamic range of the modulating signal shall be not less than 20 dB.

2.4 Necessary bandwidth

The necessary bandwidth shall not exceed 9 kHz.

PART B – Single-sideband (SSB) system

1 System parameters

1.1 Channel spacing

In a mixed DSB, SSB and digital environment (see Resolution **517 (Rev.WRC-19)**), the channel spacing shall be 10 kHz. In the interest of spectrum conservation, it is also permissible to interleave SSB emissions midway between two adjacent DSB channels, i.e. with 5 kHz separation between carrier frequencies, provided that the interleaved emission is not to the same geographical area as either of the emissions between which it is interleaved.

In an all-inclusive SSB environment, the channel spacing and carrier frequency separation shall be 5 kHz. (WRC-19)

1.2 Equivalent sideband power

When the carrier reduction relative to peak envelope power is 6 dB, an equivalent SSB emission is one giving the same audio-frequency signal-to-noise ratio at the receiver output as the corresponding DSB emission, when it is received by a DSB receiver with envelope detection. This is achieved when the sideband power of the SSB emission is 3 dB larger than the total sideband power of the DSB emission. (The peak envelope power of the equivalent SSB emission and the carrier power are the same as that of the DSB emission.)

2 Emission characteristics

2.1 Nominal carrier frequencies

Nominal carrier frequencies shall be integral multiples of 5 kHz.

2.2 Frequency tolerance

The frequency tolerance shall be 10 Hz.[1]

2.3 Audio-frequency band

The upper limit of the audio-frequency band (at −3 dB) of the transmitter shall not exceed 4.5 kHz with a further slope of attenuation of 35 dB/kHz and the lower limit shall be 150 Hz with lower frequencies attenuated at a slope of 6 dB per octave.

2.4 Modulation processing

If audio-frequency signal processing is used, the dynamic range of the modulating signal shall be not less than 20 dB.

---

[1] See Note 21 of Appendix **2**.

2.5 Necessary bandwidth

The necessary bandwidth shall not exceed 4.5 kHz.

2.6 Carrier reduction (relative to peak envelope power)

In a mixed DSB, SSB and digital environment, the carrier reduction shall be 6 dB to allow SSB emissions to be received by conventional DSB receivers with envelope detection without significant deterioration of the reception quality. (WRC-03)

2.7 Sideband to be emitted

Only the upper sideband shall be used.

2.8 Attenuation of the unwanted sideband

The attenuation of the unwanted sideband (lower sideband) and of intermodulation products in that part of the emission spectrum shall be at least 35 dB relative to the wanted sideband signal level. However, since there is in practice a large difference between signal amplitudes in adjacent channels, a greater attenuation is recommended.

3 Characteristics of the reference receiver

The reference receiver has the main characteristics as given below. For more detailed characteristics see the relevant ITU-R Recommendations.

3.1 Noise limited sensitivity

The value of the noise limited sensitivity is equal to or less than 40 dB(μV/m).

3.2 Demodulator and carrier acquisition

The reference receiver is equipped with a synchronous demodulator, using for the carrier acquisition a device which regenerates a carrier by means of a suitable control loop which locks the receiver to the incoming carrier. The reference receiver should work as well with DSB emissions as with SSB emissions having a carrier reduced to 6 dB below peak envelope power. (WRC-03)

3.3 Overall selectivity

The reference receiver has an overall bandwidth (at −3 dB) of 4 kHz, with a slope of attenuation of 35 dB/kHz.

NOTE – Other combinations of bandwidth and slope of attenuation are possible, as given below, and will provide the same performance at 5 kHz carrier difference.

Slope of attenuation	Overall bandwidth (−3 dB)
25 dB/kHz	3 300 Hz
15 dB/kHz	2 700 Hz

PART C – Digital system (WRC-03)

1 System parameters

1.1 Channel spacing

The initial spacing for digitally modulated emissions shall be 10 kHz. However, interleaved channels with a separation of 5 kHz may be used in accordance with the appropriate protection criteria appearing in Resolution **543 (Rev.WRC-19)**, provided that the interleaved emission is not to the same geographical area as either of the emissions between which it is interleaved. (WRC-19)

1.2 Channel utilization

Channels using digitally modulated emissions may share the same spectrum or be interleaved with analogue emissions in the same high frequency broadcasting (HFBC) band, provided the protection afforded to the analogue emissions is at least as great as that which is currently in force for analogue-to-analogue protection. Accomplishing this may require that the digital spectral power density (and total power) be lower by several dB than is currently used for either DSB or SSB emissions.

2 Emission characteristics

2.1 Bandwidth and centre frequency

A full digitally modulated emission will have a 10 kHz bandwidth with its centre frequency at any of the 5 kHz centre frequency locations in the channel raster currently in use within the HFBC bands.

Among several possible “simulcast” modes are those having a combination of analogue and digital emissions of the same programme in the same channel, that may use a digital emission of 5 kHz or 10 kHz bandwidth, next to either a 5 kHz or 10 kHz analogue emission. In all cases of this type, the 5 kHz interleaved raster used in HFBC shall be adhered to in placing the emission within these bands.

2.2 Frequency tolerance

The frequency tolerance shall be 10 Hz[1].

---

[1] See Note 21 of Appendix **2**.

2.3 Audio-frequency band

The quality of service, using digital source coding within a 10 kHz bandwidth, taking into account the need to adapt the emission coding for various levels of error avoidance, detection and correction, can range from the equivalent of monophonic FM (approximately 15 kHz) to the low-level performance of a speech codec (of the order of 3 kHz). The choice of audio quality is connected to the needs of the broadcaster and listener, and includes the consideration of such characteristics as the propagation conditions expected. There is no single specification, only the upper and lower bounds noted in this paragraph.

2.4 Modulation

Quadrature amplitude modulation (QAM) with orthogonal frequency division multiplexing (OFDM) shall be used. 64-QAM is feasible under many propagation conditions; others such as 32-, 16- and 8-QAM are specified for use when needed.

2.5 RF protection ratio values

The protection ratio values for analogue and digital emissions for co-channel and adjacent channel conditions shall be in accordance with Resolution **543 (Rev.WRC-19)** as provisional RF protection ratio values subject to revision or confirmation by a future competent conference. (WRC-19)

APPENDIX 12

Special rules applicable to radiobeacons

(See Article **28**)

Section I – Aeronautical radiobeacons

1) The assignment of frequencies to aeronautical radiobeacons operating in the bands between 160 kHz and 535 kHz shall be based on a protection ratio against interference of at least 15 dB for each beacon throughout its service area.

2) The radiated power should be kept to the minimum value necessary to give the desired field strength at the service range.

3) The daylight service range of radiobeacons referred to in § 1) above shall be based on the following field strengths:

4) *Regions 1 and 2*

– 70 μV/m for radiobeacons north of 30° N;

– 120 μV/m for radiobeacons between 30° N and 30° S;

– 70 μV/m for radiobeacons south of 30° S.

5) *Region 3*

– 70 μV/m for radiobeacons north of 40° N;

– 120 μV/m for radiobeacons between 40° N and 50° S;

– 70 μV/m for radiobeacons south of 50° S.

Section II – Maritime Radiobeacons

1) The protection ratio required for assignment of frequencies to maritime radiobeacons operating in the bands between 283.5 kHz and 335 kHz shall be based on the effective radiated power being kept to the minimum value necessary to give the desired field strength at the service range and the need to provide adequate geographical separation between radiobeacons operating on the same frequency and at the same time, to avoid harmful interference.

2) The daylight service range of the radiobeacons referred to in § 1) above shall be based on the following field strengths:

3) *Region 1*

– 50 μV/m for radiobeacons north of 43° N;

– 75 μV/m for radiobeacons between 43° N and 30° N;

– 100 μV/m for radiobeacons between 30° N and 30° S;

– 75 μV/m for radiobeacons between 30° S and 43° S;

– 50 μV/m for radiobeacons south of 43° S.

4) *Region 2*

– 50 μV/m for radiobeacons north of 40° N;

– 75 μV/m for radiobeacons between 40° N and 31° N;

– 100 μV/m for radiobeacons between 31° N and 30° S;

– 75 μV/m for radiobeacons between 30° S and 43° S;

– 50 μV/m for radiobeacons south of 43° S.

5) *Region 3*

– 75 μV/m for radiobeacons north of 40° N;

– 100 μV/m for radiobeacons between 40° N and 50° S;

– 75 μV/m for radiobeacons south of 50° S.

6) The carrier frequencies of maritime radiobeacons and the separation between channels shall be based on the use of integer multiples of 100 Hz. The separation between adjacent carrier frequencies should be based on relevant ITU-R Recommendations.

APPENDIX 14 (REV.WRC-23)

Phonetic alphabet and figure code

(See Articles **32** and **57**) (WRC-23)

1 When it is necessary to spell out call signs, service abbreviations and words, the following letter spelling table shall be used:

Letter to be transmitted	*Code word to be used*	*Spoken as*[1]
A	Alfa	AL FAH
B	Bravo	BRAH VOH
C	Charlie	CHAR LEE or SHAR LEE
D	Delta	DELL TAH
E	Echo	ECK OH
F	Foxtrot	FOKS TROT
G	Golf	GOLF
H	Hotel	HOH TELL
I	India	IN DEE AH
J	Juliett	JEW LEE ETT
K	Kilo	KEY LOH
L	Lima	LEE MAH
M	Mike	MIKE
N	November	NO VEM BER
O	Oscar	OSS CAH
P	Papa	PAH PAH
Q	Quebec	KEH BECK
R	Romeo	ROW ME OH
S	Sierra	SEE AIR RAH
T	Tango	TANG GO
U	Uniform	YOU NEE FORM or OO NEE FORM
V	Victor	VIK TAH
W	Whiskey	WISS KEY
X	X-ray	ECKS RAY
Y	Yankee	YANG KEY
Z	Zulu	ZOO LOO

[1] The syllables to be emphasized are underlined.

2 When it is necessary to spell out figures or marks, the following table shall be used:

Figure or mark to be transmitted	*Code word to be used*	*Spoken as*[2]
0	Nadazero	NAH-DAH-ZAY-ROH
1	Unaone	OO-NAH-WUN
2	Bissotwo	BEES-SOH-TOO
3	Terrathree	TAY-RAH-TREE
4	Kartefour	KAR-TAY-FOWER
5	Pantafive	PAN-TAH-FIVE
6	Soxisix	SOK-SEE-SIX
7	Setteseven	SAY-TAY-SEVEN
8	Oktoeight	OK-TOH-AIT
9	Novenine	NO-VAY-NINER
Decimal point	Decimal	DAY-SEE-MAL
Full stop	Stop	STOP

3 However, stations of the same country, when communicating between themselves, may use any other table recognized by their administration.

[2] Each syllable should be equally emphasized.

APPENDIX 15 (REV.WRC-23)

Frequencies for distress and safety communications for the Global Maritime Distress and Safety System

(See Article **31**)

The frequencies for distress and safety communications for the GMDSS are given in Tables 15-1 and 15-2 for frequencies below and above 30 MHz, respectively.

TABLE 15-1 (WRC-23)

Frequencies below 30 MHz

Frequency (kHz)	**Description of usage**	**Notes**
490	MSI	The frequency 490 kHz is used exclusively for maritime safety information (MSI). (WRC-03)
500	MSI	The frequency 500 kHz is used exclusively by the international NAVDAT system (see Resolution **364 (WRC-23)**).
518	MSI	The frequency 518 kHz is used exclusively by the international NAVTEX system.
*2 182	RTP-COM	The frequency 2 182 kHz uses class of emission J3E. See also No. **52.190**.
*2 187.5	DSC	
3 023	AERO-SAR	The aeronautical carrier (reference) frequencies 3 023 kHz and 5 680 kHz may be used for intercommunication between mobile stations engaged in coordinated search and rescue operations, and for communication between these stations and participating land stations, in accordance with the provisions of Appendix **27** (see Nos. **5.111** and **5.115**).
*4 125	RTP-COM	See also No. **52.221**. The carrier frequency 4 125 kHz may be used by aircraft stations to communicate with stations of the maritime mobile service for distress and safety purposes, including search and rescue (see No. **30.11**).
*4 207.5	DSC	
4 209.5	MSI	The frequency 4 209.5 kHz is exclusively used for NAVTEX-type transmissions (see Resolution **339 (Rev.WRC-07)**).
4 210	MSI-HF	By means of narrow-band direct-printing telegraphy.

TABLE 15-1 (*end*) (WRC-23)

Frequency (kHz)	Description of usage	Notes
4 226	MSI	The frequency 4 226 kHz is exclusively used for the international NAVDAT system (see Resolution **364 (WRC-23)**).
5 680	AERO-SAR	See note under 3 023 kHz above.
*6 215	RTP-COM	See also No. **52.221**.
*6 312	DSC	
6 314	MSI-HF	By means of narrow-band direct-printing telegraphy.
6 337.5	MSI-HF	By means of the NAVDAT system.
*8 291	RTP-COM	
*8 414.5	DSC	
8 416.5	MSI-HF	By means of narrow-band direct-printing telegraphy.
8 443	MSI-HF	By means of the NAVDAT system.
*12 290	RTP-COM	
*12 577	DSC	
12 579	MSI-HF	By means of narrow-band direct-printing telegraphy.
12 663.5	MSI-HF	By means of the NAVDAT system.
*16 420	RTP-COM	
*16 804.5	DSC	
16 806.5	MSI-HF	By means of narrow-band direct-printing telegraphy.
16 909.5	MSI-HF	By means of the NAVDAT system.
19 680.5	MSI-HF	By means of narrow-band direct-printing telegraphy.
22 376	MSI-HF	By means of narrow-band direct-printing telegraphy.
22 450.5	MSI-HF	By means of the NAVDAT system.
26 100.5	MSI-HF	By means of narrow-band direct-printing telegraphy.

Legend:

AERO-SAR These aeronautical carrier (reference) frequencies may be used for distress and safety purposes by mobile stations engaged in coordinated search and rescue operations.

DSC These frequencies are used exclusively for distress and safety calls using digital selective calling in accordance with No. **32.5** (see Nos. **33.8** and **33.32**). (WRC-07)

MSI In the maritime mobile service, these frequencies are used exclusively for the transmission of maritime safety information (MSI) (including meteorological and navigational warnings and urgent information) by coast stations to ships, by means of narrow-band direct-printing telegraphy or the NAVDAT system. (WRC-23)

MSI-HF In the maritime mobile service, these frequencies are used exclusively for the transmission of high seas MSI by coast stations to ships, by means of narrow-band direct-printing telegraphy or the NAVDAT system. (WRC-23)

RTP-COM These carrier frequencies are used for distress and safety communications (traffic) by radiotelephony.

* Except as provided in these Regulations, any emission capable of causing harmful interference to distress, alarm, urgency or safety communications on the frequencies denoted by an asterisk (*) is prohibited. Any emission causing harmful interference to distress and safety communications on any of the discrete frequencies identified in this Appendix is prohibited. (WRC-07)

TABLE 15-2 (WRC-23)

Frequencies above 30 MHz (VHF/UHF)

Frequency (MHz)	Description of usage	Notes
*121.5	AERO-SAR	The aeronautical emergency frequency 121.5 MHz is used for the purposes of distress and urgency for radiotelephony by stations of the aeronautical mobile service using frequencies in the frequency band between 117.975 MHz and 137 MHz. This frequency may also be used for these purposes by survival craft stations. Use of the frequency 121.5 MHz by emergency position-indicating radio beacons shall be in accordance with Recommendation ITU-R M.690-3. Mobile stations of the maritime mobile service may communicate with stations of the aeronautical mobile service on the aeronautical emergency frequency 121.5 MHz for the purposes of distress and urgency only, and on the aeronautical auxiliary frequency 123.1 MHz for coordinated search and rescue operations, using class A3E emissions for both frequencies (see also Nos. **5.111** and **5.200**). They shall then comply with any special arrangement between governments concerned by which the aeronautical mobile service is regulated.
123.1	AERO-SAR	The aeronautical auxiliary frequency 123.1 MHz, which is auxiliary to the aeronautical emergency frequency 121.5 MHz, is for use by stations of the aeronautical mobile service and by other mobile and land stations engaged in coordinated search and rescue operations (see also No. **5.200**). Mobile stations of the maritime mobile service may communicate with stations of the aeronautical mobile service on the aeronautical emergency frequency 121.5 MHz for the purposes of distress and urgency only, and on the aeronautical auxiliary frequency 123.1 MHz for coordinated search and rescue operations, using class A3E emissions for both frequencies (see also Nos. **5.111** and **5.200**). They shall then comply with any special arrangement between governments concerned by which the aeronautical mobile service is regulated.
156.3	VHF-CH06	The frequency 156.3 MHz may be used for communication between ship stations and aircraft stations engaged in coordinated search and rescue operations. It may also be used by aircraft stations to communicate with ship stations for other safety purposes (see also Note *f*) in Appendix **18**).
*156.525	VHF-CH70	The frequency 156.525 MHz is used in the maritime mobile service for distress and safety calls using digital selective calling (see also Nos. **4.9**, **5.227**, **30.2** and **30.3**).
156.650	VHF-CH13	The frequency 156.650 MHz is used for ship-to-ship communications relating to the safety of navigation in accordance with Note *k*) in Appendix **18**.
*156.8	VHF-CH16	The frequency 156.8 MHz is used for distress and safety communications by radiotelephony. Additionally, the frequency 156.8 MHz may be used by aircraft stations for safety purposes only.
*161.975	AIS-SART VHF CH AIS 1	AIS 1 is used for AIS search and rescue transmitters (AIS-SART) for use in search and rescue operations.
*162.025	AIS-SART VHF CH AIS 2	AIS 2 is used for AIS search and rescue transmitters (AIS-SART) for use in search and rescue operations.
*406-406.1	406-EPIRB	This frequency band is used exclusively by satellite emergency position-indicating radio beacons in the Earth-to-space direction (see No. **5.266**).
1 530-1 544	SAT-COM	In addition to its availability for routine non-safety purposes, the band 1 530-1 544 MHz is used for distress and safety purposes in the space-to-Earth direction in the maritime mobile-satellite service. GMDSS distress, urgency and safety communications have priority in this band (see No. **5.353A**).

TABLE 15-2 (*end*) (WRC-23)

Frequency (MHz)	Description of usage	Notes
*1 544-1 545	D&S-OPS	Use of the band 1 544-1 545 MHz (space-to-Earth) is limited to distress and safety operations (see No. **5.356**), including feeder links of satellites needed to relay the emissions of satellite emergency position-indicating radio beacons to earth stations and narrow-band (space-to-Earth) links from space stations to mobile stations.
1 614.4225-1 618.725 or 1 616.3-1 620.38 MHz (Earth-to-space) (see *resolves* 5 of Resolution **365 (WRC-23)**)	SAT-COM	In addition to its availability for routine non-safety purposes, the frequency band 1 614.4225-1 618.725 MHz or 1 616.3-1 620.38 MHz (Earth-to-space) (see *resolves* 5 of Resolution **365 (WRC-23)**) is used for distress and safety purposes in the Earth-to-space direction in the maritime mobile-satellite service. GMDSS distress, urgency and safety communications have priority in this band over non-safety communication within the same satellite network (see No. **5.368**).
1 621.35-1 626.5	SAT-COM	In addition to its availability for routine non-safety purposes, the frequency band 1 621.35-1 626.5 MHz is used for distress and safety purposes in the Earth-to-space and space-to-Earth directions in the maritime mobile-satellite service. GMDSS distress, urgency and safety communications have priority in this band over non-safety communications within the same satellite system. (WRC-19)
1 626.5-1 645.5	SAT-COM	In addition to its availability for routine non-safety purposes, the band 1 626.5-1 645.5 MHz is used for distress and safety purposes in the Earth-to-space direction in the maritime mobile-satellite service. GMDSS distress, urgency and safety communications have priority in this band (see No. **5.353A**).
1 645.5-1 646.5	SAT-COM	See No. **5.375**.
2 483.59-2 499.91	SAT-COM	In addition to its availability for routine non-safety purposes, the frequency band 2 483.59-2 499.91 MHz is used for distress and safety purposes in the space-to-Earth direction in the maritime mobile-satellite service. GMDSS distress, urgency and safety communications have priority in this band over non-safety communication within the same satellite network (see No. **5.368**).
9 200-9 500	SARTS	This frequency band is used by radar transponders to facilitate search and rescue.

Legend:

AERO-SAR These aeronautical carrier (reference) frequencies may be used for distress and safety purposes by mobile stations engaged in coordinated search and rescue operations.

D&S-OPS The use of these bands is limited to distress and safety operations of satellite emergency position-indicating radio beacons (EPIRBs).

SAT-COM These frequency bands are available for distress and safety purposes in the maritime mobile-satellite service (see Notes).

VHF-CH# These VHF frequencies are used for distress and safety purposes. The channel number (CH#) refers to the VHF channel as listed in Appendix **18**, which should also be consulted.

AIS These frequencies are used by automatic identification systems (AIS), which should operate in accordance with the most recent version of Recommendation ITU-R M.1371. (WRC-07)

* Except as provided in these Regulations, any emission capable of causing harmful interference to distress, alarm, urgency or safety communications on the frequencies denoted by an asterisk (*) is prohibited. Any emission causing harmful interference to distress and safety communications on any of the discrete frequencies identified in this Appendix is prohibited. (WRC-07)

Note: For the frequency bands 1 614.4225-1 618.725 MHz or 1 616.3-1 620.38 MHz (Earth-to-space) (see *resolves* 5 of Resolution **365 (WRC-23)**) and 2 483.59-2 499.91 MHz (space-to-Earth) when used for GMDSS, Resolution **365 (WRC-23)** applies. (WRC-23)

APPENDIX 16 (REV.WRC-07)

Documents with which stations on board ships and aircraft shall be provided

(See Articles **42** and **51**)

Section I – Ship stations for which a Global Maritime Distress and Safety System installation is required by international agreement

These stations shall be provided with:

1 the licence prescribed by Article **18**;

2 certificates of the operator or operators;

3 a log in which the following are recorded as they occur, together with the time of the occurrence, unless administrations have adopted other arrangements for recording all information which the log should contain:

a) a summary of communications relating to distress, urgency and safety traffic;

b) a reference to important service incidents;

4 the List of Ship Stations and Maritime Mobile Service Identity Assignments (see Article 20) in either printed or electronic format; (WRC-07)

5 the List of Coast Stations and Special Service Stations (see Article **20**) in either printed or electronic format; (WRC-07)

6 the Manual for Use by the Maritime Mobile and Maritime Mobile-Satellite Services (see Article **20**) in either printed or electronic format. (WRC-07)

NOTE – An administration may exempt a ship from the carriage of the documents mentioned in items 5 and 6 above under various circumstances (for example, when that ship carries equivalent information for the ship's specified trading area).

Section II – Other ship stations for which a radio installation is required by regional or international agreement (WRC-07)

These stations shall be provided with:

1 the licence prescribed by Article **18**;

2 certificates of the operator or operators;

3 a log or other arrangements which the administration may have adopted for that purpose, in which a summary of communications related to distress, urgency and safety traffic shall be recorded together with the time of their occurrence;

4 the List of Coast Stations and Special Service Stations (see Article **20**) in either printed or electronic format;

5 the relevant rules and procedures of radiocommunications, e.g. Manual for Use by the Maritime Mobile and Maritime Mobile-Satellite Services (paper or electronic format) (see Article **20**).

NOTE – An administration may exempt a ship from the carriage of the documents mentioned in items 4 and 5 above under various circumstances (for example, when that ship carries equivalent information for the ship's specified trading area).

Section III – Other ship stations (WRC-07)

These stations shall be provided with:

1 the documents mentioned in items 1 and 2 of Section II;

2 the documents mentioned in items 4 and 5 of Section II, in accordance with the requirements of the administrations concerned.

NOTE – An administration may exempt a ship from the carriage of the documents mentioned in item 2 above under various circumstances (for example, when that ship carries equivalent information for the ship's specified trading area). Administrations may also, by mutual agreement, exempt ships travelling only between their national jurisdictions from the licensing prescribed by Article **18** and the carriage of the documents mentioned in item 1 above, provided those vessels are otherwise licensed or authorized by regulation.

Section IV – Stations on board aircraft (WRC-07)

These stations shall be provided with:

1 the documents mentioned in items 1 and 2 of Section I;

2 a log, unless administrations have adopted other arrangements for recording all information which the log should contain;

3 those published documents, in either printed or electronic formats, containing official information relating to stations which the aircraft station may use for the execution of its service.

APPENDIX 17 (REV.WRC-23)

Frequencies and channelling arrangements in the high-frequency bands for the maritime mobile service

(See Article **52**)

PART A – Table of subdivided bands (WRC-23)

In the Table, where appropriate[1], the assignable frequencies in a given band for each usage are:

– indicated by the lowest and highest frequency, in heavy type, assigned in that band;

– regularly spaced, the number of assignable frequencies (*f.*) and the spacing in kHz being indicated in italics.

Table of frequencies (kHz) to be used in the band between 4 000 kHz and 27 500 kHz allocated exclusively to the maritime mobile service

Band (MHz)	**4**	**6**	**8**	**12**	**16**	**18/19**	**22**	**25/26**
Limits (kHz)	4 063	6 200	8 195	12 230	16 360	18 780	22 000	25 070
Frequencies assignable to ship stations for oceanographic data transmission *c)*	**4 063.3** to **4 064.8** *6 f.* *0.3 kHz*							
Limits (kHz)	4 065	6 200	8 195	12 230	16 360	18 780	22 000	25 070
Frequencies assignable to ship stations for telephony, duplex operation *a) i) t)*	**4 066.4** to **4 144.4** *27 f.* *3 kHz*	**6 201.4** to **6 222.4** *8 f.* *3 kHz*	**8 196.4** to **8 292.4** *33 f.* *3 kHz*	**12 231.4** to **12 351.4** *41 f.* *3 kHz*	**16 361.4** to **16 526.4** *56 f.* *3 kHz*	**18 781.4** to **18 823.4** *15 f.* *3 kHz*	**22 001.4** to **22 157.4** *53 f.* *3 kHz*	**25 071.4** to **25 098.4** *10 f.* *3 kHz*
Limits (kHz)	4 146	6 224	8 294	12 353	16 528	18 825	22 159	25 100

1 Within the non-shaded boxes.

Table of frequencies (kHz) to be used in the band between 4 000 kHz and 27 500 kHz allocated exclusively to the maritime mobile service (*continued*)

Band (MHz)	**4**	**6**	**8**	**12**	**16**	**18/19**	**22**	**25/26**
Limits (kHz)	4 146	6 224	8 294	12 353	16 528	18 825	22 159	25 100
Frequencies assignable to ship stations as well as coast stations for telephony, simplex operation *a) u) v)*	**4 147.4** to **4 150.4** *2 f. 3 kHz*	**6 225.4** to **6 231.4** *3 f. 3 kHz*	**8 295.4** to **8 298.4** *2 f. 3 kHz*	**12 354.4** to **12 366.4** *5 f. 3 kHz*	**16 529.4** to **16 547.4** *7 f. 3 kHz*	**18 826.4** to **18 844.4** *7 f. 3 kHz*	**22 160.4** to **22 178.4** *7 f. 3 kHz*	**25 101.4** to **25 119.4** *7 f. 3 kHz*
Limits (kHz)	4 152	6 233	8 300	12 368	16 549	18 846	22 180	25 121
Frequencies assignable to ship stations for data transmission *e) m) p) q) r) u)*	**4 153.5** to **4 168.5** *6 f. 3 kHz*	**6 234.5** to **6 258.5** *9 f. 3 kHz*	**8 301.5** to **8 337.5** *13 f. 3 kHz*	**12 369.5** to **12 417.5** *17 f. 3 kHz*	**16 550.5** to **16 613.5** *22 f. 3 kHz*	**18 847.5** to **18 871.5** *9 f. 3 kHz*	**22 181.5** to **22 238.5** *20 f. 3 kHz*	**25 122.5** to **25 176.5** *19 f. 3 kHz*
Limits (kHz)	4 170	6 260	8 339	12 419	16 615	18 873	22 240	25 178
Frequencies assignable to ship as well as coast stations for data transmission *e) m) p) q) u)*								**25 179.5** to **25 206.5** *10 f. 3 kHz*
Limits (kHz)	4 170	6 260	8 339	12 419	16 615	18 873	22 240	25 208.25
Frequencies (paired and non-paired) assignable to ship stations for narrow-band direct-printing (NBDP) telegraphy and data transmission systems at speeds not exceeding 100 Bd for FSK and 200 Bd for PSK *b) d)*		**6 260.25** to **6 260.75** *2 f. 0.5 kHz*	**8 339.25** to **8 339.75** *2 f. 0.5 kHz*	**12 419.25** to **12 419.75** *2 f. 0.5 kHz*	**16 615.25** to **16 616.75** *4 f. 0.5 kHz*	**18 873.5** to **18 880** *14 f. 0.5 kHz*		
Limits (kHz)	4 170	6 261	8 340	12 420	16 617	18 880.25	22 240	25 208.25
Frequencies assignable to ship stations for oceanographic data transmission *c)*		**6 261.3** to **6 262.5** *5 f. 0.3 kHz*	**8 340.3** to **8 341.5** *5 f. 0.3 kHz*	**12 420.3** to **12 421.5** *5 f. 0.3 kHz*	**16 617.3** to **16 618.5** *5 f. 0.3 kHz*		**22 240.3** to **22 241.5** *5 f. 0.3 kHz*	
Limits (kHz)	4 170	6 262.75	8 341.75	12 421.75	16 618.75	18 880.25	22 241.75	25 208.25

Table of frequencies (kHz) to be used in the band between 4 000 kHz and 27 500 kHz allocated exclusively to the maritime mobile service (*continued*)

Band (MHz)	**4**	**6**	**8**	**12**	**16**	**18/19**	**22**	**25/26**
Limits (kHz)	4 170	6 262.75	8 341.75	12 421.75	16 618.75	18 880.25	22 241.75	25 208.25
Frequencies (paired and non-paired) assignable to ship stations for narrow-band direct-printing (NBDP) telegraphy and data transmission systems at speeds not exceeding 100 Bd for FSK and 200 Bd for PSK *b) d) j)*	**4 170.5** to **4 180** *20 f.* *0.5 kHz*	**6 263** to **6 269.5** *14 f.* *0.5 kHz*		**12 422** *1 f.* *0.5 kHz*				
Limits (kHz)	4 180.25	6 269.75	8 341.75	12 422.25	16 618.75	18 880.25	22 241.75	25 208.25
Frequencies assignable to ship stations for data transmission *e) m) p) q) u)*	**4 181.75** to **4 187.75** *3f.* *3 kHz*	**6 271.25** to **6 277.25** *3 f.* *3 kHz*	**8 343.25** to **8 358.25** *6 f.* *3 kHz*	**12 423.75** to **12 450.75** *10 f.* *3 kHz*	**16 620.25** to **16 680.25** *21 f.* *3 kHz*	**18 881.75** to **18 893.75** *5 f.* *3 kHz*	**22 243.25** to **22 288.25** *16 f.* *3 kHz*	
Limits (kHz)	4 189.25	6 278.75	8 359.75	12 452.25	16 681.75	18 895.25	22 289.75	25 208.25
Frequencies assignable to ship as well as coast stations for data transmission *e) m) p) q) u)*	**4 190.75** to **4 196.75** *3f.* *3 kHz*	**6 280.25** to **6 310.25** *11 f.* *3 kHz*	**8 361.25** to **8 373.25** *5 f.* *3 kHz*	**12 453.75** to **12 474.75** *8 f.* *3 kHz*		**18 896.75** *1 f.* *3 kHz*		
Limits (kHz)	4 198.25	6 311.75	8 374.75	12 476.25	16 681.75	18 898.25	22 289.75	25 208.25
Frequencies assignable to coast stations for data transmission *e) m) p) q) u)*	**4 199.75** to **4 205.75** *3f.* *3 kHz*							
Limits (kHz)	4 207.25	6 311.75	8 374.75	12 476.25	16 681.75	18 898.25	22 289.75	25 208.25
Frequencies (paired and non-paired) assignable to ship stations for NBDP telegraphy and data transmission systems at speeds not exceeding 100 bauds for FSK and 200 bauds for PSK *b) d) j)*			**8 375** to **8 383.5** *18 f.* *0.5 kHz*	**12 476.5** to **12 522.5** *93 f.* *0.5 kHz*	**16 682** to **16 698.5** *34 f.* *0.5 kHz*		**22 290** to **22 299** *19 f* *0.5 kHz*	
Limits (kHz)	4 207.25	6 311.75	8 383.75	12 522.75	16 698.75	18 898.25	22 299.25	25 208.25

Table of frequencies (kHz) to be used in the band between 4 000 kHz and 27 500 kHz allocated exclusively to the maritime mobile service (*continued*)

Band (MHz)	**4**	**6**	**8**	**12**	**16**	**18/19**	**22**	**25/26**
Limits (kHz)	4 207.25	6 311.75	8 383.75	12 522.75	16 698.75	18 898.25	22 299.25	25 208.25
Frequencies assignable to ship as well as coast stations for data transmission *e) p) q) u)*			**8 385.5** to **8 406.5** *8 f.* *3 kHz*	**12 524.25** to **12 575.25** *18 f.* *3 kHz*	**16 700.5** to **16 802.5** *35 f.* *3 kHz*		**22 300.75** to **22 372.75** *25 f.* *3 kHz*	
Limits (kHz)	4 207.25	6 311.75	8 408	12 576.75	16 804	18 898.25	22 374.25	25 208.25
Frequencies assignable to coast stations for data transmission *e) m) p) q) u)*			**8 409.5** to **8 412.5** *2 f.* *3 kHz*					
Limits (kHz)	4 207.25	6 311.75	8 414	12 576.75	16 804	18 898.25	22 374.25	25 208.25
Frequencies assignable to ship stations for digital selective calling *k) l)*	**4 207.5** to **4 209** 4 f. 0.5 kHz	**6 312** to **6 313.5** 4 f. 0.5 kHz	**8 414.5** to **8 416** 4 f. 0.5 kHz	**12 577** to **12 578.5** 4 f. 0.5 kHz	**16 804.5** to **16 806** 4 f. 0.5 kHz	**18 898.5** to **18 899.5** 3 f. 0.5 kHz	**22 374.5** to **22 375.5** 3 f. 0.5 kHz	**25 208.5** to **25 209.5** 3 f. 0.5 kHz
Limits (kHz)	4 209.25	6 313.75	8 416.25	12 578.75	16 806.25	18 899.75	22 375.75	25 210
Limits (kHz)	4 209.25	6 313.75	8 416.25	12 578.75	16 806.25	19 680.25	22 375.75	26 100.25
Frequencies (paired and non-paired) assignable to coast stations for NBDP and data transmission systems, at speeds not exceeding 100 Bd for FSK and 200 Bd for PSK *b) d) n) o)*	**4 209.5** to **4 216** 14 f. 0.5 kHz	**6 314** to **6 321.5** 16 f. 0.5 kHz	**8 416.5** to **8 423.5** 15 f. 0.5 kHz	**12 579** to **12 624.5** 92 f. 0.5 kHz	**16 806.5** to **16 821.5** 31 f. 0.5 kHz	**19 680.5** 1 f. 0.5 kHz	**22 376** 1 f. 0.5 kHz	**26 100.5** to **26 102.5** 5 f. 0.5 kHz
Limits (kHz)	4 216.25	6 321.75	8 423.75	12 624.75	16 821.75	19 680.75	22 376.25	26 102.75
Frequencies assignable to ship stations for data transmission *e) m) p) q) u)*							**22 377.75** to **22 380.75** 2 f. 3 kHz	
Limits (kHz)	4 216.25	6 321.75	8 423.75	12 624.75	16 821.75	19 680.75	22 382.25	26 102.75
Frequencies assignable to ship as well as coast stations for data transmission *e) m) p) q) u)*	**4 217.75** 1 f. 3 kHz				**16 823.25** to **16 838.25** 6 f. 3 kHz			
Limits (kHz)	4 219.25	6 321.75	8 423.75	12 624.75	16 839.75	19 680.75	22 382.25	26 102.75

Table of frequencies (kHz) to be used in the band between 4 000 kHz and 27 500 kHz allocated exclusively to the maritime mobile service (*continued*)

Band (MHz)	**4**	**6**	**8**	**12**	**16**	**18/19**	**22**	**25/26**
Limits (kHz)	4 219.25	6 321.75	8 423.75	12 624.75	16 839.75	19 680.75	22 382.25	26 102.75
Frequencies assignable to coast stations for data transmission *e) m) q) u)*		**6 323.25** to **6329.25** *3 f.* *3 kHz*	**8 425.5** to **8 434.5** *4 f.* *3 kHz*	**12 626.25** to **12 653.25** *10 f.* *3 kHz*	**16 841.25** to **16 901.25** *21 f.* *3 kHz*	**19 682.25** *1 f.* *3 kHz*		**26 104.25** to **26 119.25** *6 f.* *3 kHz*
Limits (kHz)	4 219.25	6 330.75	8 436.25	12 654.75	16 902.75	19 683.75	22 382.25	26 120.75
Frequencies (paired and non-paired) assignable to coast stations for NBDP and data transmission systems, at speeds not exceeding 100 Bd for FSK and 200 Bd for PSK *b) d)*				**12 655** to **12 656.5** *4 f.* *0.5 kHz*		**19 684** to **19 691** *15 f.* *0.5 kHz*	**22 382.5** to **22 389** *14 f.* *0.5 kHz*	
Limits (kHz)	4 219.25	6 330.75	8 436.25	12 656.75	16 902.75	19 691.25	22 389.25	26 120.75
Frequencies assignable to coast stations for data transmission *e) m) p) q) u)*						**19 692.75** to **19 701.75** *4 f.* *3 kHz*	**22 390.75** to **22 441.75** *18 f.* *3 kHz*	
Limits (kHz)	4 219.25	6 330.75	8 436.25	12 656.75	16 902.75	19 703.25	22 443.25	26 120.75
Frequencies (non-paired) assignable to coast stations for NBDP and data transmission systems, at speeds not exceeding 100 Bd for FSK and 200 Bd for PSK *b)*							**22 443.5** *1 f.* *0.5 kHz*	
Limits (kHz)	4 219.25	6 330.75	8 436.25	12 656.75	16 902.75	19 703.25	22 443.75	26 120.75
Frequencies assignable to coast stations for digital selective calling *l)*	**4 219.5** to **4 220.5** *3 f.* *0.5 kHz*	**6 331** to **6 332** *3 f.* *0.5 kHz*	**8 436.5** to **8 437.5** *3 f.* *0.5 kHz*	**12 657** to **12 658** *3 f.* *0.5 kHz*	**16 903** to **16 904** *3 f.* *0.5 kHz*	**19 703.5** to **19 704.5** *3 f.* *0.5 kHz*	**22 444** to **22 445** *3 f.* *0.5 kHz*	**26 121** to **26 122** *3 f.* *0.5 kHz*
Limits (kHz)	4 221	6 332.5	8 438	12 658.5	16 904.5	19 705	22 445.5	26 122.5

Table of frequencies (kHz) to be used in the band between 4 000 kHz and 27 500 kHz allocated exclusively to the maritime mobile service (*end*)

Band (MHz)	**4**	**6**	**8**	**12**	**16**	**18/19**	**22**	**25/26**
Limits (kHz)	4 221	6 332.5	8 438	12 658.5	16 904.5	19 705	22 445.5	26 122.5
Frequencies assignable for wide-band systems, facsimile, special and data transmission systems and direct-printing telegraphy systems *m) p) s) pp) ppp)*								
Limits (kHz)	4 351	6 501	8 707	13 077	17 242	19 755	22 696	26 145
Frequencies assignable to coast stations for telephony, duplex operation *a) t)*	**4 352.4** to **4 436.4** *29 f. 3 kHz*	**6 502.4** to **6 523.4** *8 f. 3 kHz*	**8 708.4** to **8 813.4** *36 f. 3 kHz*	**13 078.4** to **13 198.4** *41 f. 3 kHz*	**17 243.4** to **17 408.4** *56 f. 3 kHz*	**19 756.4** to **19 798.4** *15 f. 3 kHz*	**22 697.4** to **22 853.4** *53 f. 3 kHz*	**26 146.4** to **26 173.4** *10 f. 3 kHz*
Limits (kHz)	4 438	6 525	8 815	13 200	17 410	19 800	22 855	26 175

a) See Part B, Section I.

b) See Part B, Section III.

c) The frequency bands may also be used by buoy stations for oceanographic data transmission and by stations interrogating these buoys.

d) See Part B, Section II.

e) See Part B, Section IV.

i) For the use of the carrier frequencies 4 125 kHz, 6 215 kHz, 8 291 kHz, 12 290 kHz and 16 420 kHz in these sub-bands by ship and coast stations for distress and safety purposes, by single-sideband radiotelephony, see Article **31**.

j) For the automatic connection system (ACS), the assigned frequencies 4 177.5 kHz, 6 268 kHz, 8 376.5 kHz, 12 520 kHz and 16 695 kHz shall be used by ship and coast stations. (WRC-23)

k) For the use of the assigned frequencies 4 207.5 kHz, 6 312 kHz, 8 414.5 kHz, 12 577 kHz and 16 804.5 kHz in these sub-bands by ship and coast stations for distress and safety purposes, by digital selective calling, see Article **31**.

l) The following paired assigned frequencies (for ship/coast stations) 4 208/4 219.5 kHz, 6 312.5/6 331 kHz, 8 415/8 436.5 kHz, 12 577.5/12 657 kHz, 16 805/16 903 kHz, 18 898.5/19 703.5 kHz, 22 374.5/22 444 kHz and 25 208.5/26 121 kHz are the first choice international frequencies for digital selective calling (see Article **54**).

m) Frequencies from these frequency bands may also be used for A1A or A1B Morse telegraphy subject to not claiming protection from other stations in the maritime mobile service using digitally modulated emissions. Any frequencies so assigned shall be multiples of 100 Hz. Administrations shall ensure a uniform distribution of such assignments within the bands.

n) The assigned frequencies 4 210 kHz, 6 314 kHz, 8 416.5 kHz, 12 579 kHz, 16 806.5 kHz, 19 680.5 kHz, 22 376 kHz and 26 100.5 kHz are the exclusive international frequencies for the transmission of maritime safety information (MSI) (see Articles **31** and **33**).

o) The frequency 4 209.5 kHz is an exclusive international frequency for the transmission of NAVTEX type information (see Articles **31** and **33**).

p) These sub-bands are designated for digitally modulated emissions in the maritime mobile service (e.g. as described in the most recent version of Recommendation ITU-R M.1798). The provisions of No. **15.8** apply. (WRC-23)

pp) The frequency bands 4 221-4 231 kHz, 6 332.5-6 342.5 kHz, 8 438-8 448 kHz, 12 658.5-12 668.5 kHz, 16 904.5-16 914.5 kHz and 22 445.5-22 455.5 kHz may also be used by the NAVDAT system, on condition that the use of NAVDAT system transmitting stations is limited to coast stations operating in accordance with the most recent version of Recommendation ITU-R M.2058. (WRC-19)

ppp) The frequency 4 226 kHz is an exclusive frequency for the international NAVDAT system and the frequencies 6 337.5 kHz, 8 443 kHz, 12 663.5 kHz, 16 909.5 kHz and 22 450.5 kHz are the frequencies for the transmission of MSI by means of the national NAVDAT system (see Articles **31**, **33** and **52**). (WRC-23)

q) These frequency bands may be used by narrow-band direct-printing applications by administrations, subject to not claiming protection from other stations in the maritime mobile service using digitally modulated emissions.

r) Frequencies in these bands may be used for wide-band telegraphy, facsimile and special data transmission on the condition that interference is not caused to and protection is not claimed from stations in the maritime mobile service using digitally modulated emissions.

s) The frequency bands 4 345-4 351 kHz, 6 495-6 501 kHz, 8 701-8 707 kHz may be used for simplex (single-sideband) telephone operation (regularly spaced by 3 kHz), in accordance with provision No. **52.177**, subject to not claiming protection from other stations in the maritime mobile service using digitally modulated emissions.

t) The frequency bands 4 065-4 146 kHz, 4 351-4 438 kHz, 6 200-6 224 kHz, 6 501-6 525 kHz, 8 195-8 294 kHz, 8 707-8 815 kHz, 12 230-12 353 kHz, 13 077-13 200 kHz, 16 360-16 528 kHz, 17 242-17 410 kHz, 18 780-18 825 kHz, 19 755-19 800 kHz, 22 000-22 159 kHz, 22 696-22 855 kHz, 25 070-25 100 kHz and 26 145-26 175 kHz may be used, in accordance with the Appendix **25** allotment Plan, for digitally modulated emissions as described in the most recent version of Recommendation ITU-R M.1798 on the condition that it shall not cause harmful interference to, or claim protection from other stations in the maritime mobile service using radiotelephony operations. The digitally modulated emissions may be used provided that their occupied bandwidth does not exceed 2 800 Hz, it is situated wholly within one frequency channel and the peak envelope power of coast stations does not exceed 10 kW and the peak envelope power of ship stations does not exceed 1.5 kW per channel. (WRC-15)

u) These frequency bands may be used for wide-band digitally modulated emissions by combining multiple 3 kHz contiguous channels.

v) The frequency bands 4 146-4 152 kHz, 6 224-6 233 kHz, 8 294-8 300 kHz, 12 353-12 368 kHz, 16 528-16 549 kHz, 18 825-18 846 kHz, 22 159-22 180 and 25 100-25 121 kHz may be used for simplex digitally modulated emissions as described in the most recent version of Recommendation ITU-R M.1798 on condition that it shall not cause harmful interference to, or claim protection from other stations in the maritime mobile service using radiotelephony operations. The digitally modulated emissions may be used provided that their occupied bandwidth does not exceed 2 800 Hz, it is situated wholly within one frequency channel and the peak envelope power of coast stations does not exceed 10 kW and the peak envelope power of ship stations does not exceed 1.5 kW per channel. (WRC-15)

w) (SUP WRC-19)

PART B – Channelling arrangements (WRC-23)

Section I – Radiotelephony

1 Radiotelephone channelling arrangements for the frequencies to be used by coast and ship stations in the bands allocated to the maritime mobile service are indicated in the following Sub-Sections:

Sub-Section A – Table of single-sideband transmitting frequencies (kHz) for duplex (two-frequency) operation;

Sub-Section B – Table of single-sideband transmitting frequencies (kHz) for simplex (single-frequency) operation and for intership cross-band (two-frequency) operation;

Sub-Section C-1 – Table of recommended single-sideband transmitting frequencies (kHz) for ship stations in the frequency band 4 000-4 063 kHz shared with the fixed service;

Sub-Section C-2 – Table of recommended single-sideband transmitting frequencies (kHz) for ship and coast stations in the frequency band 8 100-8 195 kHz shared with the fixed service.

2 The technical characteristics for single-sideband transmitters specified in Recommendation ITU-R M.1173-1 shall be used. (WRC-15)

3 One or more series of frequencies from Sub-Section A (with the exception of those frequencies mentioned in § 5 below) may be assigned to each coast station, which uses these frequencies associated in pairs (see No. **52.226**); each pair consists of a transmitting and a receiving frequency. The series shall be selected with due regard to the areas served and so as to avoid, as far as possible, harmful interference between the services of different coast stations.

4 The frequencies in Sub-Section B are provided for worldwide common use by ships of all categories, according to traffic requirements, for ship transmissions to coast stations and for intership communication. They are also authorized for worldwide common use for transmissions by coast stations (simplex operation) provided the peak envelope power does not exceed 1 kW.

5 The following frequencies in Sub-Section A are allocated for calling purposes:

– Channel No. 421 in the 4 MHz band;

– Channel No. 606 in the 6 MHz band;

– Channel No. 821 in the 8 MHz band;

– Channel No. 1221 in the 12 MHz band;

– Channel No. 1621 in the 16 MHz band;

– Channel No. 1806 in the 18 MHz band;

– Channel No. 2221 in the 22 MHz band;

– Channel No. 2510 in the 25 MHz band.

Calling on the carrier frequencies 12 290 kHz and 16 420 kHz shall be permitted only to and from rescue coordination centres (see No. **30.6.1**), subject to the safeguards of Resolution **352 (WRC-03)** (see Nos. **52.221A** and **52.222A**).

The remaining frequencies in Sub-Sections A, B, C-1 and C-2 are working frequencies.

5A For the use of the carrier frequencies:

4 125 kHz (Channel No. 421);
6 215 kHz (Channel No. 606);
8 291 kHz (Channel No. 833);
12 290 kHz (Channel No. 1221);
16 420 kHz (Channel No. 1621);

in Sub-Section A, by coast and ship stations for distress and safety purposes, see Article **31**.

6 *a)* Maritime radiotelephone stations using single-sideband emissions in the frequency bands between 4 000 kHz and 27 500 kHz exclusively allocated to the maritime mobile service shall operate only on the carrier frequencies shown in the Sub-Sections A and B and, in the case of analogue radiotelephony, shall be in conformity with the technical characteristics specified in Recommendation ITU-R M.1173-1. (WRC-15)

b) Ship stations, when using frequencies for single-sideband emissions in the frequency band 4 000-4 063 kHz, and ship and coast stations, when using frequencies for single-sideband emissions in the frequency band 8 100-8 195 kHz, should operate on the carrier frequencies indicated in Sub-Sections C-1 and C-2 respectively. In the case of analogue radiotelephony technical characteristics of the equipment shall be those specified in Recommendation ITU-R M.1173-1. (WRC-15)

c) Stations, when employing the single-sideband mode for analogue radiotelephony, shall use only class J3E emissions. For digital communications, class J2D emissions shall be used.

7 The channelling plan established in Sub-Section C-2 does not prejudice the rights of administrations to establish, and to notify assignments to stations in the maritime mobile service other than those using radiotelephony in the frequency band 8 100-8 195 kHz, in conformity with the relevant provisions of these Regulations.

Sub-Section A

Table of single-sideband transmitting frequencies (kHz) for duplex (two-frequency) operation

Channel No.	4 MHz band			
	Coast stations		Ship stations	
	Carrier frequency	Assigned frequency	Carrier frequency	Assigned frequency
401	4 357	4 358.4	4 065	4 066.4
402	4 360	4 361.4	4 068	4 069.4
403	4 363	4 364.4	4 071	4 072.4
404	4 366	4 367.4	4 074	4 075.4
405	4 369	4 370.4	4 077	4 078.4
406	4 372	4 373.4	4 080	4 081.4
407	4 375	4 376.4	4 083	4 084.4
408	4 378	4 379.4	4 086	4 087.4
409	4 381	4 382.4	4 089	4 090.4
410	4 384	4 385.4	4 092	4 093.4
411	4 387	4 388.4	4 095	4 096.4
412	4 390	4 391.4	4 098	4 099.4
413	4 393	4 394.4	4 101	4 102.4
414	4 396	4 397.4	4 104	4 105.4
415	4 399	4 400.4	4 107	4 108.4
416	4 402	4 403.4	4 110	4 111.4
417	4 405	4 406.4	4 113	4 114.4
418	4 408	4 409.4	4 116	4 117.4
419	4 411	4 412.4	4 119	4 120.4
420	4 414	4 415.4	4 122	4 123.4
421	4 417 *	4 418.4 *	4 125 * 3	4 126.4 *
422	4 420	4 421.4	4 128	4 129.4
423	4 423	4 424.4	4 131	4 132.4
424	4 426	4 427.4	4 134	4 135.4
425	4 429	4 430.4	4 137	4 138.4
426	4 432	4 433.4	4 140	4 141.4
427	4 435	4 436.4	4 143	4 144.4
428 1, 2	4 351	4 352.4	–	–
429 1, 2	4 354	4 355.4	–	–

Channel No.	6 MHz band			
	Coast stations		Ship stations	
	Carrier frequency	Assigned frequency	Carrier frequency	Assigned frequency
601	6 501	6 502.4	6 200	6 201.4
602	6 504	6 505.4	6 203	6 204.4
603	6 507	6 508.4	6 206	6 207.4
604	6 510	6 511.4	6 209	6 210.4
605	6 513	6 514.4	6 212	6 213.4
606	6 516 *	6 517.4 *	6 215 * 4	6 216.4 *
607	6 519	6 520.4	6 218	6 219.4
608	6 522	6 523.4	6 221	6 222.4

Channel No.	8 MHz band			
	Coast stations		Ship stations	
	Carrier frequency	Assigned frequency	Carrier frequency	Assigned frequency
801	8 719	8 720.4	8 195	8 196.4
802	8 722	8 723.4	8 198	8 199.4
803	8 725	8 726.4	8 201	8 202.4
804	8 728	8 729.4	8 204	8 205.4
805	8 731	8 732.4	8 207	8 208.4
806	8 734	8 735.4	8 210	8 211.4
807	8 737	8 738.4	8 213	8 214.4
808	8 740	8 741.4	8 216	8 217.4
809	8 743	8 744.4	8 219	8 220.4
810	8 746	8 747.4	8 222	8 223.4
811	8 749	8 750.4	8 225	8 226.4
812	8 752	8 753.4	8 228	8 229.4
813	8 755	8 756.4	8 231	8 232.4
814	8 758	8 759.4	8 234	8 235.4
815	8 761	8 762.4	8 237	8 238.4
816	8 764	8 765.4	8 240	8 241.4
817	8 767	8 768.4	8 243	8 244.4
818	8 770	8 771.4	8 246	8 247.4
819	8 773	8 774.4	8 249	8 250.4
820	8 776	8 777.4	8 252	8 253.4
821	8 779 *	8 780.4 *	8 255 *	8 256.4 *
822	8 782	8 783.4	8 258	8 259.4
823	8 785	8 786.4	8 261	8 262.4
824	8 788	8 789.4	8 264	8 265.4
825	8 791	8 792.4	8 267	8 268.4
826	8 794	8 795.4	8 270	8 271.4
827	8 797	8 798.4	8 273	8 274.4
828	8 800	8 801.4	8 276	8 277.4
829	8 803	8 804.4	8 279	8 280.4
830	8 806	8 807.4	8 282	8 283.4
831	8 809	8 810.4	8 285	8 286.4
832	8 812	8 813.4	8 288	8 289.4
833	8 291 [6]	8 292.4	8 291 [6]	8 292.4
834 [2, 5]	8 707	8 708.4	–	–
835 [2, 5]	8 710	8 711.4	–	–
836 [2, 5]	8 713	8 714.4	–	–
837 [2, 5]	8 716	8 717.4	–	–

Channel No.	12 MHz band			
	Coast stations		Ship stations	
	Carrier frequency	Assigned frequency	Carrier frequency	Assigned frequency
1201	13 077	13 078.4	12 230	12 231.4
1202	13 080	13 081.4	12 233	12 234.4
1203	13 083	13 084.4	12 236	12 237.4
1204	13 086	13 087.4	12 239	12 240.4
1205	13 089	13 090.4	12 242	12 243.4
1206	13 092	13 093.4	12 245	12 246.4
1207	13 095	13 096.4	12 248	12 249.4
1208	13 098	13 099.4	12 251	12 252.4
1209	13 101	13 102.4	12 254	12 255.4
1210	13 104	13 105.4	12 257	12 258.4
1211	13 107	13 108.4	12 260	12 261.4
1212	13 110	13 111.4	12 263	12 264.4
1213	13 113	13 114.4	12 266	12 267.4
1214	13 116	13 117.4	12 269	12 270.4
1215	13 119	13 120.4	12 272	12 273.4
1216	13 122	13 123.4	12 275	12 276.4
1217	13 125	13 126.4	12 278	12 279.4
1218	13 128	13 129.4	12 281	12 282.4
1219	13 131	13 132.4	12 284	12 285.4
1220	13 134	13 135.4	12 287	12 288.4
1221	13 137 *	13 138.4 *	12 290 * 7	12 291.4 *
1222	13 140	13 141.4	12 293	12 294.4
1223	13 143	13 144.4	12 296	12 297.4
1224	13 146	13 147.4	12 299	12 300.4
1225	13 149	13 150.4	12 302	12 303.4
1226	13 152	13 153.4	12 305	12 306.4
1227	13 155	13 156.4	12 308	12 309.4
1228	13 158	13 159.4	12 311	12 312.4
1229	13 161	13 162.4	12 314	12 315.4
1230	13 164	13 165.4	12 317	12 318.4
1231	13 167	13 168.4	12 320	12 321.4
1232	13 170	13 171.4	12 323	12 324.4
1233	13 173	13 174.4	12 326	12 327.4
1234	13 176	13 177.4	12 329	12 330.4
1235	13 179	13 180.4	12 332	12 333.4
1236	13 182	13 183.4	12 335	12 336.4
1237	13 185	13 186.4	12 338	12 339.4
1238	13 188	13 189.4	12 341	12 342.4
1239	13 191	13 192.4	12 344	12 345.4
1240	13 194	13 195.4	12 347	12 348.4
1241	13 197	13 198.4	12 350	12 351.4

Channel No.	16 MHz band			
	Coast stations		Ship stations	
	Carrier frequency	Assigned frequency	Carrier frequency	Assigned frequency
1601	17 242	17 243.4	16 360	16 361.4
1602	17 245	17 246.4	16 363	16 364.4
1603	17 248	17 249.4	16 366	16 367.4
1604	17 251	17 252.4	16 369	16 370.4
1605	17 254	17 255.4	16 372	16 373.4
1606	17 257	17 258.4	16 375	16 376.4
1607	17 260	17 261.4	16 378	16 379.4
1608	17 263	17 264.4	16 381	16 382.4
1609	17 266	17 267.4	16 384	16 385.4
1610	17 269	17 270.4	16 387	16 388.4
1611	17 272	17 273.4	16 390	16 391.4
1612	17 275	17 276.4	16 393	16 394.4
1613	17 278	17 279.4	16 396	16 397.4
1614	17 281	17 282.4	16 399	16 400.4
1615	17 284	17 285.4	16 402	16 403.4
1616	17 287	17 288.4	16 405	16 406.4
1617	17 290	17 291.4	16 408	16 409.4
1618	17 293	17 294.4	16 411	16 412.4
1619	17 296	17 297.4	16 414	16 415.4
1620	17 299	17 300.4	16 417	16 418.4
1621	17 302 *	17 303.4 *	16 420 * 8	16 421.4 *
1622	17 305	17 306.4	16 423	16 424.4
1623	17 308	17 309.4	16 426	16 427.4
1624	17 311	17 312.4	16 429	16 430.4
1625	17 314	17 315.4	16 432	16 433.4
1626	17 317	17 318.4	16 435	16 436.4
1627	17 320	17 321.4	16 438	16 439.4
1628	17 323	17 324.4	16 441	16 442.4
1629	17 326	17 327.4	16 444	16 445.4
1630	17 329	17 330.4	16 447	16 448.4
1631	17 332	17 333.4	16 450	16 451.4
1632	17 335	17 336.4	16 453	16 454.4
1633	17 338	17 339.4	16 456	16 457.4
1634	17 341	17 342.4	16 459	16 460.4
1635	17 344	17 345.4	16 462	16 463.4
1636	17 347	17 348.4	16 465	16 466.4
1637	17 350	17 351.4	16 468	16 469.4
1638	17 353	17 354.4	16 471	16 472.4
1639	17 356	17 357.4	16 474	16 475.4
1640	17 359	17 360.4	16 477	16 478.4
1641	17 362	17 363.4	16 480	16 481.4
1642	17 365	17 366.4	16 483	16 484.4
1643	17 368	17 369.4	16 486	16 487.4
1644	17 371	17 372.4	16 489	16 490.4
1645	17 374	17 375.4	16 492	16 493.4
1646	17 377	17 378.4	16 495	16 496.4
1647	17 380	17 381.4	16 498	16 499.4
1648	17 383	17 384.4	16 501	16 502.4
1649	17 386	17 387.4	16 504	16 505.4
1650	17 389	17 390.4	16 507	16 508.4
1651	17 392	17 393.4	16 510	16 511.4
1652	17 395	17 396.4	16 513	16 514.4
1653	17 398	17 399.4	16 516	16 517.4
1654	17 401	17 402.4	16 519	16 520.4
1655	17 404	17 405.4	16 522	16 523.4
1656	17 407	17 408.4	16 525	16 526.4

Channel No.	18/19 MHz band			
	Coast stations		Ship stations	
	Carrier frequency	Assigned frequency	Carrier frequency	Assigned frequency
1801	19 755	19 756.4	18 780	18 781.4
1802	19 758	19 759.4	18 783	18 784.4
1803	19 761	19 762.4	18 786	18 787.4
1804	19 764	19 765.4	18 789	18 790.4
1805	19 767	19 768.4	18 792	18 793.4
1806	19 770 *	19 771.4 *	18 795 *	18 796.4 *
1807	19 773	19 774.4	18 798	18 799.4
1808	19 776	19 777.4	18 801	18 802.4
1809	19 779	19 780.4	18 804	18 805.4
1810	19 782	19 783.4	18 807	18 808.4
1811	19 785	19 786.4	18 810	18 811.4
1812	19 788	19 789.4	18 813	18 814.4
1813	19 791	19 792.4	18 816	18 817.4
1814	19 794	19 795.4	18 819	18 820.4
1815	19 797	19 798.4	18 822	18 823.4

Channel No.	22 MHz band			
	Coast stations		Ship stations	
	Carrier frequency	Assigned frequency	Carrier frequency	Assigned frequency
2201	22 696	22 697.4	22 000	22 001.4
2202	22 699	22 700.4	22 003	22 004.4
2203	22 702	22 703.4	22 006	22 007.4
2204	22 705	22 706.4	22 009	22 010.4
2205	22 708	22 709.4	22 012	22 013.4
2206	22 711	22 712.4	22 015	22 016.4
2207	22 714	22 715.4	22 018	22 019.4
2208	22 717	22 718.4	22 021	22 022.4
2209	22 720	22 721.4	22 024	22 025.4
2210	22 723	22 724.4	22 027	22 028.4
2211	22 726	22 727.4	22 030	22 031.4
2212	22 729	22 730.4	22 033	22 034.4
2213	22 732	22 733.4	22 036	22 037.4
2214	22 735	22 736.4	22 039	22 040.4
2215	22 738	22 739.4	22 042	22 043.4
2216	22 741	22 742.4	22 045	22 046.4
2217	22 744	22 745.4	22 048	22 049.4
2218	22 747	22 748.4	22 051	22 052.4
2219	22 750	22 751.4	22 054	22 055.4
2220	22 753	22 754.4	22 057	22 058.4
2221	22 756 *	22 757.4 *	22 060 *	22 061.4 *
2222	22 759	22 760.4	22 063	22 064.4
2223	22 762	22 763.4	22 066	22 067.4
2224	22 765	22 766.4	22 069	22 070.4
2225	22 768	22 769.4	22 072	22 073.4

Channel No.	22 MHz band (*end*)			
	Coast stations		Ship stations	
	Carrier frequency	Assigned frequency	Carrier frequency	Assigned frequency
2226	22 771	22 772.4	22 075	22 076.4
2227	22 774	22 775.4	22 078	22 079.4
2228	22 777	22 778.4	22 081	22 082.4
2229	22 780	22 781.4	22 084	22 085.4
2230	22 783	22 784.4	22 087	22 088.4
2231	22 786	22 787.4	22 090	22 091.4
2232	22 789	22 790.4	22 093	22 094.4
2233	22 792	22 793.4	22 096	22 097.4
2234	22 795	22 796.4	22 099	22 100.4
2235	22 798	22 799.4	22 102	22 103.4
2236	22 801	22 802.4	22 105	22 106.4
2237	22 804	22 805.4	22 108	22 109.4
2238	22 807	22 808.4	22 111	22 112.4
2239	22 810	22 811.4	22 114	22 115.4
2240	22 813	22 814.4	22 117	22 118.4
2241	22 816	22 817.4	22 120	22 121.4
2242	22 819	22 820.4	22 123	22 124.4
2243	22 822	22 823.4	22 126	22 127.4
2244	22 825	22 826.4	22 129	22 130.4
2245	22 828	22 829.4	22 132	22 133.4
2246	22 831	22 832.4	22 135	22 136.4
2247	22 834	22 835.4	22 138	22 139.4
2248	22 837	22 838.4	22 141	22 142.4
2249	22 840	22 841.4	22 144	22 145.4
2250	22 843	22 844.4	22 147	22 148.4
2251	22 846	22 847.4	22 150	22 151.4
2252	22 849	22 850.4	22 153	22 154.4
2253	22 852	22 853.4	22 156	22 157.4

Channel No.	25/26 MHz band			
	Coast stations		Ship stations	
	Carrier frequency	Assigned frequency	Carrier frequency	Assigned frequency
2501	26 145	26 146.4	25 070	25 071.4
2502	26 148	26 149.4	25 073	25 074.4
2503	26 151	26 152.4	25 076	25 077.4
2504	26 154	26 155.4	25 079	25 080.4
2505	26 157	26 158.4	25 082	25 083.4
2506	26 160	26 161.4	25 085	25 086.4
2507	26 163	26 164.4	25 088	25 089.4
2508	26 166	26 167.4	25 091	25 092.4
2509	26 169	26 170.4	25 094	25 095.4
2510	26 172 *	26 173.4 *	25 097 *	25 098.4 *

1 These coast station frequencies may be paired with a ship station frequency from the Table of simplex frequencies for ship and coast stations (see Sub-Section B) or with a frequency from the band 4 000-4 063 kHz (see Sub-Section C-1) to be selected by the administration concerned.

2 These channels may also be used for simplex (single frequency) operation.

3 For the conditions of use of the carrier frequency 4 125 kHz, see Nos. **52.224** and **52.225**, and Appendix **15**.

4 For the conditions of use of the carrier frequency 6 215 kHz, see Appendix **15**.

5 These coast station frequencies may be paired with a ship station frequency from the Table of simplex frequencies for ship and coast stations (see Sub-Section B) or with a frequency from the band 8 100-8 195 kHz (see Sub-Section C-2) to be selected by the administration concerned.

6 For the conditions of use of the carrier frequency 8 291 kHz, see Appendix **15**.

7 For the conditions of use of the carrier frequency 12 290 kHz, see Nos. **52.221A** and **52.222A** and Appendix **15**.

8 For the conditions of use of the carrier frequency 16 420 kHz, see Nos. **52.221A** and **52.222A** and Appendix **15**.

* The frequencies followed by an asterisk are calling frequencies (see Nos. **52.221** and **52.222**).

Sub-Section B

Table of single-sideband transmitting frequencies (kHz) for simplex (single-frequency) operation and for intership cross-band (two-frequency) operation

(See § 4 of Section I of this Appendix)

4 MHz band[1]		6 MHz band		8 MHz band[2]		12 MHz band[3]	
Carrier frequency	**Assigned frequency**	**Carrier frequency**	**Assigned frequency**	**Carrier frequency**	**Assigned frequency**	**Carrier frequency**	**Assigned frequency**
4 146	4 147.4	6 224	6 225.4	8 294	8 295.4	12 353	12 354.4
4 149	4 150.4	6 227	6 228.4	8 297	8 298.4	12 356	12 357.4
		6 230	6 231.4			12 362	12 363.4
						12 365	12 366.4

1 These frequencies may be used for duplex operation with coast stations operating on Channel Nos. 428 and 429 (see Sub-Section A).

2 These frequencies may be used for duplex operation with coast stations operating on Channel Nos. 834 up to and including 837 (see Sub-Section A).

3 For use of frequencies 12 359 kHz and 16 537 kHz, see Nos. **52.221A** and **52.222A**.

16 MHz band[3]		18/19 MHz band		22 MHz band		25/26 MHz band	
Carrier frequency	**Assigned frequency**	**Carrier frequency**	**Assigned frequency**	**Carrier frequency**	**Assigned frequency**	**Carrier frequency**	**Assigned frequency**
16 528	16 529.4	18 825	18 826.4	22 159	22 160.4	25 100	25 101.4
16 531	16 532.4	18 828	18 829.4	22 162	22 163.4	25 103	25 104.4
16 534	16 535.4	18 831	18 832.4	22 165	22 166.4	25 106	25 107.4
		18 834	18 835.4	22 168	22 169.4	25 109	25 110.4
16 540	16 541.4	18 837	18 838.4	22 171	22 172.4	25 112	25 113.4
16 543	16 544.4	18 840	18 841.4	22 174	22 175.4	25 115	25 116.4
16 546	16 547.4	18 843	18 844.4	22 177	22 178.4	25 118	25 119.4

3 For use of frequencies 12 359 kHz and 16 537 kHz, see Nos. **52.221A** and **52.222A**.

Sub-Section C-1

Table of recommended single-sideband transmitting frequencies (kHz) for ship stations in the band 4 000-4 063 kHz shared with the fixed service

The frequencies in this Sub-Section may be used:

– for supplementing ship-to-shore channels for duplex operation in Sub-Section A;

– for intership simplex (single-frequency) and cross-band operation;

– for cross-band working with coast stations on channels in Sub-Section C-2;

– for duplex operation with coast stations working in the band 4 438-4 650 kHz;

– for duplex operation with Channel Nos. 428 and 429.

Channel No.	Carrier frequency	Assigned frequency	Channel No.	Carrier frequency	Assigned frequency
1	4 000*	4 001.4*	12	4 033	4 034.4
2	4 003*	4 004.4*	13	4 036	4 037.4
3	4 006	4 007.4	14	4 039	4 040.4
4	4 009	4 010.4	15	4 042	4 043.4
5	4 012	4 013.4	16	4 045	4 046.4
6	4 015	4 016.4	17	4 048	4 049.4
7	4 018	4 019.4	18	4 051	4 052.4
8	4 021	4 022.4	19	4 054	4 055.4
9	4 024	4 025.4	20	4 057	4 058.4
10	4 027	4 028.4	21	4 060	4 061.4
11	4 030	4 031.4			

* Administrations are requested to urge ship stations under their jurisdiction to refrain from using the band 4 000-4 005 kHz when navigating in Region 3 (see also No. **5.126**).

Sub-Section C-2

Table of recommended single-sideband transmitting frequencies (kHz) for ship and coast stations in the band 8 100-8 195 kHz shared with the fixed service

(See § 7 of Section I of this Appendix)

The frequencies in this Sub-Section may be used:

– for supplementing ship-to-shore and shore-to-ship channels for duplex operation in Sub-Section A;

– for intership simplex (single frequency) and cross-band operation;

– for cross-band working with ship stations on channels in Sub-Section C-1;

– for ship-to-shore or shore-to-ship simplex operation;

– for duplex operation with Channel Nos. 834, 835, 836 and 837.

Channel No.	Carrier frequency	Assigned frequency	Channel No.	Carrier frequency	Assigned frequency
1	8 101	8 102.4	17	8 149	8 150.4
2	8 104	8 105.4	18	8 152	8 153.4
3	8 107	8 108.4	19	8 155	8 156.4
4	8 110	8 111.4	20	8 158	8 159.4
5	8 113	8 114.4	21	8 161	8 162.4
6	8 116	8 117.4	22	8 164	8 165.4
7	8 119	8 120.4	23	8 167	8 168.4
8	8 122	8 123.4	24	8 170	8 171.4
9	8 125	8 126.4	25	8 173	8 174.4
10	8 128	8 129.4	26	8 176	8 177.4
11	8 131	8 132.4	27	8 179	8 180.4
12	8 134	8 135.4	28	8 182	8 183.4
13	8 137	8 138.4	29	8 185	8 186.4
14	8 140	8 141.4	30	8 188	8 189.4
15	8 143	8 144.4	31	8 191	8 192.4
16	8 146	8 147.4			

Section II – Narrow-band direct-printing telegraphy (paired frequencies)

1 Each coast station which uses paired frequencies is assigned one or more frequency pairs from the following series; each pair consists of a transmitting and a receiving frequency.

2 The speed of the narrow-band direct-printing telegraphy and data systems shall not exceed 100 Bd for FSK and 200 Bd for PSK.

Table of frequencies for two-frequency operation by coast stations (kHz)

Channel No.	4 MHz band		6 MHz band		8 MHz band	
	Transmit	Receive	Transmit	Receive	Transmit	Receive
1	4 210.5	4 172.5	6 314.5	6 263		
2	4 211	4 173	6 315	6 263.5	8 417	8 377
3	4 211.5	4 173.5	6 315.5	6 264	8 417.5	8 377.5
4	4 212	4 174	6 316	6 264.5	8 418	8 378
5	4 212.5	4 174.5	6 316.5	6 265	8 418.5	8 378.5
6	4 213	4 175	6 317	6 265.5	8 419	8 379
7	4 213.5	4 175.5	6 317.5	6 266	8 419.5	8 379.5
8	4 214	4 176	6 318	6 266.5	8 420	8 380
9	4 214.5	4 176.5	6 318.5	6 267	8 420.5	8 380.5
10	4 215	4 177	6 319	6 267.5	8 421	8 381
11					8 421.5	8 381.5
12	4 215.5	4 178	6 319.5	6 268.5	8 422	8 382
13	4 216	4 178.5	6 320	6 269	8 422.5	8 382.5
14			6 320.5	6 269.5	8 423	8 383
15					8 423.5	8 383.5

Table of frequencies for two-frequency operation by coast stations (kHz)

Channel No.	12 MHz band		16 MHz band		18/19 MHz band	
	Transmit	Receive	Transmit	Receive	Transmit	Receive
1	12 579.5	12 477	16 807	16 683.5		
2	12 580	12 477.5	16 807.5	16 684		
3	12 580.5	12 478	16 808	16 684.5		
4	12 581	12 478.5	16 808.5	16 685		
5	12 581.5	12 479	16 809	16 685.5		
6	12 582	12 479.5	16 809.5	16 686		
7	12 582.5	12 480	16 810	16 686.5	19 684	18 873.5
8	12 583	12 480.5	16 810.5	16 687	19 684.5	18 874
9	12 583.5	12 481	16 811	16 687.5	19 685	18 874.5
10	12 584	12 481.5	16 811.5	16 688	19 685.5	18 875
11	12 584.5	12 482	16 812	16 688.5	19 686	18 875.5
12	12 585	12 482.5	16 812.5	16 689	19 686.5	18 876
13	12 585.5	12 483	16 813	16 689.5	19 687	18 876.5
14	12 586	12 483.5	16 813.5	16 690	19 687.5	18 877
15	12 586.5	12 484	16 814	16 690.5	19 688	18 877.5
16	12 587	12 484.5	16 814.5	16 691	19 688.5	18 878
17	12 587.5	12 485	16 815	16 691.5	19 689	18 878.5
18	12 588	12 485.5	16 815.5	16 692	19 689.5	18 879
19	12 588.5	12 486	16 816	16 692.5	19 690	18 879.5
20	12 589	12 486.5	16 816.5	16 693	19 690.5	18 880
21	12 589.5	12 487	16 817	16 693.5		
22	12 590	12 487.5	16 817.5	16 694		
23	12 590.5	12 488	16 818	16 694.5		
24	12 591	12 488.5				
25	12 591.5	12 489	16 818.5	16 695.5		
26	12 592	12 489.5	16 819	16 696		
27	12 592.5	12 490	16 819.5	16 696.5		
28	12 593	12 490.5	16 820	16 697		
29	12 593.5	12 491	16 820.5	16 697.5		
30	12 594	12 491.5	16 821	16 698		
31	12 594.5	12 492	16 821.5	16 698.5		
32	12 595	12 492.5				
33	12 595.5	12 493				
34	12 596	12 493.5				
35	12 596.5	12 494				
36	12 597	12 494.5				
37	12 597.5	12 495				
38	12 598	12 495.5				
39	12 598.5	12 496				
40	12 599	12 496.5				
41	12 599.5	12 497				
42	12 600	12 497.5				
43	12 600.5	12 498				
44	12 601	12 498.5				
45	12 601.5	12 499				

Table of frequencies for two-frequency operation by coast stations (kHz)

Channel No.	12 MHz band (*end*)	
	Transmit	Receive
46	12 602	12 499.5
47	12 602.5	12 500
48	12 603	12 500.5
49	12 603.5	12 501
50	12 604	12 501.5
51	12 604.5	12 502
52	12 605	12 502.5
53	12 605.5	12 503
54	12 606	12 503.5
55	12 606.5	12 504
56	12 607	12 504.5
57	12 607.5	12 505
58	12 608	12 505.5
59	12 608.5	12 506
60	12 609	12 506.5
61	12 609.5	12 507
62	12 610	12 507.5
63	12 610.5	12 508
64	12 611	12 508.5
65	12 611.5	12 509
66	12 612	12 509.5
67	12 612.5	12 510
68	12 613	12 510.5
69	12 613.5	12 511
70	12 614	12 511.5
71	12 614.5	12 512
72	12 615	12 512.5
73	12 615.5	12 513
74	12 616	12 513.5
75	12 616.5	12 514
76	12 617	12 514.5
77	12 617.5	12 515
78	12 618	12 515.5
79	12 618.5	12 516
80	12 619	12 516.5
81	12 619.5	12 517
82	12 620	12 517.5
83	12 620.5	12 518
84	12 621	12 518.5
85	12 621.5	12 519
86	12 622	12 519.5
87		
88	12 622.5	12 520.5
89	12 623	12 521
90	12 623.5	12 521.5
91	12 624	12 522
92	12 624.5	12 522.5

Table of frequencies for two-frequency operation by coast stations (kHz)

Channel No.	22 MHz band	
	Transmit	Receive
13 14 15	22 382.5 22 383 22 383.5	22 290.5 22 291 22 291.5
16 17 18 19 20	22 384 22 384.5 22 385 22 385.5 22 386	22 292 22 292.5 22 293 22 293.5 22 294
21 22 23 24 25	22 386.5 22 387 22 387.5 22 388 22 388.5	22 294.5 22 295 22 295.5 22 296 22 296.5
26	22 389	22 297

Section III – Narrow-band direct-printing telegraphy (non-paired frequencies)

1 One or more frequencies are assigned to each ship station as transmitting frequencies.

2 All frequencies appearing in this Appendix may be used for NBDP duplex operation.

3 The speed of the narrow-band direct-printing telegraphy and data systems shall not exceed 100 Bd for FSK and 200 Bd for PSK.

Frequency bands								
Channel No.	4 MHz	6 MHz	8 MHz	12 MHz	16 MHz	18/19 MHz	22 MHz	25/26 MHz
1 2 3 4 5	4 170.5 4 171 4 171.5 4 172 4 179	6 260.25 6 260.75 6 321 6 321.5	8 339.25 8 339.75 8 375 8 375.5 8 376	12 419.25 12 419.75 12 422 12 476.5 12 655	16 615.25 16 615.75 16 616.25 16 616.75 16 682	19 691	22 290 22 297.5 22 298 22 298.5 22 299	26 101 26 101.5 26 102 26 102.5
6 7 8	4 179.5 4 180			12 655.5 12 656 12 656.5	16 682.5 16 683		22 443.5	

Section IV – Data transmission

Table of frequencies (kHz) assignable to ship and coast stations for data transmission (kHz)[1]

Channel No.	4 MHz band		6 MHz band		8 MHz band	
	Coast Tx (ship Rx)	Ship Tx/Rx (coast Rx)	Coast Tx (ship Rx)	Ship Tx/Rx (coast Rx)	Coast Tx (ship Rx)	Ship Tx/Rx (coast Rx)
1		4 153.5 [3, 4]		6 234.5 [3, 4]		8 301.5 [3, 4]
2		4 156.5 [3, 4]		6 237.5 [3, 4]		8 304.5 [3, 4]
3		4 159.5 [3, 4]		6 240.5 [3, 4]		8 307.5 [3, 4]
4		4 162.5 [3, 4]		6 243.5 [3, 4]		8 310.5 [3, 4]
5		4 165.5 [3, 4]		6 246.5 [3, 4]		8 313.5 [3, 4]
6		4 168.5 [3, 4]		6 249.5 [3, 4]		8 316.5 [3, 4]
7	4 199.75	4 181.75		6 252.5 [3, 4]		8 319.5 [3, 4]
8	4 202.75	4 184.75		6 255.5 [3, 4]		8 322.5 [3, 4]
9	4 205.75	4 187.75		6 258.5 [3, 4]		8 325.5 [3, 4]
10	4 190.75 [2, 3]	4 190.75 [2, 3]	6 323.25	6 271.25		8 328.5 [3, 4]
11	4 193.75 [2, 3]	4 193.75 [2, 3]	6 326.25	6 274.25		8 331.5 [3, 4]
12	4 196.75 [2, 3]	4 196.75 [2, 3]	6 329.25	6 277.25		8 334.5 [3, 4]
13	4 217.75 [2]	4 217.75 [2]	6 280.25 [2, 3]	6 280.25 [2, 3]		8 337.5 [3, 4]
14			6 283.25 [2, 3]	6 283.25 [2, 3]	8 409.5	8 343.25
15			6 286.25 [2, 3]	6 286.25 [2, 3]	8 412.5	8 346.25
16			6 289.25 [2, 3]	6 289.25 [2, 3]	8 425.5	8 349.25
17			6 292.25 [2, 3]	6 292.25 [2, 3]	8 428.5 [3]	8 352.25 [3]
18			6 295.25 [2, 3]	6 295.25 [2, 3]	8 431.5 [3]	8 355.25 [3]
19			6 298.25 [2, 3]	6 298.25 [2, 3]	8 434.5 [3]	8 358.25 [3]
20			6 301.25 [2, 3]	6 301.25 [2, 3]	8 361.25 [2, 3]	8 361.25 [2, 3]
21			6 304.25 [2, 3]	6 304.25 [2, 3]	8 364.25 [2, 3]	8 364.25 [2, 3]
22			6 307.25 [2, 3]	6 307.25 [2, 3]	8 367.25 [2, 3]	8 367.25 [2, 3]
23			6 310.25 [2, 3]	6 310.25 [2, 3]	8 370.25 [2, 3]	8 370.25 [2, 3]
24					8 373.25 [2, 3]	8 373.25 [2, 3]
25					8 385.5 [2, 3]	8 385.5 [2, 3]
26					8 388.5 [2, 3]	8 388.5 [2, 3]
27					8 391.5 [2, 3]	8 391.5 [2, 3]
28					8 394.5 [2, 3]	8 394.5 [2, 3]
29					8 397.5 [2, 3]	8 397.5 [2, 3]
30					8 400.5 [2, 3]	8 400.5 [2, 3]
31					8 403.5 [2, 3]	8 403.5 [2, 3]
32					8 406.5 [2, 3]	8 406.5 [2, 3]

Table of frequencies (kHz) assignable to ship and coast stations for data transmission (kHz)[1]

Channel No.	12 MHz		16 MHz		18/19 MHz	
	Coast Tx (ship Rx)	Ship Tx/Rx (coast Rx)	Coast Tx (ship Rx)	Ship Tx/Rx (coast Rx)	Coast Tx (ship Rx)	Ship Tx/Rx (coast Rx)
1		12 369.5 [3, 4]		16 550.5 [3, 4]		18 847.5 [3, 4]
2		12 372.5 [3, 4]		16 553.5 [3, 4]		18 850.5 [3, 4]
3		12 375.5 [3, 4]		16 556.5 [3, 4]		18 853.5 [3, 4]
4		12 378.5 [3, 4]		16 559.5 [3, 4]		18 856.5 [3, 4]
5		12 381.5 [3, 4]		16 562.5 [3, 4]		18 859.5 [3, 4]
6		12 384.5 [3, 4]		16 565.5 [3, 4]		18 862.5 [3, 4]
7		12 387.5 [3, 4]		16 568.5 [3, 4]		18 865.5 [3, 4]
8		12 390.5 [3, 4]		16 571.5 [3, 4]		18 868.5 [3, 4]
9		12 393.5 [3, 4]		16 574.5 [3, 4]		18 871.5 [3, 4]
10		12 396.5 [3, 4]		16 577.5 [3, 4]	19 682.25	18 881.75
11		12 399.5 [3, 4]		16 580.5 [3, 4]	19 692.75	18 884.75
12		12 402.5 [3, 4]		16 583.5 [3, 4]	19 695.75 [3]	18 887.75 [3]
13		12 405.5 [3, 4]		16 586.5 [3, 4]	19 698.75 [3]	18 890.75 [3]
14		12 408.5 [3, 4]		16 589.5 [3, 4]	19 701.75 [3]	18 893.75 [3]
15		12 411.5 [3, 4]		16 592.5 [3, 4]	18 896.75 [2]	18 896.75 [2]
16		12 414.5 [3, 4]		16 595.5 [3, 4]		
17		12 417.5 [3, 4]		16 598.5 [3, 4]		
18	12 626.25	12 423.75		16 601.5 [3, 4]		
19	12 629.25	12 426.75		16 604.5 [3, 4]		
20	12 632.25	12 429.75		16 607.5 [3, 4]		
21	12 635.25	12 432.75		16 610.5 [3, 4]		
22	12 638.25 [3]	12 435.75 [3]		16 613.5 [3, 4]		
23	12 641.25 [3]	12 438.75 [3]	16 841.25	16 620.25		
24	12 644.25 [3]	12 441.75 [3]	16 844.25	16 623.25		
25	12 647.25 [3]	12 444.75 [3]	16 847.25	16 626.25		
26	12 650.25 [3]	12 447.75 [3]	16 850.25	16 629.25		
27	12 653.25 [3]	12 450.75 [3]	16 853.25	16 632.25		
28	12 453.75 [2, 3]	12 453.75 [2, 3]	16 856.25	16 635.25		
29	12 456.75 [2, 3]	12 456.75 [2, 3]	16 859.25	16 638.25		
30	12 459.75 [2, 3]	12 459.75 [2, 3]	16 862.25	16 641.25		
31	12 462.75 [2, 3]	12 462.75 [2, 3]	16 865.25	16 644.25		
32	12 465.75 [2, 3]	12 465.75 [2, 3]	16 868.25 [3]	16 647.25 [3]		
33	12 468.75 [2, 3]	12 468.75 [2, 3]	16 871.25 [3]	16 650.25 [3]		
34	12 471.75 [2, 3]	12 471.75 [2, 3]	16 874.25 [3]	16 653.25 [3]		
35	12 474.75 [2, 3]	12 474.75 [2, 3]	16 877.25 [3]	16 656.25 [3]		
36	12 524.25 [2, 3]	12 524.25 [2, 3]	16 880.25 [3]	16 659.25 [3]		
37	12 527.25 [2, 3]	12 527.25 [2, 3]	16 883.25 [3]	16 662.25 [3]		
38	12 530.25 [2, 3]	12 530.25 [2, 3]	16 886.25 [3]	16 665.25 [3]		
39	12 533.25 [2, 3]	12 533.25 [2, 3]	16 889.25 [3]	16 668.25 [3]		
40	12 536.25 [2, 3]	12 536.25 [2, 3]	16 892.25 [3]	16 671.25 [3]		
41	12 539.25 [2, 3]	12 539.25 [2, 3]	16 895.25 [3]	16 674.25 [3]		
42	12 542.25 [2, 3]	12 542.25 [2, 3]	16 898.25 [3]	16 677.25 [3]		
43	12 545.25 [2, 3]	12 545.25 [2, 3]	16 901.25 [3]	16 680.25 [3]		
44	12 548.25 [2, 3]	12 548.25 [2, 3]	16 700.5 [2, 3]	16 700.5 [2, 3]		
45	12 551.25 [2, 3]	12 551.25 [2, 3]	16 703.5 [2, 3]	16 703.5 [2, 3]		

Channel No.	12 MHz (*end*)		16 MHz (*end*)	
	Coast Tx (ship Rx)	Ship Tx/Rx (coast Rx)	Coast Tx (ship Rx)	Ship Tx/Rx (coast Rx)
46	12 554.25 [2, 3]	12 554.25 [2, 3]	16 706.5 [2, 3]	16 706.5 [2, 3]
47	12 557.25 [2, 3]	12 557.25 [2, 3]	16 709.5 [2, 3]	16 709.5 [2, 3]
48	12 560.25 [2, 3]	12 560.25 [2, 3]	16 712.5 [2, 3]	16 712.5 [2, 3]
49	12 563.25 [2, 3]	12 563.25 [2, 3]	16 715.5 [2, 3]	16 715.5 [2, 3]
50	12 566.25 [2, 3]	12 566.25 [2, 3]	16 718.5 [2, 3]	16 718.5 [2, 3]
51	12 569.25 [2, 3]	12 569.25 [2, 3]	16 721.5 [2, 3]	16 721.5 [2, 3]
52	12 572.25 [2, 3]	12 572.25 [2, 3]	16 724.5 [2, 3]	16 724.5 [2, 3]
53	12 575.25 [2, 3]	12 575.25 [2, 3]	16 727.5 [2, 3]	16 727.5 [2, 3]
54			16 730.5 [2, 3]	16 730.5 [2, 3]
55			16 733.5 [2, 3]	16 733.5 [2, 3]
56			16 736.5 [2, 3]	16 736.5 [2, 3]
57			16 739.5 [2, 3]	16 739.5 [2, 3]
58			16 742.5 [2, 3]	16 742.5 [2, 3]
59			16 745.5 [2, 3]	16 745.5 [2, 3]
60			16 748.5 [2, 3]	16 748.5 [2, 3]
61			16 751.5 [2, 3]	16 751.5 [2, 3]
62			16 754.5 [2, 3]	16 754.5 [2, 3]
63			16 757.5 [2, 3]	16 757.5 [2, 3]
64			16 760.5 [2, 3]	16 760.5 [2, 3]
65			16 763.5 [2, 3]	16 763.5 [2, 3]
66			16 766.5 [2, 3]	16 766.5 [2, 3]
67			16 769.5 [2, 3]	16 769.5 [2, 3]
68			16 772.5 [2, 3]	16 772.5 [2, 3]
69			16 775.5 [2, 3]	16 775.5 [2, 3]
70			16 778.5 [2, 3]	16 778.5 [2, 3]
71			16 781.5 [2, 3]	16 781.5 [2, 3]
72			16 784.5 [2, 3]	16 784.5 [2, 3]
73			16 787.5 [2, 3]	16 787.5 [2, 3]
74			16 790.5 [2, 3]	16 790.5 [2, 3]
75			16 793.5 [2, 3]	16 793.5 [2, 3]
76			16 796.5 [2, 3]	16 796.5 [2, 3]
77			16 799.5 [2, 3]	16 799.5 [2, 3]
78			16 802.5 [2, 3]	16 802.5 [2, 3]
79			16 823.25 [2, 3]	16 823.25 [2, 3]
80			16 826.25 [2, 3]	16 826.25 [2, 3]
81			16 829.25 [2, 3]	16 829.25 [2, 3]
82			16 832.25 [2, 3]	16 832.25 [2, 3]
83			16 835.25 [2, 3]	16 835.25 [2, 3]
84			16 838.25 [2, 3]	16 838.25 [2, 3]

Table of frequencies (kHz) assignable to ship and coast stations for data transmission (kHz)[1]

Channel No.	22 MHz		25/26 MHz	
	Coast Tx (ship Rx)	Ship Tx/Rx (coast Rx)	Coast Tx (ship Rx)	Ship Tx/Rx (coast Rx)
1		22 181.5 [3, 4]		25 122.5 [3, 4]
2		22 184.5 [3, 4]		25 125.5 [3, 4]
3		22 187.5 [3, 4]		25 128.5 [3, 4]
4		22 190.5 [3, 4]		25 131.5 [3, 4]
5		22 193.5 [3, 4]		25 134.5 [3, 4]
6		22 196.5 [3, 4]		25 137.5 [3, 4]
7		22 199.5 [3, 4]		25 140.5 [3, 4]
8		22 202.5 [3, 4]		25 143.5 [3, 4]
9		22 205.5 [3, 4]		25 146.5 [3, 4]
10		22 208.5 [3, 4]		25 149.5 [3, 4]
11		22 211.5 [3, 4]		25 152.5 [3, 4]
12		22 214.5 [3, 4]		25 155.5 [3, 4]
13		22 217.5 [3, 4]		25 158.5 [3, 4]
14		22 220.5 [3, 4]	26 104.25	25 161.5
15		22 223.5 [3, 4]	26 107.25	25 164.5
16		22 226.5 [3, 4]	26 110.25	25 167.5
17		22 229.5 [3, 4]	26 113.25 [3]	25 170.5 [3]
18		22 232.5 [3, 4]	26 116.25 [3]	25 173.5 [3]
19		22 235.5 [3, 4]	26 119.25 [3]	25 176.5 [3]
20		22 238.5 [3, 4]	25 179.5 [2, 3]	25 179.5 [2, 3]
21	22 390.75	22 243.25	25 182.5 [2, 3]	25 182.5 [2, 3]
22	22 393.75	22 246.25	25 185.5 [2, 3]	25 185.5 [2, 3]
23	22 396.75	22 249.25	25 188.5 [2, 3]	25 188.5 [2, 3]
24	22 399.75	22 252.25	25 191.5 [2, 3]	25 191.5 [2, 3]
25	22 402.75	22 255.25	25 194.5 [2, 3]	25 194.5 [2, 3]
26	22 405.75	22 258.25	25 197.5 [2, 3]	25 197.5 [2, 3]
27	22 408.75 [3]	22 261.25 [3]	25 200.5 [2, 3]	25 200.5 [2, 3]
28	22 411.75 [3]	22 264.25 [3]	25 203.5 [2, 3]	25 203.5 [2, 3]
29	22 414.75 [3]	22 267.25 [3]	25 206.5 [2, 3]	25 206.5 [2, 3]
30	22 417.75 [3]	22 270.25 [3]		
31	22 420.75 [3]	22 273.25 [3]		
32	22 423.75 [3]	22 276.25 [3]		
33	22 426.75 [3]	22 279.25 [3]		
34	22 429.75 [3]	22 282.25 [3]		
35	22 432.75 [3]	22 285.25 [3]		
36	22 435.75 [3]	22 288.25 [3]		
37	22 300.75 [2, 3]	22 300.75 [2, 3]		
38	22 303.75 [2, 3]	22 303.75 [2, 3]		
39	22 306.75 [2, 3]	22 306.75 [2, 3]		
40	22 309.75 [2, 3]	22 309.75 [2, 3]		
41	22 312.75 [2, 3]	22 312.75 [2, 3]		
42	22 315.75 [2, 3]	22 315.75 [2, 3]		
43	22 318.75 [2, 3]	22 318.75 [2, 3]		
44	22 321.75 [2, 3]	22 321.75 [2, 3]		
45	22 324.75 [2, 3]	22 324.75 [2, 3]		

Channel No.	22 MHz (*end*)	
	Coast Tx (ship Rx)	Ship Tx/Rx (coast Rx)
46	22 327.75 [2, 3]	22 327.75 [2, 3]
47	22 330.75 [2, 3]	22 330.75 [2, 3]
48	22 333.75 [2, 3]	22 333.75 [2, 3]
49	22 336.75 [2, 3]	22 336.75 [2, 3]
50	22 339.75 [2, 3]	22 339.75 [2, 3]
51	22 342.75 [2, 3]	22 342.75 [2, 3]
52	22 345.75 [2, 3]	22 345.75 [2, 3]
53	22 348.75 [2, 3]	22 348.75 [2, 3]
54	22 351.75 [2, 3]	22 351.75 [2, 3]
55	22 354.75 [2, 3]	22 354.75 [2, 3]
56	22 357.75 [2, 3]	22 357.75 [2, 3]
57	22 360.75 [2, 3]	22 360.75 [2, 3]
58	22 363.75 [2, 3]	22 363.75 [2, 3]
59	22 366.75 [2, 3]	22 366.75 [2, 3]
60	22 369.75 [2, 3]	22 369.75 [2, 3]
61	22 372.75 [2, 3]	22 372.75 [2, 3]
62	22 438.75	22 377.75
63	22 441.75	22 380.75

1 The data transmission should be in accordance with the most recent version of Recommendation ITU-R M.1798.

2 Non-paired (simplex) operations only.

3 Assignable for wide-band operation using multiple 3 kHz contiguous channels.

4 Channels may be paired with wide-band coast station channels in the same band.

APPENDIX 18 (REV.WRC-19)

Table of transmitting frequencies in the VHF maritime mobile band

(See Article **52**)

NOTE A – For assistance in understanding the Table, see Notes *a)* to *zz)* below. (WRC-15)

NOTE B – The Table below defines the channel numbering for maritime VHF communications based on 25 kHz channel spacing and use of several duplex channels. The channel numbering and the conversion of two-frequency channels for single-frequency operation shall be in accordance with Recommendation ITU-R M.1084-5 Annex 4, Tables 1 and 3. The Table below also describes the harmonized channels where the digital technologies defined in the most recent version of Recommendation ITU-R M.1842 could be deployed. (WRC-15)

Channel designator	Notes	Transmitting frequencies (MHz)		Inter-ship	Port operations and ship movement		Public corres-pondence
		From ship stations	From coast stations		Single frequency	Two frequency	
60	*m)*	156.025	160.625		x	x	x
01	*m)*	156.050	160.650		x	x	x
61	*m)*	156.075	160.675		x	x	x
02	*m)*	156.100	160.700		x	x	x
62	*m)*	156.125	160.725		x	x	x
03	*m)*	156.150	160.750		x	x	x
63	*m)*	156.175	160.775		x	x	x
04	*m)*	156.200	160.800		x	x	x
64	*m)*	156.225	160.825		x	x	x
05	*m)*	156.250	160.850		x	x	x
65	*m)*	156.275	160.875		x	x	x
06	*f)*	156.300		x			
2006	*r)*	160.900	160.900				
66	*m)*	156.325	160.925		x	x	x
07	*m)*	156.350	160.950		x	x	x
67	*h)*	156.375	156.375	x	x		
08		156.400		x			
68		156.425	156.425		x		
09	*i)*	156.450	156.450	x	x		
69		156.475	156.475	x	x		
10	*h), q)*	156.500	156.500	x	x		
70	*f), j)*	156.525	156.525	Digital selective calling for distress, safety and calling			
11	*q)*	156.550	156.550		x		
71		156.575	156.575		x		
12		156.600	156.600		x		
72	*i)*	156.625		x			
13	*k)*	156.650	156.650	x	x		
73	*h), i)*	156.675	156.675	x	x		
14		156.700	156.700		x		
74		156.725	156.725		x		

Channel designator	Notes	Transmitting frequencies (MHz)		Inter-ship	Port operations and ship movement		Public corres-pondence
		From ship stations	From coast stations		Single frequency	Two frequency	
15	*g)*	156.750	156.750	x	x		
75	*n), s)*	156.775	156.775		x		
16	*f)*	156.800	156.800	DISTRESS, SAFETY AND CALLING			
76	*n), s)*	156.825	156.825		x		
17	*g)*	156.850	156.850	x	x		
77		156.875		x			
18	*m)*	156.900	161.500		x	x	x
78	*m)*	156.925	161.525		x	x	x
1078		156.925	156.925		x		
2078	*mm)*		161.525		x		
19	*m)*	156.950	161.550		x	x	x
1019		156.950	156.950		x		
2019	*mm)*		161.550		x		
79	*m)*	156.975	161.575		x	x	x
1079		156.975	156.975		x		
2079	*mm)*		161.575		x		
20	*m)*	157.000	161.600		x	x	x
1020		157.000	157.000		x		
2020	*mm)*		161.600		x		
80	*y), wa)*	157.025	161.625		x	x	x
21	*y), wa)*	157.050	161.650		x	x	x
81	*y), wa)*	157.075	161.675		x	x	x
22	*y), wa)*	157.100	161.700		x	x	x
82	*x), y), wa)*	157.125	161.725		x	x	x
23	*x), y), wa)*	157.150	161.750		x	x	x
83	*x), y), wa)*	157.175	161.775		x	x	x
24	*w), x)*	157.200	161.800		x	x	x
1024	*w)*	157.200	157.200	x (digital only)	x (digital only)		
2024	*w)*	161.800	161.800	x (digital only)	x (digital only)		
84	*w), x)*	157.225	161.825		x	x	x
1084	*w)*	157.225	157.225	x (digital only)	x (digital only)		
2084	*w)*	161.825	161.825	x (digital only)	x (digital only)		
25	*w), x)*	157.250	161.850		x	x	x
1025	*w)*	157.250	157.250	x (digital only)	x (digital only)		
2025	*w)*	161.850	161.850	x (digital only)	x (digital only)		
85	*w), x)*	157.275	161.875		x	x	x

Channel designator	Notes	Transmitting frequencies (MHz)		Inter-ship	Port operations and ship movement		Public corres-pondence
		From ship stations	From coast stations		Single frequency	Two frequency	
1085	*w)*	157.275	157.275	x (digital only)	x (digital only)		
2085	*w)*	161.875	161.875	x (digital only)	x (digital only)		
26	*w), x)*	157.300	161.900		x	x	x
1026	*w)*	157.300					
2026	*w)*		161.900				
86	*w), x)*	157.325	161.925		x	x	x
1086	*w)*	157.325					
2086	*w)*		161.925				
1027	*zz)*	157.350	157.350		x		
ASM 1	*z)*	161.950	161.950				
87	*zz)*	157.375	157.375		x		
1028	*zz)*	157.400	157.400		x		
ASM 2	*z)*	162.000	162.000				
88	*zz)*	157.425	157.425		x		
AIS 1	*f), l), p)*	161.975	161.975				
AIS 2	*f), l), p)*	162.025	162.025				

Notes referring to the Table

General notes

a) Administrations may designate frequencies in the inter-ship, port operations and ship movement services for use by light aircraft and helicopters to communicate with ships or participating coast stations in predominantly maritime support operations under the conditions specified in Nos. **51.69**, **51.73**, **51.74**, **51.75**, **51.76**, **51.77** and **51.78**. However, the use of the channels which are shared with public correspondence shall be subject to prior agreement between interested and affected administrations.

b) The channels of the present Appendix, with the exception of channels 06, 13, 15, 16, 17, 70, 75 and 76, may also be used for high-speed data and facsimile transmissions, subject to special arrangement between interested and affected administrations.

c) The channels of the present Appendix, with the exception of channels 06, 13, 15, 16, 17, 70, 75 and 76, may be used for direct-printing telegraphy and data transmission, subject to special arrangement between interested and affected administrations. (WRC-12)

d) The frequencies in this table may also be used for radiocommunications on inland waterways in accordance with the conditions specified in No. **5.226**.

e) Administrations may apply 12.5 kHz channel interleaving on a non-interference basis to 25 kHz channels, in accordance with the most recent version of Recommendation ITU-R M.1084, provided:

– it shall not affect the 25 kHz channels of the present Appendix maritime mobile distress and safety, automatic identification system (AIS), and data exchange frequencies, especially the channels 06, 13, 15, 16, 17, 70, AIS 1 and AIS 2, nor the technical characteristics set forth in Recommendation ITU-R M.489-2 for those channels;

– implementation of 12.5 kHz channel interleaving and consequential national requirements shall be subject to coordination with affected administrations. (WRC-12)

Specific notes

f) The frequencies 156.300 MHz (channel 06), 156.525 MHz (channel 70), 156.800 MHz (channel 16), 161.975 MHz (AIS 1) and 162.025 MHz (AIS 2) may also be used by aircraft stations for the purpose of search and rescue operations and other safety-related communication. The frequencies 156.525 MHz (channel 70), 161.975 MHz (AIS 1) and 162.025 MHz (AIS 2) may also be used by autonomous maritime radio devices Group A that enhance the safety of navigation, using digital selective calling and/or AIS technology. Such use should be in accordance with the most recent version of Recommendation ITU-R M.2135. (WRC-19)

g) Channels 15 and 17 may also be used for on-board communications provided the effective radiated power does not exceed 1 W, and subject to the national regulations of the administration concerned when these channels are used in its territorial waters.

h) Within the European Maritime Area and in Canada, these frequencies (channels 10, 67, 73) may also be used, if so required, by the individual administrations concerned, for communication between ship stations, aircraft stations and participating land stations engaged in coordinated search and rescue and anti-pollution operations in local areas, under the conditions specified in Nos. **51.69**, **51.73**, **51.74**, **51.75**, **51.76**, **51.77** and **51.78**.

i) The preferred first three frequencies for the purpose indicated in Note *a)* are 156.450 MHz (channel 09), 156.625 MHz (channel 72) and 156.675 MHz (channel 73).

j) Channel 70 is to be used exclusively for digital selective calling for distress, safety and calling.

k) Channel 13 is designated for use on a worldwide basis as a navigation safety communication channel, primarily for intership navigation safety communications. It may also be used for the ship movement and port operations service subject to the national regulations of the administrations concerned.

l) These channels (AIS 1 and AIS 2) are used for an automatic identification system (AIS) capable of providing worldwide operation, unless other frequencies are designated on a regional basis for this purpose. Such use should be in accordance with the most recent version of Recommendation ITU-R M.1371. (WRC-07)

m) These channels may be operated as single frequency channels, subject to coordination with affected administrations. The following conditions apply for single frequency usage:

– The lower frequency portion of these channels may be operated as single frequency channels by ship and coast stations.

– Transmission using the upper frequency portion of these channels is limited to coast stations.

– If permitted by administrations and specified by national regulations, the upper frequency portion of these channels may be used by ship stations for transmission. All precautions should be taken to avoid harmful interference to channels AIS 1, AIS 2, ASM 1 and ASM 2. (WRC-19)

mm) Transmission on these channels is limited to coast stations. If permitted by administrations and specified by national regulations, these channels may be used by ship stations for transmission. All precautions should be taken to avoid harmful interference to channels AIS 1, AIS 2, ASM 1 and ASM 2. (WRC-19)

n) With the exception of AIS, the use of these channels (75 and 76) should be restricted to navigation-related communications only and all precautions should be taken to avoid harmful interference to channel 16, by limiting the output power to 1 W. (WRC-12)

o) (SUP - WRC-12)

p) Additionally, AIS 1 and AIS 2 may be used by the mobile-satellite service (Earth-to-space) for the reception of AIS transmissions from ships. (WRC-07)

q) When using these channels (10 and 11), all precautions should be taken to avoid harmful interference to channel 70. (WRC-07)

r) In the maritime mobile service, the frequency 160.9 MHz (channel 2006) is designated for autonomous maritime radio devices Group B that do not enhance the safety of navigation, using AIS technology, in accordance with the most recent version of Recommendation ITU-R M.2135. Autonomous maritime radio devices Group B are limited to a transmitter e.i.r.p. of 100 mW and an antenna height not exceeding 1 m above the surface of the sea.

In the maritime mobile service, this frequency may also be used for experimental use for future applications or systems (e.g. new AIS applications, man over board systems, etc.). If authorized by administrations for experimental use, the operation shall not cause harmful interference to, or claim protection from, stations operating in the fixed and mobile services, including the use of autonomous maritime radio devices Group B. (WRC-19)

s) Channels 75 and 76 are also allocated to the mobile-satellite service (Earth-to-space) for the reception of long-range AIS broadcast messages from ships (Message 27; see the most recent version of Recommendation ITU-R M.1371). (WRC-12)

t) (SUP - WRC-15)

u) (SUP - WRC-15)

v) (SUP - WRC-15)

w) The frequency bands 157.1875-157.3375 MHz and 161.7875-161.9375 MHz (corresponding to channels: 24, 84, 25, 85, 26, 86, 1024, 1084, 1025, 1085, 1026, 1086, 2024, 2084, 2025, 2085, 2026 and 2086) are identified for the utilization of the VHF Data Exchange System (VDES). The VDES terrestrial and satellite components are described in the most recent version of Recommendation ITU-R M.2092. These channels shall not be used for feeder links. The channels may be merged using multiple 25 kHz contiguous channels to form channel bandwidths of 50, 100 or 150 kHz. The channel usage is shown below:

– The channels 1024, 1084, 1025 and 1085 are identified for ship-to-shore, shore-to-ship and ship-to-ship communications, but ship-to-satellite and satellite-to-ship communications may be possible without imposing constraints on ship-to-shore, shore-to-ship and ship-to-ship communications.

– The channels 2024, 2084, 2025 and 2085 are identified for shore-to-ship and ship-to-ship communications, but ship-to-satellite and satellite-to-ship communications may be possible without imposing constraints on shore-to-ship and ship-to-ship communications.

– The channels 1026, 1086, 2026 and 2086 are identified for ship-to-satellite and satellite-to-ship communications and are not used by the terrestrial component of VDES.

– The channels 24, 84, 25 and 85 are identified for ship-to-shore and shore-to-ship communications.

The Earth-to-space component of the VDES shall not cause harmful interference to, nor claim protection from, nor restrict future development of, terrestrial systems operating in the same frequency bands.

Until 1 January 2030, the channels 24, 84, 25, 85, 26 and 86 may also be used for analogue modulation described in the most recent version of Recommendation ITU-R M.1084 by an administration that wishes to do so, subject to not causing harmful interference to, or claiming protection from other stations in the maritime mobile service using digitally modulated emissions and subject to coordination with affected administrations. (WRC-19)

wa) In Regions 1 and 3:

The frequency bands 157.0125-157.1125 MHz and 161.6125-161.7125 MHz (corresponding to channels: 80, 21, 81 and 22) are identified for utilization of the digital systems described in the most recent version of Recommendation ITU-R M.1842 using multiple 25 kHz contiguous channels.

The frequency bands 157.1375-157.1875 MHz and 161. 7375-161.7875 MHz (corresponding to channels: 23 and 83) are identified for utilization of the digital systems described in the most recent version of Recommendation ITU-R M.1842 using two 25 kHz contiguous channels. The frequencies 157.125 MHz and 161.725 MHz (corresponding to channel: 82) are identified for the utilization of the digital systems described in the most recent version of Recommendation ITU-R M.1842.

The frequency bands 157.0125-157.1875 MHz and 161.6125-161.7875 MHz (corresponding to channels: 80, 21, 81, 22, 82, 23 and 83) can also be used for analogue modulation described in the most recent version of Recommendation ITU-R M.1084 by an administration that wishes to do so, subject to not claiming protection from other stations in the maritime mobile service using digitally modulated emissions and subject to coordination with affected administrations. (WRC-19)

ww) (SUP - WRC-19)

x) In Angola, Botswana, Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Democratic Republic of the Congo, Seychelles, South Africa, Tanzania, Zambia and Zimbabwe, the frequency bands 157.1125-157.3375 and 161.7125-161.9375 MHz (corresponding to channels: 82, 23, 83, 24, 84, 25, 85, 26 and 86) are designated for digitally modulated emissions.

In China, the frequency bands 157.1375-157.3375 and 161.7375-161.9375 MHz (corresponding to channels: 23, 83, 24, 84, 25, 85, 26 and 86) are designated for digitally modulated emissions. (WRC-19)

xx) (SUP - WRC-19)

y) These channels may be operated as single or duplex frequency channels, subject to coordination with affected administrations. (WRC-12)

z) Channels ASM 1 and ASM 2 are used for application specific messages (ASM) as described in the most recent version of Recommendation ITU-R M.2092. (WRC-19)

zx) (SUP - WRC-19)

zz) Channels 1027, 1028, 87 and 88 are used as single-frequency analogue channels for port operation and ship movement. (WRC-19)

APPENDIX 25 (REV.WRC-03)*

Provisions and associated frequency allotment Plan for coast radiotelephone stations operating in the exclusive maritime mobile bands between 4 000 kHz and 27 500 kHz

The provisions of this Appendix shall apply to the maritime mobile radiotelephone bands reserved for duplex operation (two-frequency channels) between 4 000 kHz and 27 500 kHz (see Appendix **17**). Section I contains the procedure for bringing up to date the frequency allotment Plan for coast stations. The allotment Plan is contained in Section II of this Appendix.

25/1 Section I – Procedure for bringing up to date the frequency allotment plan

25/1.1 1 Before notifying to the Radiocommunication Bureau or bringing into use at any coast radiotelephone station a frequency assignment not covered by an allotment in the Frequency Allotment Plan contained in Section II of this Appendix, an administration which

25/1.1.1 intends to establish a coast radiotelephone station and has no allotment in the Plan, *or*

25/1.1.2 intends to expand its coast radiotelephone service and requires an additional allotment,

shall send the information listed in Appendix **4** to the Bureau not earlier than two years in the case of No. **25**/1.1.1, or not earlier than six months in the case of No. **25**/1.1.2, before the projected date of bringing into service of the planned coast radiotelephone service but in any case not later than three months before that date.

25/1.2 The Bureau shall publish the information sent under No. **25**/1.1 in a Special Section of the BR International Frequency Information Circular (BR IFIC) together with such apparent incompatibilities between the proposed allotment which is the subject of the publication and any other existing or proposed allotments which the Bureau can identify. The Bureau shall also indicate any information of a technical nature and make such suggestions as it may be able to offer with a view to avoiding these incompatibilities.

25/1.3 If it is requested by any administration, particularly by an administration of a country in need of special assistance, and if the circumstances appear to warrant, the Bureau, using such means at its disposal as are appropriate in the circumstances, shall render the following assistance:

25/1.3.1 indication of a suitable channel or channels for the service projected by the administration before that administration submits the information for publication;

25/1.3.2 carry out the procedure for which provision is made in No. **25**/1.4;

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* This revision contains an up-to-date version of Appendix, reflecting all amendments to Section II and the Table of allotments resulting from the application of the procedure of Section I, up to and including 10 May 2016, as well as those amendments, which resulted from geopolitical changes that occurred up to and including that date.

25/1.3.3 any other assistance of a technical nature for completion of the procedure in this Section.

25/1.4 2 At the same time as sending the information listed in Appendix **4** to the Bureau for publication, an administration shall seek the agreement of the administrations having an allotment in the same channel as the proposed allotment. A copy of the relevant correspondence shall be sent to the Bureau.

25/1.5 Any administration which, upon examining the information published by the Bureau, considers that its existing services or services planned within the time-limits mentioned in No. **25**/1.1 would be affected shall have the right to be brought into the procedure undertaken pursuant to No. **25**/1.4.

25/1.6 3 An administration which receives a request under No. **25**/1.4 shall acknowledge receipt thereof immediately by telegram. If no acknowledgement is received within thirty days after the date of the BR IFIC containing the information published under No. **25**/1.2, the administration seeking agreement shall dispatch a telegram requesting acknowledgement, to which the receiving administration shall reply within a further period of fifteen days.

25/1.7 Upon receipt of the request under No. **25**/1.4, an administration shall, having regard to the proposed date of bringing into use of the assignment(s) corresponding to the allotment for which agreement was requested, promptly examine the matter with regard to harmful interference which would be caused to the services rendered by its coast station(s):

25/1.7.1 using a frequency assignment corresponding to an allotment appearing in the Plan; *or*

25/1.7.2 to be brought into service in conformity with an allotment appearing in the Plan within the time-limit prescribed in No. **25**/1.25; *or*

25/1.7.3 to be brought into service within the time-limit prescribed in No. **25**/1.25, in conformity with a proposed allotment for which the information has been submitted to the Bureau under No. **25**/1.1 for publication under No. **25**/1.2.

25/1.8 Any administration which receives a request under No. **25**/1.4 and which considers that the proposed use of a channel will not cause harmful interference to the services rendered by its coast stations as outlined in No. **25**/1.7 shall, as soon as possible and not later than two months from the date of the relevant BR IFIC, notify its agreement to the administration seeking agreement.

25/1.9 Any administration which receives a request under No. **25**/1.4 and which considers that the proposed use of a channel may cause harmful interference to the services rendered by its coast stations as outlined in No. **25**/1.7 shall inform the administration concerned of the reasons for its disagreement as soon as possible and not later than two months from the date of the relevant BR IFIC and shall furnish any information and suggestions with a view to reaching a satisfactory solution of the problem. The administration seeking agreement shall try, as far as possible, to adjust its requirements according to the comments received.

25/1.10 In a case where the administration seeking agreement has no allotment in the band concerned, the administration(s) with which agreement is sought shall, in consultation with the requesting administration, explore all means of meeting the requirement of the requesting administration.

25/1.11 4 An administration seeking agreement may request the Bureau to endeavour to obtain such agreement in those cases where:

25/1.11.1 an administration to which a request has been sent under No. **25**/1.4 fails to acknowledge receipt of the request within forty-five days from the date of the BR IFIC containing the pertinent information;

25/1.11.2 an administration has acknowledged receipt under No. **25**/1.6 but fails to give a decision within two months from the date of the BR IFIC containing the pertinent information;

25/1.11.3 there is disagreement between the administration seeking agreement and an administration with which agreement is sought as to the sharing possibilities;

25/1.11.4 it is not possible to reach agreement for any other reason.

25/1.12 Either the administration seeking agreement or an administration with which agreement is sought, or the Bureau, may request additional information which it may require in studying any problem relating to this agreement.

25/1.13 Where the Bureau receives a request under No. **25**/1.11.1, it shall forthwith send a telegram to the administration concerned requesting immediate acknowledgement.

25/1.14 Where the Bureau receives an acknowledgement following its action under No. **25**/1.13, or where the Bureau receives a request under No. **25**/1.11.2, it shall forthwith send a telegram to the administration concerned requesting an early decision in the matter.

25/1.15 Where the Bureau receives a request under No. **25**/1.11.4, it shall endeavour to obtain agreement to which reference is made in No. **25**/1.4. Where the Bureau receives from an administration no acknowledgement to the request it made under the terms of No. **25**/1.4 for agreement within the period specified in No. **25**/1.6, it shall act, in so far as this administration is concerned, in accordance with No. **25**/1.13.

25/1.16 Where an administration fails to reply within fifteen days of the Bureau's telegram requesting an acknowledgement sent under No. **25**/1.13, or fails to give a decision in the matter within thirty days of dispatch of the Bureau's telegram of request under No. **25**/1.14, it shall be deemed that the administration with which agreement was sought has undertaken, once the projected allotment is included in the Plan:

25/1.16.1 that no complaint will be made in respect of any harmful interference which may be caused to the services rendered by its coast radiotelephone stations by the use of assignments in accordance with the allotment for which agreement was requested; and

25/1.16.2 that its existing or projected coast radiotelephone stations will not cause harmful interference to the use of assignments in conformity with the allotment for which agreement was requested.

25/1.17 The Bureau shall examine the proposed allotment with respect to the probability of harmful interference which it may receive from an allotment in the Plan of the administration which failed to reply or which indicated disagreement without supplying the reasons; if the finding is favourable and where the application of the present procedure with respect to the other administrations concerned permits, the Bureau shall enter the proposed allotment in the Plan.

25/1.18 In the event of an unfavourable finding, the Bureau shall inform the administration concerned of the result of the examination; if the administration insists, and where the application of the present procedure with respect to the other administrations concerned permits, the Bureau shall enter the proposed allotment in the Plan.

25/1.19 Where the Bureau receives a request under No. **25**/1.11.3, it shall assess the sharing possibilities and it shall inform the administrations concerned of the results obtained.

25/1.20 In the case of continuing disagreement, the Bureau shall examine the proposed allotment from the point of view of harmful interference which may be caused to the services rendered by the stations of the administration having declared its disagreement. In the case where the Bureau's finding is favourable and where the application of the present procedure with respect to the other administrations concerned permits, it shall enter the proposed allotment in the Plan.

25/1.21 If, after the examination under No. **25**/1.20, the Bureau reaches an unfavourable finding, it shall then examine the proposed allotment from the point of view of harmful interference which may be caused to the services on all the various channels in the band. Should the Bureau reach an unfavourable finding in each case, it shall determine the channel which is the least affected and, if so requested by the administration seeking agreement, it shall enter the proposed allotment in this channel in the Plan.

25/1.22 5 An administration seeking agreement for a proposed allotment shall inform the Bureau of the results of its consultations with the administrations concerned. When the Bureau finds that the procedure prescribed in this Section has been applied with respect to each administration concerned, the Bureau shall publish its finding in a Special Section of the BR IFIC and, as the case may be, bring the Plan up to date.

25/1.23 6 Notwithstanding the above provisions and if the circumstances justify, an administration may, in exceptional circumstances, notify to the Bureau for provisional entry in the Master International Frequency Register an assignment which is not covered by an allotment in the Plan. That administration shall, however, begin forthwith the procedure prescribed in this Section.

25/1.24 7 When, within twelve months from the date of the inclusion of the allotment in the Plan, the Bureau does not receive a notice of a first frequency assignment corresponding to this allotment, or where the first notified frequency assignment has not been brought into use within the time-limits prescribed in these Regulations, before proceeding with the deletion of the allotment from the Plan, it shall consult with the administration concerned on the appropriateness of such a deletion and of publishing this information in connection with bringing the Plan up to date. However, in the case where the Bureau, in the light of a request from the administration concerned, finds that exceptional circumstances warrant an extension of this period, the extension shall in no case exceed six months, except in the case of an administration which has no coast station in service in which case the period may be extended to eighteen months.

25/1.25 8 Any administration in whose name an allotment is shown in the Plan, and which has a need to replace this allotment by another allotment in the same frequency band with a view to improving its service, shall apply the procedure described in this Section. When that administration arrives at a positive result in applying this procedure, the Bureau, at its request, shall replace the existing allotment in the Plan by the proposed allotment.

25/1.26 9 The Bureau shall maintain an up-to-date master copy of the Plan resulting from the application of this procedure. It shall prepare in a suitable form, for publication by the Secretary-General, the whole or part of the revised version of the Plan as and when the circumstances justify and in any case once annually.

25/2 Section II – Allotment Plan for coast radiotelephone stations operating in the exclusive maritime mobile bands between 4 000 kHz and 27 500 kHz[1]

25/2.1 The frequencies in Column 1 are assigned frequencies (see No. 1.148) as listed in Section I of Part B of Appendix **17**. Each frequency is followed, in parentheses, by the carrier frequency and the channel number (see Section I of Part B of Appendix **17**).

25/2.2 The coast radiotelephone stations operating in the bands allocated exclusively to the maritime mobile service between 4 000 kHz and 27 500 kHz must use the minimum power required to cover their service area. They may in no case use a peak envelope power above 10 kW per channel (see No. 52.219).

25/2.3 The Plan contained in this Appendix will be updated in accordance with the procedure defined in Section I of this Appendix.

25/2.4 (WRC-03)

Column 1	Column 2	Column 3
Assigned frequency (carrier frequency) (channel number)	Allotment area[2]	Observations[3]

[1] The Plan includes additions, modifications and deletions of allotments in the channels of the Frequency Allotment Plan adopted by the WMARC-74, resulting from the application of the relevant plan updating procedures up to and including 10 May 2016, as well as those amendments, which resulted from geopolitical changes that occurred up to and including that date.

[2] The meaning of the symbols is given in Tables “Areas” and “Standard Defined Areas” of the Preface to the BR IFIC.

[3] This allotment has been entered in the Plan as a result of the application of the procedure of Section I of this Appendix.

1	2	3
4 358.4 **(4 357)** (401)	AFS AUS CHL CKH CUB D1 DNK E GEO GRC HRV INS J KOR LVA MNE NIU PNR PRG RUS EO RUS NW S SMO SOM TKM TUR UKR URG USA CL USA E USA SO USA W YEM	ADD ADD
4 361.4 **(4 360)** (402)	ALB ALS ARG AZE BEN CHN G GUM HWA I IRN J KAZ MDG PNG PNR POL PTR RUS AS RUS NW THA TKM TUN USA CL USA E USA SO USA W	 ADD

1	2	3
4 364.4 **(4 363)** (403)	AFS ARG CAN CL CAN E CAN NO CAN W DNK E GRC HWA IND E IRQ MAC MCO NOR PNR PTR RUS EO S UKR USA CL USA E USA SO USA W	 ADD ADD
4 367.4 **(4 366)** (404)	ALS AUS B CHL SO CHN COG F IRN ISR J MCO NCL OMA PAQ POL SEN THA USA CL USA E USA W	 ADD
4 370.4 **(4 369)** (405)	AFS ALS AUS E AZE B CHL CHN CME CNR D2 F GMB GRC HOL >> >>	

1	2	3
(405)	<< << HWA IRN LTU LVA ROU RUS AS RUS EO RUS SW SNG URG USA CL USA E USA SO USA W	 ADD
4 373.4 **(4 372)** (406)	ALB ALS ARG ARS CHN CLM COG CYP E FIN FJI G GUM HWA ISL MDG PNR POL PTR TUN USA CL USA E USA SO USA W	
4 376.4 **(4 375)** (407)	AFS ALS ARG AUS BRB CAN CL CME D2 E GUM HOL HWA I IND E IRN J NOR PTR RUS AN >> >>	 ADD ADD

1	2	3
(407)	<< <<	
	RUS NW	
	SNG	
	TUR	
	USA E	
	USA W	
4 379.4	ALS	
(4 378)	ARG	
	B	ADD
(408)	BEL	
	BES	
	CAN E	
	CAN W	
	CUW	
	CHN	
	GUM	
	HRV	
	HWA	
	I	
	INS	
	IRN	
	J	
	MDA	ADD
	MLD	ADD
	MOZ	
	NZL	
	POL	
	SMA	ADD
	SUI	
	SXM	
	USA E	
	USA W	
4 382.4	ARS	
(4 381)	B	
	CHN	
(409)	CUB	
	DNK	
	GHA	ADD
	I	
	IND W	
	NOR	
	PNG	
	QAT	ADD
	S	
	THA	
	TUR	
	USA CL	
	USA E	
	USA SO	
	USA W	
4 385.4	ALG	
(4 384)	ARG SO	
	CAN W	
(410)	CHN	
	CNR	
	D2	
	G	
	GRC	
	GUM	
	>> >>	

1	2	3
(410)	<< <<	
	HNG	
	HOL	
	IRN	
	ISR	
	MLT	
	MTN	
	NZL	
	ROU	
	SEY	
	USA E	
4 388.4	AMS	ADD
(4 387)	ARG NO	
	BEL	
(411)	E	
	EQA	ADD
	FLK	
	HKG	
	I	ADD
	INS	
	IRN	
	J	
	KIR	ADD
	RUS NW	
	TUR	
	UKR	
	USA CL	
	USA E	
	USA W	
4 391.4	AUS	
(4 390)	D1	
	EST	
(412)	GEO	
	I	
	IND W	
	IRQ	
	J	
	LTU	
	LVA	
	RUS EO	
	RUS NW	
	RUS SW	
	RUS W	
	UKR	
	USA E	
	USA SO	
	USA W	
	YEM	
4 394.4	AGL	
(4 393)	ALG	
	ALS	
(413)	ARG	
	AZR	
	BHR	
	CAN E	
	CAN W	
	CPV	
	D1	
	>> >>	

1	2	3
(413)	<< <<	
	FIN	
	GNB	
	GRC	
	GUM	
	HWA	
	J	
	MCO	
	MDR	
	PNR	
	POR	
	PTR	
	RUS EO	
	TLS	
	UKR	
	USA CL	
	USA E	
	USA SO	
	USA W	
4 397.4	ALS	
(4 396)	CYP	
	D1	
(414)	E	
	FIN	
	INS	
	ISL	
	J	
	KEN	
	PTR	
	RUS EO	
	RUS SW	
	RUS W	
	SHN	
	USA E	
	USA SO	
4 400.4	ALS	
(4 399)	ARG	
	AUS	
(415)	CHN	
	DNK	
	EST	
	F	
	GRC	
	GUM	
	HWA	
	IRN	
	LTU	
	LVA	
	MDG	
	MLA	
	PNR	
	PTR	
	ROU	
	RUS NW	
	RUS SW	
	RUS W	
	USA E	
	USA SO	
	USA W	

1	2	3
4 403.4 **(4 402)** (416)	ALS ARG CL B EST F G GRC HNG INS IRN ISL J LTU LVA MAU OCE RUS SW USA CL USA E USA W	
4 406.4 **(4 405)** (417)	ARG AUS BEL CZE FIN G HKG HRV IND W J MLA MNE MRC PNG RUS EO SVK TUR TZA USA CL USA E USA SO USA W YEM	 ADD
4 409.4 **(4 408)** (418)	ARG AZE B BUL CAN E CAN W CUB DJI DNK E EGY HWA I INS ISR >> >>	 ADD ADD

1	2	3
(418)	<< << J KAZ MTN ROU RUS AS S TKM USA CL	
4 412.4 **(4 411)** (419)	AUS B CHL CHN CZE D2 F GUM HOL HRV HWA ISL J KOR LBY PTR RUS NW SVN TZA USA SO USA W	 ADD
4 415.4 **(4 414)** (420)	ALS AZE BUL CME DNK GUM HWA I IND E IRN J JOR KAZ MLA MRC PNR PTR RUS AN RUS AS S TKM TUR USA E USA W	
4 421.4 **(4 420)** (422)	ALS BEL CAN W CHN >> >>	

1	2	3
(422)	<< << CNR CUB EST FIN G GRC HNG INS IRQ J LBY LTU LVA MRC RUS NW RUS SW RUS W SUI USA E USA W	 ADD
4 424.4 **(4 423)** (423)	ALS B CHN D1 I INS ISR J MLT PNG PNR POL QAT USA CL USA E USA SO USA W	 ADD ADD ADD
4 427.4 **(4 426)** (424)	ALG ALS ARG AUS E AUS W CHN DNK GRC GUM HWA MRC PNR PTR S SUI THA USA CL USA E USA SO USA W	 ADD ADD

1	2	3
4 430.4	ALS	
(4 429)	B	ADD
	BEL	
(425)	CHL	
	DNK	
	E	
	GRC	
	GUM	
	HNG	
	HOL	
	HWA	
	J	
	JOR	ADD
	LBY	
	MLA	
	NZL	
	PNR	
	PTR	
	USA CL	
	USA E	
	USA SO	
	USA W	
4 433.4	AGL	
(4 432)	ALG	
	ALS	
(426)	ARG	
	AZR	
	BUL	
	CHN	
	CPV	
	CYP	
	DNK	
	G	
	GNB	
	GUM	
	HWA	
	J	
	MDR	
	MOZ	
	NOR	
	PNR	
	POR	
	PTR	
	THA	
	TLS	
	USA E	
	USA SO	
	USA W	
4 436.4	ALS	
(4 435)	AUS	
	BUL	
(427)	CHL	
	CHN	
	DGA	
	E	
	G	
	HWA	
	I	
	J	
	>> >>	

1	2	3
(427)	<< <<	
	MDG	
	MNE	
	PAQ	
	POR	
	RUS AN	
	RUS EO	
	RUS NW	
	UAE	
	USA CL	
	USA E	
	USA SO	
	USA W	
	VIR	
	VTN	
4 352.4	ARG CL	
(4 351)	ARG SO	
	AZE	
(428)	BRU	ADD
	CHN	
	GRC	
	I	
	J	
	OMA	
	RUS AN	
	RUS AS	
	RUS EO	
	RUS NW	
	RUS SW	
	RUS W	
	TKM	
	UKR	
	USA SO	
4 355.4	ALS	
(4 354)	ARG SO	
	AUS	
(429)	AZE	
	B	
	BLR	
	CLM	
	DGA	
	E	
	G	
	GRC	
	GUM	
	HKG	
	HWA	
	I	
	J	
	KAZ	
	MDG	
	MDW	
	PTR	
	RUS AS	
	RUS EO	
	RUS NW	
	RUS SW	
	RUS W	
	TKM	
	>> >>	

1	2	3
(429)	<< <<	
	UKR	
	USA E	
	USA SO	
	USA W	
6 502.4	ALG	
(6 501)	ALS	
	ARG CL	
(601)	ARG SO	
	ARS	
	AZE	
	CAN NO	ADD
	CAN W	
	CHL CL	
	CHL NO	
	CHN	
	COG	
	CZE	
	D1	
	EST	
	GEO	
	GRC	
	GUM	
	HNG	
	HRV	
	HWA	
	I	ADD
	INS	
	IRN	
	IRQ	
	ISL	
	J	
	KAZ	
	LBY	
	LTU	
	LVA	
	MLA	ADD
	MLD	ADD
	MNE	
	NCL	
	NZL	
	PTR	
	ROU	
	RUS AS	
	RUS SW	
	RUS W	
	SVK	
	TKM	
	UKR	
	USA CL	
	USA E	
	USA SO	
	USA W	
6 505.4	AFS	
(6 504)	ALS	
	AUS E	ADD
(602)	AZE	
	B	ADD
	BEL	
	BUL	
	>> >>	

1	2	3
(602)	<< <<	
	CAN E	
	CAN W	
	EQA	ADD
	EST	
	FJI	ADD
	GEO	
	GHA	ADD
	GUM	
	HOL	
	HRV	
	HWA	
	I	
	INS	
	IRN	
	KAZ	
	KOR	
	LTU	
	LVA	
	MCO	
	MDG	
	POL	
	POR	
	PTR	
	RUS AN	
	RUS AS	
	RUS EO	
	RUS NW	
	RUS SW	
	RUS W	
	SNG	
	TKM	
	TUN	
	TUR	
	USA CL	
	USA E	
	USA SO	
	USA W	
6 508.4	ALB	
(6 507)	ALG	
	ALS	
(603)	ARG	
	ARS	
	AUS	ADD
	CAN NO	
	CAN W	
	CYP	
	DNK	
	E	
	GRC	
	GUM	
	HNG	
	HWA	
	IND E	
	INS	
	IRN	
	IRQ	
	ISL	
	ISR	
	>> >>	

1	2	3
(603)	<< <<	
	J	
	LBY	
	MLT	ADD
	MTN	
	PTR	
	ROU	
	RUS EO	
	RUS NW	
	S	
	SMO	
	UKR	
	USA CL	
	USA E	
	USA SO	
	USA W	
	VTN	ADD
6 511.4	ALS	
(6 510)	AUS	
	B	ADD
(604)	BES	ADD
	BUL	
	CAN W	
	CHL	
	CHN	
	CME	
	CUW	ADD
	E	
	GUM	
	HKG	
	HRV	
	HWA	
	I	
	INS	
	IRN	
	ISR	
	MDG	
	MTN	
	PNG	
	POL	
	PTR	
	RUS EO	ADD
	RUS NW	
	SXM	ADD
	TUN	
	TUR	
	TUV	ADD
	USA CL	
	USA E	
	USA SO	
	USA W	
	VTN	ADD
6 514.4	ALG	
(6 513)	ALS	
	B	ADD
(605)	BUL	
	CAN E	
	CAN W	
	CNR	
	COG	
	>> >>	

1	2	3
(605)	<< <<	
	DNK	
	EGY	
	F	ADD
	GUM	
	HNG	
	HOL	
	HRV	
	HWA	
	IND W	
	INS	
	IRN	
	IRQ	
	J	
	KOR	
	LBY	
	MDG	
	NZL	ADD
	PTR	
	RUS EO	
	S	
	SVN	
	UKR	
	URG	
	USA CL	
	USA E	
	USA SO	
	USA W	
6 520.4	ARG	
(6 519)	AUS	
	CHN	
(607)	CLM	
	CUB	
	DGA	
	F	
	GRC	
	HKG	
	J	
	MDA	ADD
	MDG	
	OMA	
	RUS AN	
	RUS EO	
	RUS NW	
	UAE	
	USA SO	
	VTN	
6 523.4	ALS	
(6 522)	ARG CL	
	ARG SO	
(608)	AUS	
	B	
	BLR	
	BRU	ADD
	CHN	
	DGA	
	E	
	EST	
	G	
	>> >>	

1	2	3
(608)	<< << GRC GUM HWA J KOR LVA MDW MOZ PTR RUS AS RUS AN RUS EO RUS NW RUS SW RUS W UKR USA E USA SO USA W	
8 720.4 **(8 719)** (801)	AFS ALS BHR CHL DNK E GUM HWA ISR J MLA PNR PTR ROU RUS AN S USA E USA SO USA W	
8 723.4 **(8 722)** (802)	AGL ALG ALS ARG AUS AZR CHN CLN CPV D2 FIN G GNB GRC HOL HWA IND E IRQ MDA >> >>	 ADD

1	2	3
(802)	<< << MDR MOZ POR USA E USA SO	
8 726.4 **(8 725)** (803)	AFS BEL BES CAN E CUB CUW E KOR LTU LVA PNG RUS EO RUS NW RUS SW S SEN SUI SXM TUR USA CL	 ADD
8 729.4 **(8 728)** (804)	ARG E FIN GRC IRQ J JOR MCO POL QAT RUS AS RUS EO SNG USA E USA SO USA W	 ADD ADD
8 732.4 **(8 731)** (805)	AFS ALB BEL E EQA FIN HOL IRN ISL ISR J LVA NCL PNG RUS EO RUS SW >> >>	 ADD

1	2	3
(805)	<< << USA E USA SO USA W	
8 735.4 **(8 734)** (806)	ALS ARG AUS BEL BHR E GRC GUM HOL HWA I J PNR POL PTR SMA UKR USA E USA W	 ADD ADD
8 738.4 **(8 737)** (807)	AZE CAN W CHL COG CUB CYP CZE I ISL J MDG MTN NZL RUS AN RUS AS RUS SW RUS W SHN TKM USA CL	 ADD
8 741.4 **(8 740)** (808)	AFS ALS ARG ARS DNK E GRC GUM HWA I J ROU S USA E USA W	 ADD

1	2	3
8 744.4 **(8 743)** (809)	ALG AUS W CHL CNR CUB CZE D2 FIN GRC ISL J MCO NOR SVK THA USA E USA W	
8 747.4 **(8 746)** (810)	ARG BUL CAN E CHN E FJI HRV INS IRN J MOZ NOR POL TUR USA E USA SO USA W	
8 750.4 **(8 749)** (811)	ARG ARS AUS BEN DNK F HKG HNG HRV J MNE NOR S TUR USA E USA SO USA W	ADD
8 753.4 **(8 752)** (812)	ALS ARG SO BEL CAN NO CHN E GEO >> >>	

1	2	3
(812)	<< << HWA I INS ISR J LTU LVA NZL POL RUS NW USA CL USA E USA SO USA W	ADD
8 756.4 **(8 755)** (813)	AGL ALG ALS AUS AZR BEL CHL NO CHN CPV DNK GNB GRC GUM HNG HWA IND W MDR MOZ NOR PNR POR PTR USA CL USA E USA SO USA W VTN	ADD
8 759.4 **(8 758)** (814)	ALS ARG AZE CAN W CUB EST GEO GRC HWA I INS J KIR LTU LVA RUS AN >> >>	ADD

1	2	3
(814)	<< << RUS AS RUS EO RUS SW RUS W USA CL USA E USA SO USA W	
8 762.4 **(8 761)** (815)	AUS W BEL CHL CHN D1 EST GRC IRQ J JOR MRC RUS NW RUS SW SNG USA E USA SO USA W	ADD
8 765.4 **(8 764)** (816)	ALS ARG BRB CHN COG E G GRC GUM HWA INS LTU LVA PTR RUS NW RUS SW RUS W TUN USA E USA SO USA W	
8 768.4 **(8 767)** (817)	ALS AUS CAN E CHL D1 EGY F GUM HWA IRN PNR >> >>	ADD

1	2	3
(817)	<< <<	
	PTR	
	ROU	
	RUS EO	
	RUS SW	
	THA	
	USA CL	
	USA E	
	USA SO	
	USA W	
	YEM	
8 771.4	ALS	
(8 770)	ARG	
	BUL	
(818)	CHN	
	CME	
	CYP	
	DNK	
	GUM	
	HWA	
	LBY	
	MLA	
	PNR	
	PTR	
	S	
	SEY	
	UKR	
	USA E	
	USA W	
8 774.4	ALS	
(8 773)	AZE	
	B	
(819)	CAN W	
	EST	
	G	
	GEO	
	GRC	
	GUM	
	HWA	
	I	
	INS	
	J	
	KAZ	
	LVA	
	PAQ	
	PNR	ADD
	RUS AN	
	RUS AS	
	RUS NW	
	RUS SW	
	THA	
	TKM	
	USA CL	
	USA E	
	USA SO	
	USA W	
	YEM	

1	2	3
8 777.4	ALS	
(8 776)	ARG	
	CYP	
(820)	D1	
	D2	ADD
	GRC	
	GUM	
	HWA	
	I	
	IND E	
	IRN	
	J	
	PNR	
	PTR	
	RUS NW	
	SMO	
	TZA	ADD
	USA E	
	USA W	
8 783.4	AUS	ADD
(8 782)	B	
	CHN	
(822)	G	
	HNG	
	HRV	
	IRN	
	KEN	
	MRC	
	SUI	
	UKR	
	USA E	
	USA SO	
	USA W	
8 786.4	ARG	
(8 785)	CAN E	
	DNK	
(823)	GRC	
	I	
	IND W	
	IRQ	
	J	
	ROU	
	RUS EO	
	RUS NW	
	S	
	TLS	
	TZA	ADD
	USA W	ADD
8 789.4	B	
(8 788)	CHN	
	D1	
(824)	GRC	
	IRN	
	MRC	
	OMA	
	POL	
	RUS NW	
	SNG	
	SUI	
	>> >>	

1	2	3
(824)	<< <<	
	TUN	
	USA E	
	USA SO	
	USA W	
8 792.4	ALG	
(8 791)	ALS	
	AMS	ADD
(825)	ARG	
	BRB	
	CAN CL	
	CKH	
	DNK	
	F	
	GHA	ADD
	HNG	
	IND E	
	IRN	
	KAZ	
	KGZ	
	RUS EO	
	S	ADD
	TKM	
	UKR	
	USA E	
	USA SO	
	USA W	
8 795.4	CAN W	
(8 794)	CAN NO	ADD
	CHN	
	CLM	
(826)	CME	
	D2	
	G	
	GUM	
	HOL	
	I	
	INS	
	J	
	QAT	ADD
	UKR	
	USA CL	
	USA E	
8 798.4	ALS	
(8 797)	ARG	
	DJI	
(827)	DNK	
	E	
	GUM	
	HRV	
	HWA	
	IRN	
	ISR	
	KOR	
	MAC	
	MNE	
	NIU	
	>> >>	

1	2	3
(827)	<< <<	
	PNR	
	PTR	
	S	
	SVN	
	USA E	
	USA W	
8 801.4	ALB	
(8 800)	ALS	
	B	
(828)	D1	
	F	
	GUM	
	HNG	
	HWA	
	INS	
	J	
	MAU	
	MRC	
	MTN	
	NOR	
	PNR	
	PTR	
	UKR	
	USA E	
	USA W	
8 804.4	AUS	
(8 803)	BEL	
	BRM	ADD
(829)	CHN	
	CYP	
	DNK	
	FIN	
	GMB	
	IRN	
	LBY	
	MLD	ADD
	NOR	
	OCE	
	PRG	
	S	
	UKR	
	USA E	
	USA SO	
	USA W	
8 807.4	AZE	
(8 806)	B	
	BUL	
(830)	CHN	
	F	
	HRV	
	IND W	
	INS	
	IRN	
	KAZ	
	MCO	ADD
	PNG	
	>> >>	

1	2	3
(830)	<< <<	
	POL	
	PTR	
	RUS AS	
	RUS EO	
	USA SO	
	YEM	
	VTN	ADD
8 810.4	CHN	
(8 809)	COG	
	D2	
(831)	FLK	
	G	
	I	
	IRN	
	ISL	
	J	
	MDG	
	MLA	
	MRC	
	PTR	
	SUI	
	TUR	
	USA SO	
	USA W	
8 813.4	ALS	
(8 812)	B	
	BUL	
(832)	CHN	
	CLM	
	GUM	
	HKG	
	HWA	
	KOR	
	MDG	
	MLT	
	PTR	
	QAT	
	RUS AN	
	RUS EO	
	TUR	
	UAE	
	URG	
	USA E	
	USA SO	
	USA W	
	VTN	
8 708.4	AUS	
(8 707)	BHR	ADD
	CHL	
(834)	CHN	
	CLM	
	DGA	
	GRC	
	GUM	
	HWA	
	J	
	KOR	
	MDW	
	>> >>	

1	2	3
(834)	<< <<	
	POR	
	PTR	
	RUS AS	
	RUS NW	
	RUS SW	
	RUS W	
	UKR	
	USA E	
	USA SO	
8 711.4	ALS	
(8 710)	ARG CL	
	ARG SO	
(835)	AZE	
	BRU	ADD
	DGA	
	E	
	F	
	GRC	
	GUM	
	HWA	
	J	
	KOR	
	MDW	
	MNE	
	OMA	
	PTR	
	RUS AN	
	RUS AS	
	RUS EO	
	RUS NW	
	SUI	
	THA	
	TKM	
	TUR	
	UKR	
	USA E	
	USA SO	
	USA W	
8 714.4	AUS	
(8 713)	AZE	
	CHL	
(836)	CHN	
	E	
	I	
	RUS AN	
	RUS AS	
	RUS EO	
	RUS NW	
	TKM	
	UKR	
	URG	
	USA SO	
8 717.4	ARG CL	
(8 716)	ARG SO	
	AZE	
(837)	BLR	
	CHN	
	CUB	
	>> >>	

1	2	3
(837)	<< << G GRC J KAZ MDG RUS AN RUS AS RUS EO RUS NW RUS SW RUS W TKM UKR USA SO	
13 078.4 **(13 077)** (1201)	ARG CAN NO CHN CYP E G INS QAT RUS EO RUS NW RUS SW UKR USA E USA SO USA W	ADD
13 081.4 **(13 080)** (1202)	ARS CHL D2 FJI G GRC HNG J MRC RUS AN SUI TUN USA CL USA E USA SO USA W	
13 084.4 **(13 083)** (1203)	AGL ALS AUS E AZR CHN CLM CPV DNK GNB GRC HWA IRQ LBY >> >>	

1	2	3
(1203)	<< << MDR MOZ POR RUS EO S TLS USA CL USA E USA SO USA W	
13 087.4 **(13 086)** (1204)	ALS D2 F GRC GUM HWA ISR J LVA MAC NOR PNR PTR RUS SW RUS W USA E USA SO USA W	
13 090.4 **(13 089)** (1205)	ALS ARG D1 E GEO GUM HWA I J LTU LVA MOZ NCL NOR PTR TLS UKR USA E USA SO USA W YEM	
13 093.4 **(13 092)** (1206)	ALB AUS W CHN D2 E FIN G >> >>	

1	2	3
(1206)	<< << I IRN ISL J MDG MRC TUR USA E USA SO USA W	
13 096.4 **(13 095)** (1207)	AGL ALG AZR BEL BES CAN W CHN CPV CUW EQA GRC HOL IRN ISR J MDR MNE MOZ POR RUS NW SXM TLS	ADD
13 099.4 **(13 098)** (1208)	ARG CHN CYP D1 EST GRC HNG I ISL J LTU LVA RUS SW RUS W USA E USA SO	ADD
13 102.4 **(13 101)** (1209)	AFS ALS B BHR CAN W E EST >> >>	

1	2	3
(1209)	<< <<	
	FIN	
	I	
	INS	
	J	
	NZL	
	POL	
	RUS NW	
	RUS SW	
	TUR	
	USA E	
	USA SO	
	USA W	
13 105.4	CHL	
(13 104)	DJI	
	DNK	
(1210)	E	
	GRC	
	GUM	
	IND W	
	INS	
	ROU	
	RUS AN	
	RUS EO	
	S	
	SUI	ADD
	URG	
	USA E	
	USA SO	
	USA W	
13 108.4	ALS	
(13 107)	B	
	CHN	
(1211)	CUB	
	DNK	
	E	
	I	
	IRQ	
	J	
	KAZ	
	MLA	
	NOR	
	PAQ	
	RUS AN	
	RUS AS	
	S	
	TKM	
	USA CL	
	USA E	
	USA SO	
	USA W	
13 111.4	ALS	
(13 110)	D1	
	GRC	
(1212)	HWA	
	INS	
	J	
	MAU	
	MDA	ADD
	>> >>	

1	2	3
(1212)	<< <<	
	PTR	
	RUS AS	ADD
	RUS EO	
	RUS SW	
	RUS W	
	USA E	
	USA SO	
13 114.4	ARG	
(13 113)	BEL	
	BRB	
(1213)	CAN E	
	CHN	
	CNR	
	FIN	
	GRC	
	HOL	
	I	
	IND E	
	IRN	
	IRQ	
	ISR	
	KOR	
	NOR	
	RUS AN	
	SMO	
	USA W	ADD
13 117.4	ALS	
(13 116)	AUS	
	B	
(1214)	CAN W	
	CUB	
	DNK	
	GRC	
	GUM	
	HNG	
	IRN	
	PTR	
	RUS EO	
	S	
	USA CL	
	USA E	
	USA SO	
	USA W	
13 120.4	ALG	
(13 119)	BEL	
	BHR	ADD
(1215)	CME	
	DNK	
	E	
	GRC	
	HOL	
	IND W	
	ISL	
	ISR	
	J	
	PNR	
	PTR	
	ROU	
	>> >>	

1	2	3
(1215)	<< <<	
	S	
	SEY	
	USA SO	
	USA W	
13 123.4	ALB	
(13 122)	ALS	
	ARG	
(1216)	CHN	
	EGY	
	FIN	
	GUM	
	HWA	
	IRN	
	MRC	
	PNR	
	POL	
	PTR	
	SNG	
	TUR	
	USA E	
	USA SO	
	USA W	
13 126.4	ALG	
(13 125)	AZE	
	BUL	
(1217)	CUB	
	DNK	
	GRC	
	GUM	
	IND E	
	IRQ	
	J	
	KAZ	
	NOR	
	RUS AS	
	RUS EO	
	S	
	SHN	
	USA CL	
	USA E	
	USA SO	
	USA W	
13 129.4	ALS	
(13 128)	BEL	
	CHL	
(1218)	CME	
	CNR	
	D1	
	GUM	
	HWA	
	I	
	IRN	
	J	
	NIU	
	NOR	
	PNR	
	PTR	
	RUS SW	
	>> >>	

1	2	3
(1218)	<< << TUR USA E USA SO USA W	
13 132.4 **(13 131)** (1219)	ALS B BEL BUL DNK HOL J LTU LVA MRC RUS EO RUS NW RUS SW RUS W S SNG UKR USA E USA SO USA W	
13 135.4 **(13 134)** (1220)	ALS ARG D2 FJI GRC GUM HWA IRN ISL J JOR PNR POL PTR TUN USA E USA SO USA W	 ADD ADD
13 141.4 **(13 140)** (1222)	ALS ARG BEN CAN E CKH F HWA IND W IRN J NOR ROU RUS EO TUR USA W	ADD ADD
13 144.4 **(13 143)** (1223)	ARS B CZE DNK GRC GUM J MRC S SVK UKR USA E USA SO USA W	
13 147.4 **(13 146)** (1224)	AFS ALS CHL D1 FIN G GHA GUM HRV HWA J MCO NZL PNR PTR USA E USA W	 ADD
13 150.4 **(13 149)** (1225)	CHN E GRC IRN JOR MDG NOR PNG ROU RUS NW USA E USA SO	 ADD
13 153.4 **(13 152)** (1226)	AUS CHL CZE DNK F IRN J MCO RUS NW S TUR USA E USA SO USA W	 ADD ADD
13 156.4 **(13 155)** (1227)	ALS AUS E FIN GUM HRV HWA IND E PNR POL PTR RUS EO SUI TZA USA E USA W	 ADD
13 159.4 **(13 158)** (1228)	B CHL CHN CUB EST G GEO HNG I LVA MLD NOR RUS SW RUS W UKR USA CL USA E USA W VTN	 ADD ADD ADD
13 162.4 **(13 161)** (1229)	ARG AUS AZE BUL CAN E F HRV J KAZ KGZ KOR LTU LVA POL QAT RUS AN RUS AS RUS NW RUS SW RUS W USA W	 ADD

1	2	3
13 165.4 **(13 164)** (1230)	ARG CYP FIN G HWA I J MTN SUI UKR USA E USA SO USA W	
13 168.4 **(13 167)** (1231)	ALS AUS F GRC GUM HKG HWA IRN LBY NOR PNR POL PRG PTR USA E USA W VTN	 ADD
13 171.4 **(13 170)** (1232)	ALG ALS ARG AZE D2 G GRC GUM HWA J KAZ MTN PNR SMA TKM USA E USA W	 ADD ADD
13 174.4 **(13 173)** (1233)	AZE B CHN CLM E G GEO GRC J LVA MLT RUS AN >> >>	

1	2	3
(1233)	<< << RUS AS RUS EO RUS NW RUS SW RUS W TKM TUR UKR USA SO VTN	
13 177.4 **(13 176)** (1234)	ALS AUS CHN CLM E HWA KOR MDG OMA RUS EO USA SO USA W	
13 180.4 **(13 179)** (1235)	ARG CHN F G HOL J KOR LVA RUS AN RUS EO RUS NW RUS SW THA TUR UKR USA SO UZB	
13 183.4 **(13 182)** (1236)	BRM CHN I RUS EO UAE UKR USA SO	ADD
13 186.4 **(13 185)** (1237)	CHN F ISR J LVA PTR RUS AS RUS SW SUI TUR UAE UKR >> >>	

1	2	3
(1237)	<< << USA CL USA E USA SO VIR	
13 189.4 **(13 188)** (1238)	ALS B BLR CHL CHN EST GUM HWA KOR MCO PAQ PTR RUS AN RUS AS RUS EO RUS NW RUS SW TKM TUR UKR USA E USA SO USA W	 ADD
13 192.4 **(13 191)** (1239)	ALS AZE B BRU BUL CAN E CHN E F GUM HWA J KAZ MDG MNE PTR QAT RUS AN RUS AS RUS EO RUS SW RUS W TKM TUR UKR USA E USA SO USA W	 ADD
13 195.4 **(13 194)** (1240)	ARG CL ARG SO AUS >> >>	

1	2	3
(1240)	<< << CHN DGA GRC GUM HKG HWA KGZ MDW POR PTR RUS AN RUS EO RUS NW RUS SW RUS W USA E USA SO USA W	
13 198.4 **(13 197)** (1241)	ALS CHN D2 DGA GUM HWA IND E IND W J MDW PTR UKR USA E USA W	
17 243.4 **(17 242)** (1601)	ALS ARG DNK HWA J LTU NOR RUS NW RUS SW RUS W S SEY TUN UKR USA E USA SO	
17 246.4 **(17 245)** (1602)	ARS AUS E CME G GRC MRC RUS AN RUS EO RUS SW >> >>	

1	2	3
(1602)	<< << USA E USA SO USA W	
17 249.4 **(17 248)** (1603)	ALS ARG NO CHN CYP DNK HNG I MLT NOR S USA E USA SO USA W	ADD
17 252.4 **(17 251)** (1604)	AUS BEN CAN E F GRC J NOR ROU	ADD
17 255.4 **(17 254)** (1605)	DNK F IND W IRN J OCE RUS SW S UKR USA E USA W	
17 258.4 **(17 257)** (1606)	B CUB FIN G I ISL J NZL PTR RUS SW TUR USA SO USA W	
17 261.4 **(17 260)** (1607)	ALS BES CAN E CUW GRC IND E IRN MCO NOR POL >> >>	

1	2	3
(1607)	<< << RUS EO RUS NW SXM USA E USA SO USA W	
17 264.4 **(17 263)** (1608)	AFS CAN W CHN CZE DNK EQA I MTN S SVK TUR	ADD
17 267.4 **(17 266)** (1609)	ARS BEL CKH E GRC IND E ISR J RUS NW USA E USA SO USA W	
17 270.4 **(17 269)** (1610)	AUS CHN D1 EGY INS IRN MTN NOR RUS NW TUN UKR URG USA E USA SO USA W	
17 273.4 **(17 272)** (1611)	B FIN G HRV J LBY MLA SUI TUR USA E USA SO USA W	

1	2	3
17 276.4 **(17 275)** (1612)	ALS AUS CUB GEO GUM HWA JOR MRC PTR RUS EO RUS NW RUS SW UKR USA E USA SO USA W	ADD
17 279.4 **(17 278)** (1613)	ALS B BEL E GRC GUM HWA IRN ISR NOR PNR PTR ROU RUS EO SNG USA E USA SO USA W	
17 282.4 **(17 281)** (1614)	CAN W CHN DNK FIN I MLD NIU RUS AN S	ADD
17 285.4 **(17 284)** (1615)	AGL AZR CPV FIN G GNB IRN ISL MDR MOZ POR RUS EO SUI TLS	

1	2	3
17 288.4 **(17 287)** (1616)	ALS D1 HWA I IRN J MRC RUS NW TUR USA E USA SO USA W	
17 291.4 **(17 290)** (1617)	B CNR DNK F GRC HNG IRN ISR RUS EO S	
17 294.4 **(17 293)** (1618)	ARG BHR DNK G HRV IND W J MRC S TUR	
17 297.4 **(17 296)** (1619)	ALS D2 F GRC GUM HWA MAU NOR PNR PTR RUS EO USA E USA W	
17 300.4 **(17 299)** (1620)	J LBY LTU LVA NOR RUS SW RUS W TUR UKR USA CL USA E	

1	2	3
17 306.4 **(17 305)** (1622)	ALS AUS DNK F GHA GRC HWA J PNR ROU S SUI	ADD ADD ADD ADD ADD
17 309.4 **(17 308)** (1623)	ALS CHN E FIN G GUM HOL HWA PNR PRG PTR UKR USA E USA SO USA W	
17 312.4 **(17 311)** (1624)	D1 E I J LTU LVA RUS SW RUS W SMO USA E USA SO USA W	
17 315.4 **(17 314)** (1625)	ALS BEL GRC GUM HWA IRN ISL J POL PTR USA E USA SO USA W	
17 318.4 **(17 317)** (1626)	CAN W CUB GRC HOL IRQ J >> >>	

1	2	3
(1626)	<< << QAT RUS AN RUS EO RUS NW USA E	 ADD
17 321.4 **(17 320)** (1627)	ALS BEL E EST GRC HNG HRV J LTU LVA NOR RUS SW RUS W	ADD
17 324.4 **(17 323)** (1628)	CUB EQA F GRC IRQ ISR MCO ROU RUS EO RUS NW	 ADD ADD
17 327.4 **(17 326)** (1629)	ALG AUS BRM CAN E D2 GRC IRN J NOR SEN	 ADD
17 330.4 **(17 329)** (1630)	ALS BEL E GEO GUM HWA IND W ISL J LTU LVA PNR PTR RUS SW USA E USA SO USA W	
17 333.4 **(17 332)** (1631)	ALG BUL CHL >> >>	

1	2	3
(1631)	<< << CHN GRC IRQ POL SUI USA E	
17 336.4 **(17 335)** (1632)	ALS ARG AZR CYP G HNG J MDG MDR POR USA E USA SO USA W	
17 339.4 **(17 338)** (1633)	AFS ALS AZE B CHN D2 F GRC GUM HWA KAZ KGZ PNR POL PTR RUS AS TKM USA E USA W	
17 342.4 **17 341** (1634)	CAN NO CHN D1 E GRC J KOR ROU	
17 345.4 **(17 344)** (1635)	AGL AUS AZR BUL CPV DNK GNB I J MAC MDR MOZ >> >>	 ADD

1	2	3
(1635)	<< << PNR POR S TLS	 ADD
17 348.4 **(17 347)** (1636)	ALG ALS FIN GRC GUM HOL HWA IND E J PNR PTR USA E USA W	
17 351.4 **(17 350)** (1637)	AZE CHN E G HKG KAZ KOR MDG NZL RUS AS	
17 354.4 **(17 353)** (1638)	ALS BUL D2 FIN GUM HWA MNE MRC POL SMA USA E USA W	 ADD ADD
17 357.4 **(17 356)** (1639)	ALB ALS CHN D1 E GUM HOL HWA PNR PTR USA E USA W	
17 360.4 **(17 359)** (1640)	BRB CHL D2 EST G GRC >> >>	

1	2	3
(1640)	<< <<	
	J	
	LVA	
	PNR	ADD
17 363.4	ALG	
(17 362)	DNK	
	IRQ	
(1641)	J	
	S	
	SNG	
	UKR	
	USA E	
	USA SO	
	USA W	
17 366.4	ALS	
(17 365)	AUS	
	CLM	
(1642)	F	
	HWA	
	J	
	PTR	
	RUS EO	
	UAE	
	USA CL	
	USA E	
	USA SO	
	USA W	
	VIR	
17 369.4	AZE	
(17 368)	CHN	
	CLM	
(1643)	F	
	KAZ	
	QAT	
	RUS AN	
	RUS EO	
	RUS NW	
	TKM	
	UKR	
	USA SO	
17 372.4	ALS	
(17 371)	B	
	HWA	
(1644)	I	
	MDA	ADD
	RUS EO	
	RUS NW	
	UAE	
	USA CL	
	USA E	
	USA SO	
	USA W	
(17 375.4)	ARG	
(17 374)	CHN	
	ISR	
(1645)	KGZ	
	KOR	
	LVA	
	OMA	
	>> >>	

1	2	3
(1645)	<< <<	
	RUS AN	
	RUS EO	
	RUS NW	
	RUS SW	
	RUS W	
	TUR	
	UKR	
	USA SO	
	UZB	
17 378.4	CHN	
(17 377)	I	
	RUS EO	
(1646)	RUS SW	
	RUS W	
	USA W	
	VTN	ADD
17 381.4	ALS	
(17 380)	CAN E	
	CHN	
(1647)	EST	
	HWA	
	KOR	
	LTU	
	RUS AS	
	RUS EO	
	RUS NW	
	TUR	
	UKR	
	USA CL	
	USA E	
	USA SO	
	USA W	
17 384.4	ALS	
(17 383)	BLR	
	CHN	
(1648)	HWA	
	KOR	
	PTR	
	RUS AN	
	RUS AS	
	RUS EO	
	RUS NW	
	RUS SW	
	UKR	
	USA CL	
	USA W	
	VIR	
17 387.4	ALS	
(17 386)	B	
	BUL	
(1649)	GUM	
	HWA	
	J	
	MDG	
	PTR	
	RUS AN	
	USA E	
	USA SO	
	USA W	

1	2	3
17 390.4	ALS	
(17 389)	ARG CL	
	ARG SO	
(1650)	AZE	
	CHN	
	E	
	GRC	
	HKG	
	HWA	
	J	
	PTR	
	RUS AN	
	RUS NW	
	RUS SW	
	UKR	
	USA E	
	USA SO	
	USA W	
17 393.4	ALS	
(17 392)	BLR	
	CHN	
(1651)	DGA	
	E	
	GUM	
	HWA	
	J	
	MDW	
	PTR	
	RUS AN	
	RUS EO	
	RUS SW	
	UKR	
	USA E	
	USA SO	
	USA W	
17 396.4	CHN	
(17 395)	GUM	
	HOL	
(1652)	J	
	MDG	
	MDW	
	MNE	
	PTR	
	RUS AN	
	RUS EO	
	RUS NW	
	RUS SW	
	TKM	
	UKR	
	USA E	
	USA SO	
17 399.4	B	
(17 398)	CHN	
	E	
(1653)	PTR	
	RUS AS	
	RUS EO	
	RUS NW	
	RUS SW	
	>> >>	

1	2	3
(1653)	<< << RUS W UKR USA E USA SO USA W VTN	
17 402.4 **(17 401)** (1654)	CHN G HWA J PTR RUS SW UKR USA E USA SO USA W	
17 405.4 **(17 404)** (1655)	ALS CHL CHN DGA E G GRC GUM HWA KGZ MDW PTR RUS AN RUS NW RUS SW TUR UKR USA E USA SO USA W	
17 408.4 **(17 407)** (1656)	AUS CHN GUM HWA LVA MDW PTR RUS AN RUS NW RUS SW RUS W SUI UKR USA E USA SO USA W	
19 756.4 **(19 755)** (1801)	ALS AUS CHN E G HWA >> >>	

1	2	3
(1801)	<< << J JOR PTR RUS AN RUS EO RUS NW TUR UAE USA CL USA E USA SO USA W VIR	
19 759.4 **(19 758)** (1802)	CHN G HOL ISL J MOZ PTR RUS NW RUS SW RUS W UKR USA CL USA E USA SO VIR	
19 762.4 **(19 761)** (1803)	ALS AZE B CHN G HWA J JOR KOR LTU POR PTR RUS EO RUS NW RUS SW TKM UAE UKR USA CL USA E USA W VIR	
19 765.4 **(19 764)** (1804)	ALS BRU CAN W CHN D2 HWA J RUS EO >> >>	ADD

1	2	3
(1804)	<< << S TUR USA SO USA W	ADD
19 768.4 **(19 767)** (1805)	ALS CHN HWA I J LVA RUS EO RUS SW RUS W TUR USA W	
19 774.4 **(19 773)** (1807)	ARG CL ARG SO CHN D2 GEO ISL J LVA RUS AN RUS EO RUS NW RUS SW TKM TUR USA SO	
19 777.4 **(19 776)** (1808)	ALS BLR CHN CUB HWA ISR MCO MDG PTR RUS AN RUS AS RUS EO RUS NW TUR UKR USA CL USA E USA SO USA W VIR	ADD
19 780.4 **(19 779)** (1809)	ALS B CHN E GRC GUM HWA POL >> >>	ADD

1	2	3
(1809)	<< << RUS NW RUS W SUI TUR UKR USA E USA SO USA W	
19 783.4 **(19 782)** (1810)	ALS ARG BUL CHN EST HKG HWA J LTU PTR RUS AN RUS AS RUS SW UKR USA W	
19 786.4 **(19 785)** (1811)	ALS B CAN E CHN DGA GRC GUM HWA J KOR MDG MDW PTR RUS EO RUS NW TUR UKR USA E USA SO USA W	
19 789.4 **(19 788)** (1812)	ALS ARG AZE CAN E CHN HWA J MNE PTR RUS EO RUS NW TUR UKR USA E USA SO USA W	

1	2	3
19 792.4 **(19 791)** (1813)	ALS CHN E F HWA IND E IND W J MDA PTR S TUR USA E USA SO USA W	 ADD ADD
19 795.4 **(19 794)** (1814)	ALS AUS AZE B CHN DGA E GUM HWA ISL MDW MNE PTR RUS EO RUS NW TUR USA E USA SO USA W	
19 798.4 **(19 797)** (1815)	ARG CL ARG SO AZE BLR CHN GUM J KAZ PTR RUS AN RUS AS RUS EO RUS NW RUS SW TKM UKR USA E USA SO USA W	
22 697.4 **(22 696)** (2201)	AUS CHN CME E GRC GUM >> >>	

1	2	3
(2201)	<< << HNG RUS NW USA E USA SO USA W	
22 700.4 **(22 699)** (2202)	ARG BRM CAN E HNG I IRN MTN NOR RUS EO UKR	 ADD
22 703.4 **(22 702)** (2203)	AUS E BUL DNK IRN J MRC PNR S	 ADD
22 706.4 **(22 705)** (2204)	AFS ARG CAN NO F FIN HRV ISR RUS EO RUS NW	
22 709.4 **(22 708)** (2205)	ALG AUS EST GRC HOL IRN LTU LVA RUS EO RUS NW RUS W USA E USA SO USA W	
22 712.4 **(22 711)** (2206)	AFS ALS BHR G GUM HRV HWA IND W J MRC POL PTR >> >>	 ADD

1	2	3
(2206)	<< << USA E USA SO USA W	
22 715.4 **(22 714)** (2207)	AZR CHN CPV D1 ISR LVA MDR POR RUS SW TLS TUN	
22 718.4 **(22 717)** (2208)	ARG NO BUL DNK I IND E J MRC NOR PNR S	 ADD ADD
22 721.4 **(22 720)** (2209)	ALS BEL CHN GRC GUM HWA KOR MRC PNR POL PTR RUS NW USA E USA W	
22 724.4 **(22 723)** (2210)	E FIN GRC HOL J UKR USA E	
22 727.4 **(22 726)** (2211)	CHN CUB DNK I J S UKR	
22 730.4 **(22 729)** (2212)	ALS AUS CYP G >> >>	

1	2	3
(2212)	<< << GUM HNG HWA MCO PNR PTR SNG USA E USA W	 ADD
22 733.4 **(22 732)** (2213)	BUL CAN E DNK E GEO IRQ LBY LTU NZL RUS EO RUS SW RUS W S TUR	
22 736.4 **(22 735)** (2214)	BEL CHN E FIN IRN RUS NW SUI TUR URG USA E USA SO USA W	
22 739.4 **(22 738)** (2215)	CHN F GHA GRC IRQ J NOR POL USA E USA SO USA W	 ADD
22 742.4 **(22 741)** (2216)	CAN W DNK GRC GUM I J MTN USA E USA SO	

1	2	3
22 745.4 **(22 744)** (2217)	ALS D1 E GRC GUM HKG HWA IRN ISR PNR PTR USA E USA W	
22 748.4 **(22 747)** (2218)	ALS CHN CYP DNK F GUM HWA PTR S UKR USA E USA SO USA W	
22 751.4 **(22 750)** (2219)	BEL CHN CUB GRC MCO POL SMO	
22 754.4 **(22 753)** (2220)	CAN W CHN CZE D2 G GRC SEN SUI SVK	 ADD
22 760.4 **(22 759)** (2222)	ARS AZR CPV D1 FIN GRC KOR MDR MLD POR TLS USA E USA SO USA W	 ADD

1	2	3
22 763.4 **(22 762)** (2223)	ALS AUS D1 HWA I J MLT PTR TUR USA E USA W	 ADD
22 766.4 **(22 765)** (2224)	ALS D2 E GRC GUM HWA IRQ MAU PNR PTR USA E USA W	
22 769.4 **(22 768)** (2225)	ALG BEL CHL GRC IND W ISL J	
22 772.4 **(22 771)** (2226)	ALB ALS CHN D2 EGY F HWA ISL JOR ROU USA W	 ADD ADD ADD ADD
22 775.4 **(22 774)** (2227)	ALG G GRC IND E J UKR USA E USA SO USA W	
22 778.4 **(22 777)** (2228)	AUS DNK GRC MRC QAT >> >>	 ADD

1	2	3
(2228)	<< << RUS EO S USA E USA W	
22 781.4 **(22 780)** (2229)	BEN BRU CAN E E G IND W J UKR	ADD ADD
22 784.4 **(22 783)** (2230)	ALS AUS AZE D2 E GUM HWA KAZ KGZ PNR PTR RUS AS S TUR USA E USA W	
22 787.4 **(22 786)** (2231)	ALS ARS CAN W EST F FIN GRC J LVA MLA NIU RUS SW USA E USA SO USA W	
22 790.4 **(22 789)** (2232)	CUB GEO GRC HOL IRQ LTU LVA POL RUS EO RUS SW RUS W SUI	

1	2	3
22 793.4 **(22 792)** (2233)	ALS CKH GRC GUM HWA IRN NOR PNR PTR ROU USA E USA SO USA W	 ADD
22 796.4 **(22 795)** (2234)	ARG DNK INS J LBY NOR ROU S	
22 799.4 **(22 798)** (2235)	ALS F GRC GUM HWA IRN J PTR QAT RUS NW USA E USA SO USA W	 ADD
22 802.4 **(22 801)** (2236)	DNK E GRC IRQ J NZL UKR USA E USA W	
22 805.4 **(22 804)** (2237)	AZR CHN I IRN J MDR NOR POR ROU USA E USA SO USA W	

1	2	3
22 808.4 **(22 807)** (2238)	ALG AUS B D1 GRC HNG IRQ J LTU LVA RUS SW RUS W	
22 811.4 **(22 810)** (2239)	ALS BEL CHN E GUM HRV HWA IND E IRN NOR PNR PTR USA E USA W	
22 814.4 **(22 813)** (2240)	CHL GRC J MDG NOR TUN	
22 817.4 **(22 816)** (2241)	ALS AZE CHN CLM GEO HKG HWA J PTR RUS EO RUS NW RUS SW TUR UKR USA CL USA E USA SO USA W VIR VTN	
22 820.4 **(22 819)** (2242)	BLR CLM RUS AN >> >>	

1	2	3
(2242)	<< << RUS AS RUS EO RUS NW RUS SW RUS W UKR USA SO	
22 823.4 **(22 822)** (2243)	ALS AUS B BUL HWA J KOR PTR RUS EO RUS W UAE USA CL USA E USA SO USA W VIR	
22 826.4 **(22 825)** (2244)	ALS HWA I J RUS AN RUS EO UKR USA W	
22 829.4 **(22 828)** (2245)	ALS ARG CL ARG SO CHN E HWA J RUS EO UAE USA SO USA W	
22 832.4 **(22 831)** (2246)	B J KGZ KOR LVA RUS EO RUS SW RUS W SUI TUR USA SO	

1	2	3
22 835.4 **(22 834)** (2247)	ALS CAN E HWA J RUS AN RUS AS RUS EO RUS NW RUS SW UKR USA CL USA E USA SO USA W VIR	
22 838.4 **(22 837)** (2248)	ALS CHN E HWA MDA PTR USA E USA SO USA W	ADD
22 841.4 **(22 840)** (2249)	ALS CHN HWA I J PTR RUS EO RUS NW RUS W UKR USA E USA SO USA W	
22 844.4 **(22 843)** (2250)	ALS AZE B DGA E GRC GUM HWA KAZ KOR MDW MNE PTR RUS EO RUS NW RUS SW TKM TUR >> >>	

1	2	3
(2250)	<< << UKR USA E USA SO USA W	
22 847.4 **(22 846)** (2251)	ALS B BLR CHN GUM HWA J MCO MDW PTR RUS AN RUS NW RUS SW TUR UKR USA E USA SO USA W	ADD
22 850.4 **(22 849)** (2252)	ALS G GUM HWA J LVA PTR RUS NW RUS SW TKM UAE UKR USA E USA SO USA W	
22 853.4 **(22 852)** (2253)	ALS AUS AZE CHN DGA E G GEO GRC GUM HWA J KAZ MDW PTR RUS NW >> >>	

1	2	3
(2253)	<< << RUS W TKM UKR USA E USA SO USA W	
26 146.4 **(26 145)** (2501)	ALS AZE B CAN E CHN D1 HNG HWA JOR MNE RUS EO TUR UKR USA CL USA E USA SO USA W	
26 149.4 **(26 148)** (2502)	ALS AUS BLR CHN G HWA J MOZ PTR RUS EO RUS SW UKR USA CL USA E USA SO USA W VIR	
26 152.4 **(26 151)** (2503)	ARG CL BUL CHN J RUS EO SUI UAE USA SO	
26 155.4 **(26 154)** (2504)	ALS ARG SO B >> >>	

1	2	3
(2504)	<< << BLR CHN HWA J PTR RUS AN RUS AS RUS EO RUS NW RUS SW TKM UKR USA CL USA E USA SO USA W VIR	
26 158.4 **(26 157)** (2505)	ALS B CHN E GUM HWA IND E IND W ISR PTR RUS EO RUS NW RUS SW RUS W TUR UKR USA E USA SO USA W	
26 161.4 **(26 160)** (2506)	ALS ARG CHN HWA I J S TUR USA SO USA W	ADD
26 164.4 **(26 163)** (2507)	ALS ARG AZE CAN E CHN DGA >> >>	

1	2	3
(2507)	<< << E GRC GUM HKG HWA J KAZ MDW PTR RUS EO TKM TUR UKR USA E USA SO USA W	

1	2	3
26 167.4 **(26 166)** (2508)	ALS AUS B CAN W CHN DGA GRC GUM HNG JOR MDW POR PTR RUS EO RUS SW TUR UKR USA E >> >>	

1	2	3
(2508)	<< << USA SO USA W	
26 170.4 **(26 169)** (2509)	ALS ARG CL ARG SO CHN D2 GUM HWA J MDW PTR RUS EO S TUR USA E USA SO USA W	ADD

TABLE OF ALLOTMENTS ADDED TO THE PLAN
adopted by the WMARC-74

Column headings

1 Channel number (the corresponding carrier and assigned frequencies are indicated in Sub-section A of Section I of Part B Appendix **17** and in the present Appendix).

2 Country or area of allotment.

3 Service area description.

3.1 Main service area.

A number between 1 and 22 refers to a Zone defined on the Map of Maritime Zones appearing in the Preface to the BR IFIC.

3.2 Maximum length of circuit in kilometres.

4 Nature of service.

5 Class of emission.

6 Peak envelope power in dBW.

7 Transmitting antenna characteristics.

7.1 In the case of a non-directional antenna, the symbol ND is entered in this column and columns 7.2a), b) and c) are left blank. In the case of a directional antenna, the symbol D is entered in this column and the characteristics are given in columns 7.2a), b) and c).

7.2a) Azimuth of maximum radiation. The symbol ROT entered in this column means that a rotatable antenna is used.

7.2b) Angular width of main lobe.

7.2c) Relative gain of the antenna in dB.

8 Planned scheduled hours of operation in the channel (UTC).

9 Traffic data.

9a) Estimated peak hours of traffic.

9b) Estimated daily volume of traffic in minutes.

10 Special section No./Weekly Circular or BR IFIC No./Date (e.g. MAR/10/1305/280278). (WRC-03)

1	2	3		4	5	6	7				8	9		10
		3.1	3.2				7.1	7.2 a)	7.2 b)	7.2 c)		9a)	9b)	
401	AUS	12	800	CV	J3E	20.0	ND				2200-1000	2200-1000	30	MAR/54/1640/021084
401	PNR	9, 18	500	CP	J3E	30.0	ND				0000-1200		25	AR16/84/1838/160888
402	BEN	19	–	CP	J3E	30.0	ND				0000-2359	2000-0800	40	AP25/133/2520/010604
403	CAN CL	2, 16	1 000	CV	J3E	30.0	ND				0000-2359	0800-2000	360	AR16/120/2318/100398
403	PNR	9, 18	500	CP	J3E	30.0	ND				0800-1200		25	AR16/84/1838/160888
404	MCO	17	300	CP	J3E	40.0	ND				0700-2200	0800-1000 1500-1700	50	AP25/125/2379/250599
405	USA CL	16	800	CP	J3E	30.0 15.0	ND				1100-2300 2300-1100	1200-1800	180	MAR/50/1609/280284
407	AUS	11, 12	800	CO/CP	J3E	37.0	ND				0000-2400			MAR/48/1602/100184
407	I	17	1 200	CO	J3E	31.8	ND				0500-2200	0700-1100	60	MAR/58/1682/300785
408	B	18, 20	800	CV	J3E	21.8	ND				0000-2400		120	MAR/69/1712/040386
408	CHN	5	200	OT	J3E	26.0	D	340	60	3	1100-1900	1200-1300	190	
408	MDA	17	–	CO	J3E	30.0	ND				0000-2400	0300-2000	180	AP25/142/2692/190411
408	MLD	6	–	CO	J3E	30.0	D	300	120	5	0000-2400			AR16/79/1816/150388
408	SMA	8, 12, 13	1 000	CP	J3E	30.0	ND				1800-0400		30	MAR/10/1305/280278
409	GHA	19	500	CP	J3E	30.0	ND D D	 110 330	 30 30	 10 10	0000-2359			AR16/114/2237/230796
409	QAT	6	2 500	CP	J3E	30.0	ND				0000-2400			AR16/89/1886/250789
411	AMS	10	–	CP	J3E	24.8	ND				0430-0445 0830-0845 1230-1245		25	MAR/15/1347/191278
411	EQA	9	800	CP	J3E	24.0	ND				0030-0530		30	AR16/90/1895/260989
411	I	17	–	CO	J3E	31.8	ND				0500-2200	0700-1100	60	AR16/75/1747/041186
411	KIR	7, 8	500	CP	J3E	27.0	ND				0800-1800			MAR/59/1686/270885
416	ARG CL	14, 20	1 000	CP	J3E	30.0	D	90	60	2	0000-2400	1100-1700	490	
417	TZA	6, 10, 19, 21	3 200	CO/CP	J3E	37.0	ND				0700-1800	0800-1000 1500-1700	240	MAR/66/1707/280186
418	B	18, 20	800	CV	J3E	21.8	ND				0000-2400	0700-1100	240	MAR/69/1712/040386
418	I	17	–	CO	J3E	31.8	ND				0500-2200	0700-1100	60	AR16/75/1747/041186
419	TZA	6, 10, 19, 21	3 200	CO/CP	J3E	37.0	ND				0700-1800	0800-1000 1500-1700	240	MAR/57/1680/160785
422	SUI	15, 16, 17, 18, 19	4 000	CP	J2D	37.0	D	ROT	30	8	0000-2400	1900-0200	240	AP25/147/2718/010512
423	B	18, 20	800	CV	J3E	27.0	ND				0000-2400			MAR/16/1350/160179
423	MLT	6, 15, 17	3 000	CP	J3E	31.8	ND				1700-0500	2000-2100	60	MAR/41/1565/190483
423	QAT	6	800	CP	J3E	37.0	ND				0000-2400		200	MAR/23/1412/010480
		6	1 500	CP	J3E	37.0	D	130	60	9	0000-2400		200	
		6	1 500	CP	J3E	37.0	D	200	60	9	0000-2400		200	
		6	1 500	CP	J3E	37.0	D	310	60	9	0000-2400		200	
424	AUS E	12	800	CO/CP	J3E	30.0	ND				0000-2400			MAR/48/1602/100184
424	PNR	9, 18	500	CP	J3E	30.0	ND				0800-1200		25	AR16/73/1742/300986
425	B	18, 20	800	CV	J3E	27.0	ND				1000-2300	1900-2200	100	MAR/16/1350/160179
425	JOR	6, 15, 17	5 000	CP	J3E	37.0	ND				1700-0500			MAR/49/1604/240184
428	BRU	7	1200	CP	J3E	21.76	ND				2100-1400	2200-0100	100	AP25/141/2691/050411
601	CAN NO	02, 04, 16	-	CP	J3EJN	29.2	ND				0000-2400	0800-2000	20	AP25/149/2731/301012
601	I	17	–	CO	J3E	31.8	ND				0400-2200	0600-1400	60	AR16/75/1747/041186
601	MLD	6	–	CO	J3E	30.0	D	300	120	5	0000-2400			AR16/79/1816/150388
601	NCL	7, 8, 12	2 500	CP	J3E	27.0	ND				0000-2400			AR16/71/1737/260886
602	AUS E	12	1 000	CV	J3E	26.0	ND				0000-2359	1900-0700		AP25/128/2406/301199

1	2	3		4	5	6	7				8	9		10
		3.1	3.2				7.1	7.2 a)	7.2 b)	7.2 c)		9a)	9b)	
602	B	18, 20	800	CP	J3E	30.0	ND				0000-2400			MAR/69/1712/040386
602	EQA	9	800	CP	J3E	24.0	ND				0630-1000		30	AR16/90/1895/260989
602	FJI	12	1 000	CP	J3E	30.0	ND				1800-0600	2000-0500	120	MAR/37/1519/180582
602	GHA	19	500	CP	J3E	30.0	ND				0000-2359			AR16/114/2237/230796
							D	110	30	10				
							D	330	30	10				
603	AUS	11, 12	4 000	CP	J3E	30.0	ND				0000-2400	2100-0900	30	MAR/55/1651/181284
603	MLT	6, 15, 17	3 000	CP	J3E	31.8	ND				0500-1700	0900-1100	60	MAR/41/1565/190483
603	VTN	5, 6, 7	–	CP	J3E	34.8	ND				0000-2400	0630-1700	230	AP25/146/2710/100112
604	B	18, 20	800	CP	J3E	30.0	ND				1000-1300 1700-2000			MAR/69/1712/040386
604	BES	18	1 500	CP	J3E	30.0	ND				0000-0200 0600-1000		120	MAR/35/1495/171181
604	CUW	18	1 500	CP	J3E	30.0	ND				0000-0200 0600-1000		120	MAR/35/1495/171181
604	RUS EO	01, 03, 05	1500	CP	J3E	30.0	ND			2.7	0000-2400	0000-2400	200	AP25/151/2742/160413
604	SXM	18	1 500	CP	J3E	30.0	ND				0000-0200 0600-1000		120	MAR/35/1495/171181
604	TUV	8, 12	450	CP	J3E	30.0	ND				1800-1200	2000-0400	30	AR16/91/1897/101089
604	VTN	5, 6, 7, 10, 11	–	CP	J3E	30.0	ND				0000-2400	0100-0400 1000-1800	600	AP25/137/2632/111108
605	B	18, 20	800	CP	J3E	30.0	ND				1000-1300 1700-2000			MAR/69/1712/040386
605	F	15, 17	2 500	CP	J3E	40.0	ND				0600-0900 1700-2200	1800-2200	300	MAR/56/1679/090785
605	NZL	7, 8, 11, 12, 13	6 000	CP	J3E	37.0	ND				0000-2400	0400-0900	90	MAR/63/1695/291085
607	MDA	17	–	CO	J3E	30.0	ND				0000-2400	0300-2000	180	AP25/142/2692/190411
608	BRU	7, 11	1300	CP	J3E	21.76	ND				2100-1400	2200-0100	100	AP25/141/2691/050411
802	MDA	17	–	CO	J3E	30.0	ND				0000-2400	0300-2000	180	AP25/142/2692/190411
803	SUI	15, 16, 17, 18, 19	6 000	CP	J3E	40.0	D	ROT	30	8	0600-0200	0600-1000 1700-2200	50	MAR/62/1694/221085
804	JOR	6, 15, 17	5 000	CP	J3E	37.0	ND				0500-1700			MAR/49/1604/240184
804	QAT	6	1 500	CP	J3E	37.0	ND				0000-2400		200	MAR/23/1412/010480
		6	2 500	CP	J3E	37.0	D	130	60	10	0000-2400		200	
		6	2 500	CP	J3E	37.0	D	200	60	10	0000-2400		200	
		6, 17	2 500	CP	J3E	37.0	D	310	60	10	0000-2400		200	
805	EQA	9	800	CP	J3E	24.0	ND				1130-1730		30	AR16/90/1895/260989
806	AUS	11	2 000	CP	J3E	30.0	ND				2100-0500	2100-0500	90	MAR/52/1631/310784
806	SMA	8, 12, 13	3 000	CP	J3E	30.0	ND				1800-0400		30	MAR/11/1310/040478
807	I	15, 17	–	CO	J3E	31.8	ND				0000-2400	0500-1300	60	AR16/75/1747/041186
808	I	15, 17	–	CO	J3E	31.8	ND				0000-2400	1300-2100	60	AR16/75/1747/041186
811	BEN	19	–	CP	J3E	30.0	ND				0000-2359	0800-2000	40	AP25/133/2520/010604
812	I	15, 17	–	CO	J3E	31.8	ND				0000-2400	2100-0500	60	AR16/75/1747/041186
813	VTN	5, 6, 7, 10, 11	–	CP	J3E	30.0	ND				0000-2400	0100-0400 1100-1400	650	AP25/137/2632/111108
814	KIR	7, 8	500	CP	J3E	27.0	ND				1800-0800			MAR/65/1702/171285
815	JOR	6, 17	3 000	CP	J3E	37.0	ND				0700-2000	0800-1200	60	AR16/100/2084/060793
817	PNR	9, 18	2 000	CP	J3E	30.0	ND				1200-2300		25	AR16/84/1838/160888
819	PNR	9, 18	2 000	CP	J3E	30.0	ND				1200-2300		25	AR16/84/1838/160888

1	2	3		4	5	6	7				8	9		10
		3.1	3.2				7.1	7.2 a)	7.2 b)	7.2 c)		9a)	9b)	
820	D2	6, 15, 16, 17, 18, 19	6 000	CP	J3E	40.0	ND				0400-2000		30	AR16/82/1827/310588
820	TZA	6, 10, 19, 21	3 200	CO/CP	J3E	37.0	ND				0700-1800	0800-1000 1500-1700	240	MAR/66/1707/280186
822	AUS	11, 12	3 000	CP	J3E	30.0	ND				2100-0900	2100-0900	90	MAR/64/1696/051185
823	TZA	6, 10, 19, 21	3 200	CO/CP	J3E	30.0	ND				0700-1800	0800-1000 1500-1700	240	MAR/66/1707/280186
823	USA W	9	1 200	CO	J3E	30.0	ND				1600-0400	1600-1800 0000-0200	180	AR16/92/1910/230190
825	AMS	10	–	CP	J3E	24.8	ND				0445-0500 0845-0900 1245-1300		25	MAR/15/1347/191278
825	GHA	19	500	CP	J3E	30.0	ND D D	110 330	30 30	10 10	0000-2359			AR16/114/2237/230796
825	S	5, 15 5, 15 6, 10, 17 6, 10, 17, 19, 21 15, 16, 17, 18, 19, 21 15, 16, 18, 19 15, 16	–	CP	J3E	40.0 40.0 40.0 40.0 40.0 40.0 40.0	D D D D D D D	10 50 130 170 210 250 310	60 60 60 60 60 60 60	11 11 11 11 11 11 11	0000-2400 0000-2400 0000-2400 0000-2400 0000-2400 0000-2400 0000-2400	0800-1000 0800-1000 0800-1000 0800-1000 0800-1000 0800-1000 0800-1000	90 90 90 90 90 90 90	AR16/70/1730/080786
826	CAN NO	02, 04, 16	–	CP	J3EJN	29.2	ND				0000-2400	0800-2000	20	AP25/148/2720/290512
826	QAT	6	2 500	CP	J3E	30.0	ND				0000-2400			AR16/89/1886/250789
829	BRM	5, 6, 7	3 300	CP	J3E	24.0	ND				2330-1130	0330-0430	30	AR16/112/2223/160496
829	MLD	6	–	CO	J3E	30.0	D	300	120	5	0000-2400			AR16/79/1816/150388
830	CHN	5, 6, 7, 8	8 000	CP	J3E	38.5	ND				0000-2400	0000-0800	400	
830	MCO	15, 17	800	CP	J3E	40.0	ND				0700-2200	0800-1000 1500-1700	50	AP25/125/2379/250599
830	VTN	5, 6, 7	–	CP	J3E	30.0	ND				0000-2400	0800-1800	320	AP25/146/2710/100112
834	BHR	6	–	CO	J3E	30.0	ND				0001-2400	1300-0100	300	AP25/145/2707/151111
835	BRU	7, 11	1500	CP	J3E	21.76	ND				2100-1400	2200-0100	100	AP25/141/2691/050411
1 201	QAT	6	2 500	CP	J3E	30.0	ND				0400-0600 1400-1600			AR16/89/1886/250789
1 207	EQA	9	800	CP	J3E	24.0	ND				1830-2330		30	AR16/90/1895/260989
1 208	I	6, 15, 16, 17, 18	–	CO	J3E	31.8	ND				0300-2200	0600-1100	30	AR16/75/1747/041186
1 210	SUI	6, 10, 15, 16, 17, 18, 19, 20, 21	9 000	CP	J3E	40.0	D	ROT	30	8	0600-0200	0800-1200 1600-2100	60	MAR/62/1694/221085
1 212	MDA	17	–	CO	J3E	30.0	ND				0000-2400	0300-2000	180	AP25/142/2692/190411
1 212	RUS AS	01	2 500	OT	J3E	33.0	D	346	60	1.5	0000-2400	0000-2400	100	AP25/153/2869/010518
1 213	USA W	9	1 600	CO	J3E	30.0	ND				1800-2300	2100-2200	180	AR16/95/1996/011091
1 215	BHR	6	–	CO	J3E	37.0	ND				0001-2400	1300-0100	300	AP25/145/2707/151111
1 220	D2	6, 15, 16, 17, 18, 19	6 000	CP	J3E	40.0	ND				0400-2000		30	AR16/82/1827/310588
1 220	JOR	6, 15, 17	5 000	CP	J3E	37.0	ND				0500-1700			MAR/49/1604/240184
1 222	ALS	4	1 600	CO	J3E	30.0	ND				2000-0100	2300-2400	180	AR16/95/1996/011091
1 222	BEN	19	–	CP	J3E	30.0	ND				0000-2359	0800-2000	20	AP25/133/2520/010604
1 222	USA W	9	1 600	CO	J3E	30.0	ND				1800-2300	2100-2200	180	AR16/95/1996/011091
1 224	GHA	19	500	CP	J3E	30.0	ND D D	110 330	30 30	10 10	0000-2359			AR16/114/2237/230796
1 225	JOR	6, 10	5 000	CP	J3E	37.0	D	144	60	9	0900-1700	1300-1500	30	AR16/100/2084/060793

1	2	3		4	5	6	7				8	9		10
		3.1	3.2				7.1	7.2 a)	7.2 b)	7.2 c)		9a)	9b)	
1 226	MCO	01, 02, 06, 15, 16, 17, 18, 19	6 000	CP	J3E	40.0	ND				0700-2200	0800-1000 1500-1700	50	AP25/125/2379/250599
1 226	S	5, 15	–	CP	J3E	40.0	D	10	60	11	0000-2400	0800-1000	90	AR16/70/1730/080786
		5, 15				40.0	D	50	60	11	0000-2400	0800-1000	90	
		6, 10, 17				40.0	D	130	60	11	0000-2400	0800-1000	90	
		6, 10, 17, 19, 21				40.0	D	170	60	11	0000-2400	0800-1000	90	
		15, 16, 17, 18, 19, 21				40.0	D	210	60	11	0000-2400	0800-1000	90	
		15, 16, 18, 19				40.0	D	250	60	11	0000-2400	0800-1000	90	
		15, 16				40.0	D	310	60	11	0000-2400	0800-1000	90	
1 227	TZA	6, 10, 19, 21	3 200	CO/CP	J3E	37.0	ND				0700-1800	0800-1000 1500-1700	240	MAR/66/1707/280186
1 228	I	6, 15, 16, 17, 18	–	CO	J3E	31.8	ND				2200-0500	2300-0200	30	AR16/75/1747/041186
1 228	MLD	6	–	CO	J3E	30.0	D	300	120	5	0000-2400			AR16/79/1816/150388
1 228	VTN	5, 6, 7, 10, 11	–	CP	J3E	37.0	ND				0000-2400	0100-0400 1000-1800	800	AP25/137/2632/111108
1 229	QAT	6, 17	2 000	CP	J3E	37.0	ND				0400-0600 1400-1600		200	MAR/23/1412/010480
		6	3 000	CP	J3E	37.0	D	130	60	11	0400-0600 1400-1600			
		6, 17	3 000	CP	J3E	37.0	D	200	60	11	0400-0600 1400-1600			
		6, 17	3 000	CP	J3E	37.0	D	310	60	11	0400-0600 1400-1600			
1 231	VTN	5, 6, 7	–	CP	J3E	30.0	ND				0000-2400	0000-1500	398	AP25/146/2710/100112
1 232	PNR	9, 14, 16, 18	4 000	CP	J3E	30.0	ND				1200-2400		25	AR16/84/1838/160888
1 232	SMA	8, 12, 13	3 000	CP	J3E	30.0	ND				1800-0400		30	MAR/11/1310/040478
1 236	BRM	5, 6, 7	3 300	CP	J3E	24.0	ND				2330-1130	0330-0430	30	AR16/112/2223/160496
1 238	MCO	15, 16, 17	5 000	CP	J3E	40.0	ND				0700-2200	0800-1600	120	AP25/129/2445/290501
1239	BRU	5, 7, 11	2000	CP	J3E	21.76	ND				2100-1400	2200-0100	100	AP25/141/2691/050411
1 603	MLT	15, 17	3 000	CP	J3E	31.8	ND				0000-1159			MAR/21/1379/070879
1 604	BEN	19	–	CP	J3E	30.0	ND				0000-2359		20	AP25/133/2520/010604
1 608	EQA	9, 14	800	CP	J3E	27.0	ND				1800-2300	2000-2300	40	AR16/111/2221/020496
1 612	JOR	6, 10	6 000	CP	J3E	37.0	D	144	60	9	1000-1600	1300-1500	20	AR16/100/2084/060793
1 614	MLD	6	–	CO	J3E	30.0	D	300	120	5	0000-2400			AR16/79/1816/150388
1 622	ALS	4	2 400	CO	J3E	30.0	ND				2000-0600	0200-0300	180	AR16/95/1996/011091
1 622	GHA	19	500	CP	J3E	30.0	ND				0000-2359			AR16/114/2237/230796
							D	110	30	10				
							D	330	30	10				
1 622	HWA	8	2 400	CO	J3E	30.0	ND				2000-0600	0200-0300	180	AR16/95/1996/011091
1 622	PNR	9, 14, 16, 18	4 000	CP	J3E	30.0	ND				1200-2400		25	AR16/84/1838/160888
1 622	SUI	3, 4, 5, 6, 7, 9, 10, 15, 16, 17, 18, 19, 20, 21	10 000	CP	J3E	40.0	D	ROT	30	8	0600-0200	0800-1700	60	MAR/62/1694/221085
1 626	J	3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	–	CR	J3E	37.0	ND				0000-2400	0800-1000	500	
1 626	QAT	6, 17	4 000	CP	J3E	40.0	ND				0600-0800 1200-1400		200	MAR/23/1412/010480
		6	6 000	CP	J3E	40.0	D	130	60	11	0600-0800 1200-1400			
		6, 10, 17	6 000	CP	J3E	40.0	D	200	60	11	0600-0800 1200-1400			
		6, 15, 17	6 000	CP	J3E	40.0	D	310	60	11	0600-0800 1200-1400			

1	2	3		4	5	6	7				8	9		10
		3.1	3.2				7.1	7.2 a)	7.2 b)	7.2 c)		9a)	9b)	
1 627	ALS	4	2 400	CO	J3E	30.0	ND				2000-0600	0200-0300	180	AR16/95/1996/011091
1 628 1 628	EQA MCO	9, 14 01, 02, 06, 15, 16, 17, 18, 19	800 6 000	CP CP	J3E J3E	27.0 40.0	ND ND				1800-2300 0700-2200	2000-2300 0800-1000 1400-1600	40 50	AR16/111/2221/020496 AP25/125/2379/250599
1 629	BRM	5, 6, 7	3 300	CP	J3E	24.0	ND				2330-1130	0330-0430	30	AR16/112/2223/160496
1 630	J	3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	–	CR	J3E	37.0	ND				0000-2400	0300-0700	650	
1 634	CHN	8, 9, 10, 11, 12, 13, 14, 15, 17, 19, 20, 21	19 000	CP	J3E	40.0	ND				0000-1000	0200-0600	200	
1 635	I	5, 6, 7, 9, 10, 14, 15, 16, 18, 20, 21	–	CO	J3E	31.8	ND				0400-2400	0600-1600	30	AR16/75/1747/041186
1 635	PNR	9, 14, 16, 18	4 000	CP	J3E	30.0	ND				1500-2400		25	AR16/84/1838/160888
1 637	CHN	8, 9, 10, 11, 12, 13, 14, 15, 17, 19, 20, 21	19 000	CP	J3E	40.0	ND				0000-1000	0200-0600	200	
1 638 1 638	SMA D2	8, 12, 13 6, 15, 16, 17, 18, 19	4 000 6 000	CP CP	J3E J3E	30.0 40.0	ND ND				1800-0400 0400-2000		30 30	MAR/10/1305/280278 AR16/82/1827/310588
1 639	CHN	5	800	OT	J3E	31.8	D	90	60	3	0000-1200	0100-0230	300	
1 640	PNR	9, 14, 16, 18	4 000	CP	J3E	30.0	ND				1500-2400		25	AR16/84/1838/160888
1 644	MDA	17	–	CO	J3E	30.0	ND				0000-2400	0300-2000	180	AP25/142/2692/190411
1 646	VTN	5, 6, 7, 10, 11	–	CP	J3E	37.0	ND				0000-2400	0830-1630	750	AP25/137/2632/111108
1 804	BRU	5, 6, 7, 10, 11, 12	5000	CP	J3E	21.76	ND				2100-1400	2200-0100	100	AP25/141/2691/050411
1 804	S	06, 15, 16, 17, 18, 19	7 000	CP	J3E	38.5	ND				0000-2359	0600-1900	120	AP25/126/2388/270799
1 808	MCO	15, 16, 17	5 000	CP	J3E	40.0	ND				0700-2200	0800-1600	120	AP25/129/2445/290501
1 809	POL	5, 11, 21	20 000	CP	J3E	40.0	ND				0000-2230	1730-2230	90	AR16/119/2310/130198
1 813 1 813	MDA S	17 06, 15, 16, 17, 18, 19	– 7 000	CO CP	J3E J3E	30.0 38.5	ND ND				0000-2400 0000-2359	0300-2000 0600-1900	180 120	AP25/142/2692/190411 AP25/130/2445/290501
2 202	BRM	5, 6, 7	3 300	CP	J3E	24.0	ND				2330-1130	0330-0430	30	AR16/112/2223/160496
2 203	PNR	9, 14, 16, 18	4 000	CP	J3E	30.0	ND				1500-2400		25	AR16/84/1838/160888
2 206	BHR	6, 10, 15, 17, 19, 21	–	CP	J3E	34.8	ND				0000-2359			AR16/100/2084/060793
2 208	I	5, 6, 7, 9, 10, 14, 15, 16, 18, 20, 21	–	CO	J3E	31.8	ND				0500-2400	0700-2200	30	AR16/75/1747/041186
2 208	PNR	9, 14, 16, 18	4 000	CP	J3E	30.0	ND				1200-2400		25	AR16/84/1838/160888
2 209	CHN	4, 9, 10, 11, 12, 13, 14, 15, 17, 19, 20, 21	19 000	CP	J3E	40.0	ND				0000-1000	0200-0600	200	
2 211	CHN	4, 9, 10, 11, 12, 13, 14, 15, 17, 19, 20, 21	18 000	CP	J3E	40.0	ND				0000-1000	0200-0600	240	

1	2	3		4	5	6	7				8	9		10
		3.1	3.2				7.1	7.2 a)	7.2 b)	7.2 c)		9a)	9b)	
2 212	MCO	01, 02, 06, 10, 15, 16, 17, 18, 19, 20, 21	8 000	CP	J3E	40.0	ND				0700-2200	0800-1000 1400-1600	50	AP25/125/2379/250599
2 215	CHN	4, 9, 10, 11, 12, 13, 14, 15, 17, 19, 20, 21	19 000	CP	J3E	40.0	ND				0000-1000	0200-0600	200	
2 215	GHA	19	500	CP	J3E	30.0	ND D D	 110 330	 30 30	 10 10	0000-2359			AR16/114/2237/230796
2 218	CHN	4, 9, 10, 11, 12, 13, 14, 15, 17, 19, 20, 21	19 000	CP	J3E	40.0	ND				0000-1000	0200-0600	200	
2 220	CHN	4, 9, 10, 11, 12, 13, 14, 15, 17, 19, 20, 21	19 000	CP	J3E	40.0	ND				0000-1000	0200-0600	240	
2 220	SUI	6, 10, 18, 20, 21	14 000	CP	J3E	40.0	D	ROT	70	8,5	0600-1800	0900-1600	60	MAR/27/1431/120880
2 222	MLD	6	–	CO	J3E	30.0	D	300	120	5	0000-2400			AR16/79/1816/150388
2 223	MLT	15, 17	3 000	CP	J3E	31.8	ND				0000-1159			MAR/20/1372/190679
2 226	ALS	4	2 400	CO	J3E	30.0	ND				2000-0400	0100-0200	180	AR16/95/1996/011091
2 226	HWA	8	2 400	CO	J3E	30.0	ND				2000-0400	0100-0200	180	AR16/95/1996/011091
2 226	JOR	6, 10, 11	8 000	CP	J3E	37.0	D	144	60	9	1100-1400			AR16/100/2084/060793
2 226	USA W	9	2 400	CO	J3E	30.0	ND				1800-0200	2300-2400	180	AR16/95/1996/011091
2 228	QAT	6, 10, 11	2 500	CP	J3E	33.0	D	140	60	10	0000-1800	0400-1100		AR16/96/1997/081091
2 229	BEN	19	–	CP	J3E	30.0	ND				0000-2359		20	AP25/133/2520/010604
2 229	BRU	5, 6, 7, 8, 10, 11, 12	6000	CP	J3E	21.76	ND				2100-1400	2200-0100	100	AP25/141/2691/050411
2 233	GRC	17	2 600	CO	J3E	30.0	ND				0500-2200	0600, 1000, 2200	30	MAR/51/1621/220584
2 235	QAT	6, 17 6, 10, 11 6, 10, 17, 21 17, 15	5 000 8 000 8 000 8 000	CP CP CP CP	J3E J3E J3E J3E	40.0 40.0 40.0 40.0	ND D D D	 130 200 310	 60 60 60	 11 11 11	0800-1200 0800-1200 0800-1200 0800-1200		200 200 200 200	MAR/23/1412/010480
2 237	CHN	4, 9, 10, 11, 12, 13, 14, 15, 17, 19, 20, 21	19 000	CP	J3E	40.0	ND				0000-1000	0200-0600	200	
2 239	CHN	7	2 700	CP	J3E	20.0	ND				0100-0930	0200-0400	280	
2 248	MDA	17	–	CO	J3E	30.0	ND				0000-2400	0300-2000	180	AP25/142/2692/190411
2 251	MCO	15, 16, 17	5 000	CP	J3E	40.0	ND				0700-2200	0800-1600	120	AP25/129/2445/290501
2 506	S	06, 15, 16, 17, 18, 19	7 000	CP	J3E	38.5	ND				0000-2359	0600-1900	120	AP25/130/2445/290501
2 509	S	06, 15, 16, 17, 18, 19	7 000	CP	J3E	38.5	ND				0000-2359	0600-1900	120	AP25/126/2388/270799

APPENDIX 26 (REV.WRC-15)*

Provisions and associated Frequency Allotment Plan for the aeronautical mobile (OR) service in the bands allocated exclusively to that service between 3 025 kHz and 18 030 kHz

(See Article **43**)

PART I – General provisions, definitions

26/1 The provisions of this Appendix shall apply to the aeronautical mobile (OR) service in the following frequency bands:

3 025-3 155 kHz	8 965- 9 040 kHz
3 900-3 950 kHz (Region 1 only)	11 175-11 275 kHz
4 700-4 750 kHz	13 200-13 260 kHz
5 680-5 730 kHz	15 010-15 100 kHz
6 685-6 765 kHz	17 970-18 030 kHz.

26/2 For the purpose of this Appendix, the terms used comprise the following:

26/2.1 **Frequency Allotment Plan**

The Plan for the aeronautical mobile (OR) service contained in Part III of this Appendix.

26/2.2 **Allotment in the aeronautical mobile (OR) service**

A frequency allotment in the aeronautical mobile (OR) service which comprises:

– a frequency channel from the channels appearing in the channelling arrangement in No. **26**/3;

– a bandwidth of up to 2.8 kHz, situated wholly within the frequency channel concerned;

– a power within the limits laid down in No. **26**/4.4 or specified against the allotted frequency channel;

– an allotment area which is the area in which the aeronautical station can be situated and which coincides with all or part of the territory of the country, or of the geographical area, as indicated against the frequency channel concerned in the Frequency Allotment Plan.

* This revision contains an up-to-date version of Part III, reflecting all amendments to Part III resulting from the application of the procedures of Part V, up to and including 10 May 2016, as well as those amendments, which resulted from geopolitical changes that occurred up to and including that date.

PART II – Technical bases used for the establishment of the Frequency Allotment Plan for the aeronautical mobile (OR) service in the bands allocated exclusively to that service between 3 025 kHz and 18 030 kHz

26/3 Channelling arrangement

26/3.1 The channelling arrangement for the frequencies to be used by aeronautical stations in the aeronautical mobile (OR) service in the bands allocated exclusively to that service between 3 025 kHz and 18 030 kHz is indicated in Table 1.

TABLE 1

Frequency band 3 025-3 155 kHz: 43 + 1 channels

3 023 [1]	3 026	3 029	3 032	3 035	3 038	3 041	3 044	3 047	3 050
3 053	3 056	3 059	3 062	3 065	3 068	3 071	3 074	3 077	3 080
3 083	3 086	3 089	3 092	3 095	3 098	3 101	3 104	3 107	3 110
3 113	3 116	3 119	3 122	3 125	3 128	3 131	3 134	3 137	3 140
3 143	3 146	3 149	3 152						

Frequency band 3 900-3 950 kHz (Region 1 only): 16 channels

3 900	3 903	3 906	3 909	3 912	3 915	3 918	3 921	3 924	3 927
3 930	3 933	3 936	3 939	3 942	3 945				

Frequency band 4 700-4 750 kHz: 16 channels

4 700	4 703	4 706	4 709	4 712	4 715	4 718	4 721	4 724	4 727
4 730	4 733	4 736	4 739	4 742	4 745				

Frequency band 5 680-5 730 kHz: 15 + 1 channels

5 680[1]	5 684	5 687	5 690	5 693	5 696	5 699	5 702	5 705	5 708
5 711	5 714	5 717	5 720	5 723	5 726				

Frequency band 6 685-6 765 kHz: 26 channels

6 685	6 688	6 691	6 694	6 697	6 700	6 703	6 706	6 709	6 712
6 715	6 718	6 721	6 724	6 727	6 730	6 733	6 736	6 739	6 742
6 745	6 748	6 751	6 754	6 757	6 760				

Frequency band 8 965-9 040 kHz: 25 channels

8 965	8 968	8 971	8 974	8 977	8 980	8 983	8 986	8 989	8 992
8 995	8 998	9 001	9 004	9 007	9 010	9 013	9 016	9 019	9 022
9 025	9 028	9 031	9 034	9 037					

Frequency band 11 175-11 275 kHz: 33 channels

11 175	11 178	11 181	11 184	11 187	11 190	11 193	11 196	11 199	11 202
11 205	11 208	11 211	11 214	11 217	11 220	11 223	11 226	11 229	11 232
11 235	11 238	11 241	11 244	11 247	11 250	11 253	11 256	11 259	11 262
11 265	11 268	11 271							

Frequency band 13 200-13 260 kHz: 20 channels

13 200	13 203	13 206	13 209	13 212	13 215	13 218	13 221	13 224	13 227
13 230	13 233	13 236	13 239	13 242	13 245	13 248	13 251	13 254	13 257

Frequency band 15 010-15 100 kHz: 30 channels

15 010	15 013	15 016	15 019	15 022	15 025	15 028	15 031	15 034	15 037
15 040	15 043	15 046	15 049	15 052	15 055	15 058	15 061	15 064	15 067
15 070	15 073	15 076	15 079	15 082	15 085	15 088	15 091	15 094	15 097

Frequency band 17 970-18 030 kHz: 20 channels

17 970	17 973	17 976	17 979	17 982	17 985	17 988	17 991	17 994	17 997
18 000	18 003	18 006	18 009	18 012	18 015	18 018	18 021	18 024	18 027

[1] For use of the carrier (reference) frequencies 3 023 kHz and 5 680 kHz, see No. **26**/3.4.

26/3.2 The frequencies indicated in No. **26**/3.1 are the carrier (reference) frequencies.

26/3.3 With the exception of the carrier (reference) frequencies 3 023 kHz and 5 680 kHz (see No. **26**/3.4), one or more frequencies from Table 1 may be assigned to any aeronautical station and/or aircraft station, in accordance with the Frequency Allotment Plan, as contained in Part III of this Appendix.

26/3.4 The carrier (reference) frequencies 3 023 kHz and 5 680 kHz are intended for worldwide common use (see also Appendix **27**, Nos. **27**/232 to **27**/238).

26/3.5 The aeronautical radiotelephone stations shall use only single-sideband emissions (J3E). The upper sideband shall be employed, and the assigned frequency (see No. **1.148**) shall be 1 400 Hz higher than the carrier (reference) frequency.

26/3.6 The channelling arrangement specified in No. **26**/3.1 does not prejudice the rights of administrations to establish, and to notify assignments to stations in the aeronautical mobile (OR) service other than those using radiotelephony, provided that:

– the occupied bandwidth does not exceed 2 800 Hz and is situated wholly within one frequency channel;

– the limits of unwanted emission are met (see Appendix **27**, No. **27**/74). (WRC-2000)

26/4 **Classes of emission and power**

26/4.1 In the aeronautical mobile (OR) service, in the bands governed by this Appendix, the use of the emissions listed below is permissible; additionally, the use of other emissions is also permissible, subject to compliance with No. **26**/3.6.

26/4.2 **Telephony**

– J3E (single-sideband, suppressed carrier).

26/4.3 **Telegraphy (including automatic data transmission)**

– A1A, A1B, F1B;

– (A,H)2(A,B);

– (R,J)2(A,B,D);

– J(7,9)(B,D,X).

26/4.4 Unless otherwise specified in Part III of this Appendix, the following transmitter power limits (i.e. power supplied to the antenna), shall be applied:

Class of emission	Power limit values (peak envelope power supplied to the antenna)	
	Aeronautical station	Aircraft station
J3E	36 dBW (PX)	23 dBW (PX)
A1A, A1B	30 dBW (PX)	17 dBW (PX)
F1B	30 dBW (PX)	17 dBW (PX)
A2A, A2B	32 dBW (PX)	19 dBW (PX)
H2A, H2B	33 dBW (PX)	20 dBW (PX)
(R,J)2(A,B,D)	36 dBW (PX)	23 dBW (PX)
J(7,9)(B,D,X)	36 dBW (PX)	23 dBW (PX)

26/4.5 On the assumption that no antenna gain is involved, the transmitter powers specified in No. **26**/4.4 above will result in a mean effective radiated power of 1 kW (for the aeronautical stations) and 50 W (for the aircraft stations), used as the basis for the establishment of the Plan contained in Part III of this Appendix.

PART III – Arrangement for the allotment of frequencies for the aeronautical mobile (OR) service in the exclusive bands between 3 025 and 18 030 kHz

26/5.1 **Column headings**

Column 1: Carrier (reference) frequency, in kHz.

Column 2: Allotment area (See Notes *a)*, *b)* and *c)* below).

26/5.2 Whenever the allotment area is followed by another administration's code, indicated in parentheses, the notifications are receivable from the latter administration on the basis of an agreement in accordance with Resolution **1 (Rev.WRC-97)**.

NOTE *a)*: The allotment area is designated by the symbol of the country or the geographical area, the meaning of which is given in the Preface to the International Frequency Information Circular (BR IFIC). The meaning of the following symbol, which does not appear in the Preface to the BR IFIC, is given below: (WRC-19)

CG7 CUB(Guantanamo) (7), as defined in Appendix **26** to the Radio Regulations, Geneva, 1959; (7) means "United States of America stations"

NOTE *b)*: For ease of reference, the allotment arrangement is presented by ITU Region. The symbols REG1, REG2 and REG3 correspond to the definitions of Regions 1, 2 and 3 respectively; the symbol REGY is used for the allotment area ATA (Antarctica), whose parts lie in all three Regions.

NOTE *c)*: The allotment which is followed by an asterisk (*) is subject to coordination with another administration (see Notes on the concluded operational agreements which follow the Arrangement).

1	2	
3 026	REG1	ARS BEN G KAZ KGZ LIE MCO RUS
	REG2	ATG DMA GRD JMC KNA LCA VCT
	REG3	BRU KOR TON
3 029	REGY	ATA(ARG)
	REG1	ARS AZR BLR COG E F G I IRQ KAZ MDA NOR POL RUS SEN TUN UKR UZB
	REG2	ALS ARG B BER(USA) CLM HWA USA
	REG3	AUS CHN GUM IND J KOR MHL(USA) NZL PNG VTN
3 032	REGY	ATA(ARG)
	REG1	ALG AZR BLR COG CTI E EGY F HNG IRQ KAZ MDA MDG MLT MRC NOR OMA POL RUS SEN TUN UKR UZB
	REG2	ALS ARG B BER(USA) CAN CLM DOM GRL HWA SLV USA
	REG3	AUS CBG CHN GUM IND J J(USA) LAO MHL(USA) NZL PNG VTN VUT
3 035	REGY	ATA(ARG)
	REG1	ARM ARS BFA BHR(USA) BLR COG F G G(USA) GEO HRV I(USA) ISL KAZ KGZ LVA MLT MRC NOR RUS SEN TCD TJK TKM TUN TUR
	REG2	ALS ARG B BER(USA) BRB(USA) CG7 HWA MDW PNR PTR TRD(USA) USA
	REG3	AUS CHN GUM IND INS J(USA) NZL PNG
3 038	REGY	ATA(ARG)
	REG1	ARM ARS BFA BHR(USA) BLR COG CTI CYP(G) EGY F G G(USA) GEO GRC HRV I(USA) ISL KAZ KGZ LVA MDG MNE MRC MTN* NOR OMA REU RUS SEN SRB SVN TCD TJK TKM TUN
	REG2	ALS ARG ATG(USA) B BAH(USA) BER(USA) BRB(USA) CAN CG7 GRL HWA MDW MRT NCG PNR PTR TCA(USA) TRD(USA) USA
	REG3	AUS CBG CHN GUM IND INS J(USA) LAO MHL(USA) NCL NZL OCE PNG VTN VUT
3 041	REG1	ALG G I ISL KWT NMB RUS TJK
	REG3	HKG IRN KRE PHL TUV
3 044	REGY	ATA(ARG)
	REG1	AFS ALG CME COG CZE DJI(F) F G GAB I ISR KAZ LTU MDA MDG MLI* MTN POR ROU RUS SEN* TCD TJK TKM UKR
	REG2	ARG CAN CLM JON MEX
	REG3	AUS BGD CHN GUM IRN J NCL NZL OCE PAK PNG
3 047	REGY	ATA(ARG)
	REG1	AFS ALG AZE BLR CME COG CTI CZE DJI(F) E F GAB IRL ISL ISR KAZ LTU MDA MDG MLI* MLT MTN NIG POR RUS SEN* TCD TKM TUR UKR
	REG2	ARG CAN CLM CTR HTI HWA JON MEX
	REG3	AUS BGD CBG CHN FJI GUM INS J(USA) LAO NCL NZL OCE PNG VTN VUT
3 050	REGY	ATA(ARG)
	REG1	AZE AZR BLR CME COG DNK F G GIB I KAZ MDG MLI MLT MRC POR REU RUS SEN* TCD TJK UKR UZB
	REG2	ALS ARG B BER(USA) CAN CUB HWA MDW PNR PTR USA
	REG3	AUS CHN DGA(USA) FJI GUM IND IRN J(USA) MHL(USA) NZL PAK PNG
3 053	REGY	ATA(ARG)
	REG1	ALB AZR CME COG CTI DNK F G GIB HNG KAZ MDG MLI MRC POR RUS SEN* TCD TJK UKR UZB
	REG2	ALS ARG B BER(USA) BES CAN CUB CUW GTM HWA MDW PNR PTR SXM USA
	REG3	AUS CHN FJI GUM IND INS IRN J(USA) MHL(USA) NZL PNG VTN
3 056	REG1	BLR COG D EST F G GAB GIB KAZ MDG MLI ROU RUS SEN* TCD TJK UAE UKR UZB
	REG2	B BES CAN CUW HWA JON MEX MRT SXM USA
	REG3	AUS GUM IND INS J(USA) KOR PNG

1	2	
3 059	REG1	AZR BLR COG CTI D E F G GAB GRC I KAZ MDG MLI REU ROU RUS SEN* SYR TCD TKM UKR UZB
	REG2	B CAN CHL HWA JON MEX MRT USA
	REG3	AUS IND INS J J(USA) KOR NZL PNG VTN
3 062	REG1	G GUI I ROU RUS SSD SWZ TKM
	REG3	IRN J
3 065	REGY	ATA(ARG)
	REG1	ARM AZE AZR D F G JOR LVA POR ROU RUS S TJK TKM UKR
	REG2	ALS ARG B BER(USA) CUB GRL HWA JON PNR USA
	REG3	AUS GUM IND IRN J MHL(USA) PNG
3 068	REGY	ATA(ARG)
	REG1	ARM AZE AZR ERI ETH F G HOL ISL LTU LVA MNE POR RUS S SRB SYR TJK TKM UAE UKR
	REG2	ALS ARG B BER(USA) CAN CG7 CUB HWA JON PNR PRU USA
	REG3	AUS CBG GUM INS J(USA) LAO MHL(USA) PNG VTN
3 071	REGY	ATA(ARG)
	REG1	AGL AZE BUL DJI(F) F G GRC HOL I ISL KAZ KGZ LTU LVA MOZ POR REU RUS STP TKM TUN UKR UZB
	REG2	ALS ARG B BER(USA) CLM JON MDW USA
	REG3	AUS BGD CHN HKG J MHL(USA) PAK PNG
3 074	REGY	ATA(ARG)
	REG1	AGL AZE AZR BUL CPV EGY F G GIB GRC HNG I KAZ KGZ LVA MLT MOZ NIG POR RUS S STP TUN UKR UZB
	REG2	ALS ARG B BER(USA) CAN CLM GRL GTM HTI JON MDW USA
	REG3	AUS BGD CHN CLN GUM HKG J MHL(USA) MLA PAK PNG SNG*
3 077	REGY	ATA(ARG)
	REG1	ARS AZR CYP(G) D F G GRC KGZ LVA MLT POR RUS UKR
	REG2	ALS ARG B CAN HWA PRG URG USA VEN
	REG3	AUS CHN HKG J KOR NZL PNG SNG
3 080	REGY	ATA(ARG)
	REG1	ARS AZR CYP(G) D EGY F FIN G GIB KEN KGZ LBY LVA MLT POR ROU RUS SOM TUR UKR
	REG2	ALS ARG B CAN CUB HWA PRG PRU SLV URG USA VEN
	REG3	AUS CHN CLN FJI GUM HKG IND J J(USA) KOR MLA* NZL PNG SNG
3 083	REG1	CYP(G) G GMB GRC I KGZ QAT RUS
	REG3	HKG J MLD
3 086	REG1	AFS BLR CYP(G) D F G GRC KAZ KGZ MDA OMA ROU RUS SVK UKR UZB
	REG2	ALS B BER(USA) CAN CG7 CHL HWA MDW PNR PTR USA
	REG3	AUS BRM CHN GUM J(USA) MHL(USA) PNG
3 089	REGY	ATA(USA)
	REG1	ALG AZE BLR D EGY G GRC GRC(USA) I I(USA) KAZ MDA MRC POR ROU RUS SEY SUI SVK UAE UKR UZB
	REG2	ALS B BER(USA) CG7 CHL GRL HWA MDW PNR PTR USA
	REG3	AUS CHN GUM J(USA) MHL(USA) PNG
3 092	REGY	ATA(ARG)
	REG1	ALG ARS AZE AZR DJI(F) F G GEO GIB ISL KAZ POL REU RUS TJK TKM UZB
	REG2	ALS ARG B BER(USA) CAN CG7 DOM HWA MDW MEX PNR PTR USA
	REG3	AUS BGD CHN GUM J MHL(USA) NZL PNG

1	2	
3 095	REGY	ATA(ARG)
	REG1	ALG ARS CYP(G) E EGY F G GEO GIB GRC(USA) I ISR KAZ KEN LBY MLT POL RUS SOM TJK TKM UZB ZWE
	REG2	ALS ARG B CAN CG7 CTR DOM HWA MDW MEX PNR PRU PTR USA
	REG3	AUS BGD CHN CLN FJI GUM HKG J MHL(USA) MLA NZL PNG SNG*
3 098	REG1	ALB AZE AZR BHR(USA) BLR CNR E G GEO GIB I I(USA) KAZ NIG RUS TJK UKR
	REG2	ALS ATG(USA) B BAH(USA) BER(USA) BRB(USA) CHL HWA MDW MRT PNR PTR TCA(USA) TRD(USA) USA
	REG3	AUS BGD GUM HKG J MHL(USA) PAK PNG
3 101	REG1	AFS ALB AZE AZR BHR(USA) BLR CNR D E EGY ERI ETH G GEO GIB GRC(USA) HNG I I(USA) ISL KAZ LBY MLT RUS SUI TJK TUN UKR
	REG2	ALS B BER(USA) BRB(USA) CAN CHL GRL HND HWA MDW MRT PNR PTR TRD(USA) USA
	REG3	AUS BGD CHN CLN GUM HKG J MHL(USA) MLA PAK PNG SNG*
3 104	REG1	E GEO GIB I IRL ISL RUS SDN TUN UAE UKR
	REG2	ALS
	REG3	J NPL
3 107	REG1	CNR D E F G GRC(USA) I KAZ LTU MDA MNG RUS S UKR ZMB
	REG2	ALS B BER(USA) CG7 CHL HWA MDW PNR PTR USA
	REG3	AUS BRM CHN GUM IND INS J MHL(USA) PAK PNG
3 110	REG1	AFS ALB AZR CNR D E EGY G GRC(USA) I ISL KAZ LTU MDA MNG MRC NIG RUS S TJK TUR UKR UZB
	REG2	ALS B BER(USA) CAN CG7 CHL GRL HWA MDW PNR PTR USA
	REG3	AUS CHN DGA(USA) GUM IND INS J(USA) MHL(USA) PAK PNG
3 113	REG1	ALB ALG AZE BLR E F G G(USA) GRC ISL KAZ KEN KGZ MDA RUS SVK TJK TKM TUN UKR UZB
	REG2	B CAN CHL DOM MEX USA VEN
	REG3	AUS CHN GUM HKG J(USA) PAK PNG SNG
3 116	REG1	AFS ALG AZE BLR D EGY G GIB I ISL KAZ KGZ MDA MLT MNG RUS SVK TJK TKM TUN UKR UZB
	REG2	B CAN CHL CTR DOM EQA MEX USA VEN
	REG3	AUS CHN CLN HKG IND J J(USA) MLA NZL PAK PNG SNG*
3 119	REGY	ATA(ARG)
	REG1	ALB BLR DJI F G GRC(USA) HOL I I(USA) KAZ MRC ROU RUS SVN UKR UZB
	REG2	ALS ARG B BER(USA) HWA MDW PNR PTR USA
	REG3	AUS BGD CHN FJI GUM IND INS J KIR MHL(USA) PNG
3 122	REGY	ATA(ARG)
	REG1	AZR BLR E EGY F G GEO GRC(USA) HOL I I(USA) KAZ MRC ROU RUS TUR UKR
	REG2	ALS ARG B BER(USA) BOL CAN GRL HWA MDW PNR PTR USA
	REG3	AUS BGD CHN FJI GUM INS J KIR MHL(USA) NZL PAK PNG
3 125	REG1	BLR CYP(G) G GEO HOL KAZ LBR MLT MNG MWI ROU RUS SMR
	REG2	BLZ
	REG3	J PAK SMO
3 128	REG1	BEL BLR G GRC HNG HOL I KAZ LVA NIG ROU RUS UKR
	REG2	ALS BES CAN CUB CUW HWA MDW PNR PTR SXM URG USA
	REG3	AUS CHN FJI GUM HKG IND INS J MHL(USA) NCL NZL OCE PAK PNG
3 131	REG1	BEL EGY G GRC HOL I LSO LVA MNG RUS SRL TKM UKR
	REG2	ALS BES BOL CAN CHL CUB CUW EQA GTM HWA MDW PNR PTR SUR SXM URG USA
	REG3	AUS CHN CKH FJI GUM IND INS J MHL(USA) NCL NZL OCE PAK PNG VUT

1	2	
3 134	REG1	ARM ARS(USA) AZE AZR BUL D(USA) E G HOL I KAZ LVA OMA RUS TJK TKM TUR(USA) UKR UZB
	REG2	ALS B BER(USA) DOM HWA JON PRG USA VEN
	REG3	AUS CHN GUM IND J MHL(USA) PNG TLS
3 137	REG1	ARM ARS(USA) AZE AZR BHR BUL D(USA) E EGY F G G(USA) I ISL KAZ LVA MDA MNG MRC NIG RUS TJK TKM TUR(USA) UKR UZB
	REG2	ALS B BER(USA) CAN CHL DOM EQA GRL GTM HWA JON PRG SUR USA VEN
	REG3	AUS CHN GUM IND J(USA) MHL(USA) PHL(USA) PNG TLS
3 140	REGY	ATA(ARG)
	REG1	ALG AZE CME COG D F G GAB GEO GRC I KAZ LVA MDA MDG MKD MLI ROU RUS SEN* TCD TJK UKR
	REG2	ALS ARG B BER(USA) GRL HWA JON PNR USA
	REG3	AUS CHN GUM J J(USA) MHL(USA) PNG
3 143	REGY	ATA(ARG)
	REG1	ALG AZE BIH CME COG CTI CYP(G) D EGY F G GAB GEO GIB GRC HRV KAZ KGZ LVA MDG MKD MLI* MLT MNE MRC ROU RUS SEN SRB SVN TCD TJK TUN UKR
	REG2	ALS ARG B BER(USA) CAN GRL HWA JON PNR USA
	REG3	AUS BRM CHN GUM J J(USA) MHL(USA) PNG
3 146	REG1	AZE BEL COM CYP G GHA I KGZ MLT MNG RUS
	REG2	BAH
	REG3	J NRU PAK
3 149	REG1	AGL ALG AZE BLR BUL CME COG D D(F) EST G GAB GHA GRC I KAZ MDG MLI* MLT MTN ROU RUS SEN* TCD TUN UKR
	REG2	ALS CAN DOM HWA MDW MEX PNR PTR USA
	REG3	AUS BRM CHN GUM INS J PAK PNG WAK
3 152	REG1	ALG BLR BUL CME COG CTI D D(F) EGY G GAB KAZ MDG MLI* MRC NIG ROU RUS SEN TCD TUN UAE UKR
	REG2	ALS ARG B BOL CAN CHL CLM DOM EQA HWA MDW MEX PNR PRG PRU PTR SUR URG USA VEN
	REG3	AUS CHN GUM INS J NZL PNG WAK
3 900	REG1	ALG BIH CME COG CZE D E F G ISL KAZ KGZ LTU MDA MDG MLI* OMA RUS SEN TCD TJK TKM TUN TUR UKR
3 903	REG1	AFS ALG CME COG CTI CZE D EGY F G HRV ISL KAZ KGZ LTU MDA MDG MLI MNE MRC REU RUS SEN* SRB SVN TCD TJK TKM TUN TZA UGA UKR
3 906	REG1	ALB AZE BEL GMB HOL HRV IRL KAZ MLT NIG RUS TZA UGA UKR YEM
3 909	REG1	AZE BLR COG DJI(F) E F G GIB HRV KAZ LVA MDG REU RUS SEN TCD UKR UZB
3 912	REG1	BLR COG CTI EGY F G GIB HRV KAZ LVA MDG MNE MRC RUS SEN SRB SVN TCD UKR UZB
3 915	REG1	ALB ALG BLR COM CZE F G GRC KAZ LTU LVA MNG ROU RUS SSD SVK TJK TKM UKR UZB YEM
3 918	REG1	AFS ALB ALG BLR CZE EGY ERI ETH F G I KAZ LTU LVA MRC NIG ROU RUS SVK TJK TKM UKR UZB
3 921	REG1	ALG DJI F G GRC KWT LVA MLT POR ROU RUS UKR UZB ZMB
3 924	REG1	AZR BEN CYP(G) D EGY F G GEO GIB GRC LSO LVA MLT POR ROU RUS SEY UAE UKR
3 927	REG1	BUL GEO GIB HOL IRL LBR LIE MWI RUS SDN TUR
3 930	REG1	AFS ALG BUL CAF CME CYP(G) DJI(F) G GIB GRC HOL LVA MDG MLI MLT ROU RUS SMR SVK TUN UKR
3 933	REG1	ALG AUT CAF CME CTI CYP(G) D DJI(F) E F G GIB GRC I KAZ LVA MDG MLI MLT MRC QAT ROU RUS SVK TUN UKR
3 936	REG1	AFS AZE BEL CNR E G I KAZ NIG POL RUS TJK TUR UZB YEM

1	2	
3 939	REG1	AFS AZE CNR CYP(G) D E F G GRC I KAZ MLT POL RUS TJK TUN UZB YEM
3 942	REG1	CYP CZE F G GIB ISL KAZ LVA NOR POL RUS SRL SWZ UKR UZB YEM
3 945	REG1	AFS ALG CZE ERI ETH F G GIB GRC ISL KAZ LVA MRC NOR POL RUS SEN UKR UZB
4 700	REG1	ARM ARS AZE BEN BHR(USA) CYP(G) G GIB I KAZ KEN LBY MLT POL RUS SEY SWZ TJK TKM
	REG2	ALS B CAN DOM HWA MDW MEX PNR PTR USA
	REG3	AUS BGD BRM CHN DGA(USA) FJI GUM HKG IND J(USA) KOR MAC MHL(USA) NZL PAK PNG TLS
4 703	REG1	AFS ALG ARM ARS AZE AZR BHR(USA) CYP(G) DNK E EGY F G GEO GIB I KAZ KEN LBY MLT MRC POL RUS SOM TJK TKM TUR
	REG2	ALS B CAN CHL DOM HWA MDW MEX PNR PTR SUR USA
	REG3	AUS BGD BRM CHN CLN FJI GUM HKG IND J J(USA) KOR MAC MHL(USA) MLA NZL PAK PNG TLS
4 706	REGY	ATA(USA)
	REG1	ALG BLR CYP(G) D F G GEO HRV I I(USA) KAZ KEN KGZ LBY LSO LTU MDA MLT RUS TJK TKM TUR UKR YEM
	REG2	ALS B BER(USA) CAN CG7 HWA MDW PAQ PNR PRG PTR URG USA
	REG3	AUS CHN DGA(USA) GUM IND J(USA) MHL(USA) NZL SNG THA
4 709	REG1	AFS ALG ARS BLR CYP(G) D F G GRC I I(USA) KAZ KEN KGZ LBR LBY LTU MDA MLT MNE OMA RUS SRB TJK TKM TUR UKR
	REG2	ALS B BER(USA) CG7 CHL HWA MDW PAQ PNR PRG PTR URG USA
	REG3	AUS CHN GUM IND INS J MHL(USA) NZL THA
4 712	REGY	ATA(USA)
	REG1	AZR BLR CYP(G) EGY F GIB I(USA) IRL ISL KAZ MLT MRC MWI POL ROU RUS SOM SRL SSD UKR YEM
	REG2	ALS BER(USA) CAN CG7 GRL HWA MDW PNR PRU PTR USA
	REG3	AUS CBG FJI GUM J(USA) KRE LAO MHL(USA) NPL PHL PNG VTN
4 715	REGY	ATA(ARG) ATA(USA)
	REG1	AGL ALB AZR BHR(USA) BLR CME DJI(F) F G GMB GRC HOL I ISL ISR KAZ LTU MDA MNG MOZ POL POR RUS STP TCD TUN TUR UKR UZB
	REG2	ALS ARG ATG(USA) BAH(USA) BER(USA) BES BRB(USA) CAN CLM CUW HWA MDW PNR PTR SXM TCA(USA) TRD(USA) USA
	REG3	AUS BGD BRM FJI GUM HKG IND J(USA) MHL(USA) MLA PAK THA
4 718	REGY	ATA(ARG) ATA(USA)
	REG1	AGL ALB ALG AZR BHR(USA) CME CPV DJI(F) F G HOL I ISL ISR KAZ KGZ LTU MDA MDG MLT MOZ POR RUS STP TCD TUN UKR UZB
	REG2	ALS ARG BER(USA) BES BRB(USA) CAN CLM CUW GRL HWA MDW PNR PRU PTR SXM TRD(USA) USA
	REG3	AUS BGD BRM CLN FJI GUM HKG IND J(USA) MHL(USA) MLA NZL PAK PNG SNG* THA
4 721	REGY	ATA(ARG)
	REG1	AGL ALG BLR CME CNR D D(USA) DJI(F) E F G GEO I KAZ KGZ MLT MOZ POR ROU RUS STP TCD TJK TUR(USA) UKR
	REG2	ALS ARG BER(USA) CAN CUB GRL HWA JON PNR PRU USA
	REG3	AUS BGD CHN GUM IND J(USA) MHL(USA) NCL NZL OCE PAK PNG THA TLS

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4 724	REGY	ATA(ARG)
	REG1	AGL ALG AZR BEL BLR CME CNR CPV D D(USA) DJI(F) E EGY EST F G G(USA) GEO HNG I KAZ MDG MOZ POR REU RUS STP TCD TJK TUR(USA) UAE UKR
	REG2	ALS ARG BER(USA) CAN CG7 CUB GRL HWA JON PNR USA
	REG3	AUS BGD CBG CHN GUM IND INS J(USA) LAO MHL(USA) NCL NZL OCE PAK PHL(USA) PNG THA TLS VTN VUT
4 727	REG1	AZE BEL BUL COG CYP(G) CZE DJI(F) F G GEO KAZ LVA MDG QAT ROU RUS SEN TCD TJK TUN TUR UKR
	REG2	ALS BER(USA) CAN CUB FLK GRL HWA JON URG USA
	REG3	AUS BRM CHN GUM IND J MHL(USA) THA TON
4 730	REG1	AFS AZE BUL COG CTI CYP(G) CZE F G GEO I KAZ LVA MDG MNG ROU RUS SEN TJK TUN UKR YEM
	REG2	ALS ATG BER(USA) CAN CUB DMA EQA FLK GRD GRL HWA JMC JON KNA LCA URG USA VCT
	REG3	AUS BRM CHN GUM IND INS J(USA) MHL(USA) NZL THA
4 733	REG1	ALG BDI BEL COM DJI E G GUI KWT LBN LIE MLT MRC NMB RUS S SDN SMR TKM UAE
	REG2	BAH HND HWA NCG PRU USA
	REG3	AUS BTN GUM J MLD NRU SMO VUT
4 736	REGY	ATA(ARG)
	REG1	AFS ALB ALG ARS AUT AZE AZR BLR BUL COG D DJI(F) E ERI ETH F GRC I IRL KAZ LBN MDG MLI MRC NOR OMA POR REU RUS SEN* TCD TJK TKM UKR UZB
	REG2	ALS ARG B BER(USA) CAN CG7 HND HWA JON MDW MEX MRT PNR PTR USA
	REG3	AUS CHN GUM IND J MHL(USA) NZL THA TUV WAK
4 739	REGY	ATA(ARG)
	REG1	ALB ALG ARS AUT AZE AZR BLR COG CTI D EGY F G GIB I ISL KAZ LBN MDG MLI NOR POR ROU RUS SEN* TCD TJK TKM UKR UZB
	REG2	ALS ARG B BOL CAN CG7 HWA JON MDW MRT PNR PTR USA
	REG3	AUS CHN FJI GUM IND J MHL(USA) MLA* NZL PAK PNG SNG THA WAK
4 742	REG1	ALG CME COG CYP DJI(F) F G GEO GIB I KAZ MDG MKD MLI MNG POL POR REU ROU RUS SEN* TCD TGO TUN UZB YEM
	REG2	ALS BER(USA) CAN CHL GRL HND HWA JON PRG URG USA VEN
	REG3	AUS BRU CHN FJI GUM HKG IND IRN J J(USA) KOR MHL(USA) PAK PNG
4 745	REG1	AZR BEL CME COG CTI D DJI(F) EGY F G GEO I ISL KAZ MDG MLI* MRC POL POR REU RUS SEN SUI TCD TGO TUN TUR UZB YEM ZMB
	REG2	ALS BER(USA) CAN CHL GRL HND HWA JON PRG URG USA VEN
	REG3	AUS CBG CHN FJI GUM IND IRN J(USA) KOR LAO MHL(USA) NZL PNG VTN
5 684	REGY	ATA(ARG)
	REG1	AGL ALB AZE AZR BLR CPV CYP D F G GEO I KAZ KWT LVA MOZ POR RUS SRL STP TJK TKM UKR UZB YEM
	REG2	ARG BES CAN CUW MEX PRG SXM USA
	REG3	AUS CHN GUM HKG IND J(USA) KOR SMO THA VTN
5 687	REGY	ATA(ARG)
	REG1	AFS AGL ALB AZE AZR BLR CPV D E EGY G GEO GIB HRV I KAZ LVA MNE MOZ NIG OMA POR RUS SRB STP SVN TJK TKM UKR UZB
	REG2	ARG BES CAN CUW EQA MEX PRG SXM USA
	REG3	AUS CHN GUM IND INS IRN J KOR NZL PNG THA VUT
5 690	REG1	BDI DJI E GMB GNE GRC HOL I IRL ROU RUS SWZ TUR UAE
	REG2	HTI
	REG3	CHN IRN J TON

1	2	
5 693	REGY	ATA(ARG)
	REG1	AFS ARS AZR CME COG CYP(G) F G GIB I IRQ ISL ISR KAZ LVA MLI MRC ROU RUS SVK TUN TUR UKR YEM
	REG2	ALS ARG ATG(USA) BAH(USA) BER(USA) BRB(USA) CAN CG7 HWA MDW PNR PTR TCA(USA) TRD(USA) USA VEN
	REG3	AUS BGD BRM GUM HKG J J(USA) MLA NZL PAK PNG THA
5 696	REGY	ATA(ARG)
	REG1	ARS BEL CME COG CTI CYP(G) EGY G GIB GRC(USA) IRQ ISL KAZ KEN LBY LVA MCO MDG MLI MLT OMA ROU RUS SOM SVK TUR UKR
	REG2	ALS ARG BER(USA) BOL BRB(USA) CAN CG7 GRL GTM HWA MDW MEX PNR PTR TRD(USA) USA VEN
	REG3	AUS BGD BRM CLN FJI GUM J(USA) NZL PAK SNG THA
5 699	REGY	ATA(ARG)
	REG1	ALG AZR BFA BLR CME DJI(F) F G GAB KAZ LTU LVA MDA MLI MNE MWI RUS SRB TCD TUR UKR
	REG2	ALS ARG CAN GRL GTM HWA MEX PTR USA
	REG3	AUS BRM CHN GUM IND IRN J MAC MHL(USA) NZL PAK THA VTN
5 702	REGY	ATA(ARG)
	REG1	ALG AZR BFA BLR CME CTI DJI(F) E EGY ERI ETH F G G(USA) GAB GRC HOL KAZ LSO LTU LVA MDA MDG MLI* MNE MRC MTN OMA POR REU ROU RUS SEN* SRB TCD TJK UKR UZB
	REG2	ALS ARG BOL CAN CLM GRL MEX USA
	REG3	AUS BRM CHN FJI IND INS IRN J(USA) MAC NZL PNG THA
5 705	REG1	BEN CYP(G) ERI ETH F G GIB GRC HOL KAZ MLT QAT ROU RUS TJK UAE UKR UZB ZMB
	REG2	ATG B BLZ DMA GRD JMC KNA LCA VCT
	REG3	BRU HKG J MLD NPL NRU
5 708	REG1	AFS AGL COG F GRC HNG IRL IRQ KAZ KGZ LBN MTN* NOR OMA POL ROU RUS SEN SEY SYR TJK TKM TUN TUR YEM
	REG2	ALS B BER(USA) BOL CAN CHL CLM GRL HWA MDW USA
	REG3	AUS BRM CHN IND J KOR MHL(USA) NZL PNG SNG THA TLS
5 711	REG1	AGL COG CTI F G GIB GRC IRQ ISL KAZ KGZ LBN MDG MRC MTN* NOR POL RUS SEN SYR TJK TKM TUN TUR UAE UKR YEM
	REG2	ALS B BER(USA) BOL CAN CHL CLM GRL HWA MDW USA
	REG3	AUS BRM CHN IND J(USA) KOR MHL(USA) MLA NZL PNG THA TLS
5 714	REGY	ATA(USA)
	REG1	AFS ARM AUT AZE BLR BOT BUL CME CTI CYP(G) D D(F) DJI(F) F G GIB HRV I KAZ MLI MLT MNG NMB(AFS) REU ROU RUS TCD TGO TJK TKM TUN UKR UZB
	REG2	ALS B CAN CUB HWA MDW PNR PTR USA
	REG3	AUS CHN DGA(USA) FJI GUM J(USA) MHL(USA) NZL PAK THA
5 717	REGY	ATA(USA)
	REG1	AFS ARM AUT AZE AZR BLR BOT BUL CME CTI CYP(G) D D(F) DJI(F) E EGY EST ERI ETH F G GRC KAZ MDG MLI MLT MRC NMB(AFS) OMA REU ROU RUS SEN* TCD TGO TJK TKM TUN UKR UZB
	REG2	ALS B BOL CAN CHL CUB GTM HWA MDW MEX PNR PTR USA
	REG3	AUS CBG CHN DGA(USA) FJI GUM J(USA) LAO MHL(USA) NZL PAK PNG THA VTN
5 720	REG1	ALG BEL COM CYP(G) G GIB ISL LBR LIE MLT NMB OMA ROU RUS SMR SSD TKM UAE
	REG2	BAH BOL GTM
	REG3	HKG IND J KRE PHL TUV

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5 723	REGY	ATA(USA)
	REG1	AFS ALG AZE BHR(USA) BLR COG F G GRC(USA) HNG I ISL KAZ LVA MRC MTN NMB(AFS) POR RUS SEN* SOM SVK TKM UAE UKR
	REG2	ALS ATG(USA) B BER(USA) BRB BRB(USA) CAN CG7 CHL HND HWA MDW PNR PTR TCA(USA) URG USA
	REG3	AUS CHN GUM IND J J(USA) KOR MHL(USA) NCL OCE PNG THA
5 726	REGY	ATA(USA)
	REG1	AFS ALG AZE AZR BHR(USA) BLR COG CTI EGY F G GIB I ISL KAZ LVA MDG MTN NMB(AFS) POR ROU RUS S SEN* SVK TKM UKR YEM
	REG2	ALS ATG(USA) B BAH(USA) BER(USA) BRB CAN CG7 CHL GRL HND HWA MDW PNR PTR TCA(USA) URG USA
	REG3	AUS CBG CHN GUM IND J J(USA) KOR LAO MHL(USA) NCL NZL OCE THA VTN VUT
6 685	REG1	AFS AGL ALB ARS AZE BHR(USA) CPV D EGY G GEO GNB GRC(USA) I I(USA) ISL KAZ MOZ MNE MRC NIG NOR POR RUS SRB STP SUI SVK TJK TUR UZB
	REG2	ALS B BER(USA) CAN CG7 DOM EQA HWA MDW MEX PNR PTR URG USA
	REG3	AUS CBG CHN CLN GUM HKG IND J LAO MHL(USA) MLA PAK PNG SNG* VTN
6 688	REG1	ALB ALG AZR EGY F FIN G GRC(USA) HRV I I(USA) ISL MLT MRC RUS SVK TJK TUN YEM ZMB
	REG2	ALS CG7 DOM HWA MDW NCG PNR PTR USA
	REG3	AFG AUS BGD FJI GUM J KRE MHL(USA) PAK VUT
6 691	REGY	ATA(ARG)
	REG1	ALG ARS AZR BUL CYP(G) CZE E G GHA GIB HNG I I(USA) KAZ KEN LBY MLT ROU RUS TJK TKM UZB
	REG2	ALS ARG CAN CLM HWA MDW MEX PNR PTR USA
	REG3	AUS BGD BRM CHN GUM HKG IND J J(USA) KOR PAK SLM SNG WAK
6 694	REGY	ATA(ARG)
	REG1	ALG ARS AZR BLR BUL CYP(G) CZE EGY ERI ETH G GIB I I(USA) KAZ KEN LBY NIG OMA ROU RUS SOM TKM UZB
	REG2	ALS ARG CAN HWA MDW MEX PNR PTR USA
	REG3	AUS BRM CHN CLN FJI GUM HKG IND J(USA) KOR MLA NZL PNG SNG* WAK
6 697	REGY	ATA(ARG)
	REG1	ARS BDI BHR(USA) BLR CYP(G) D G I I(USA) ISL MLT MRC RUS SMR
	REG2	ALS ARG BER(USA) CAN CG7 HWA MDW PNR PTR TRD USA
	REG3	AUS BGD GUM HKG J(USA) PAK THA
6 700	REGY	ATA(ARG)
	REG1	ARS AZR BHR(USA) CYP(G) D EGY F G GIB GRC I I(USA) ISL KEN LBY MLT MRC RUS SOM TUR
	REG2	ALS ARG ATG(USA) BAH(USA) BER(USA) BRB CAN CG7 GRL HWA MDW PNR PTR TCA(USA) TRD USA
	REG3	AUS BGD CLN GUM HKG J(USA) MHL(USA) MLA NZL PAK PNG SNG* THA
6 703	REG1	ALB BEN ERI ETH I IRL ISL LUX NMB QAT RUS SEY SVN UKR
	REG2	HTI
	REG3	J MLD NPL PHL SMO
6 706	REG1	AFS BLR CYP(G) EGY G GIB GNE GRC KAZ MDA MLT MNE RUS SRB SVK UKR UZB YEM
	REG2	ALS B CAN CUB HWA MDW PNR PTR USA
	REG3	AUS BGD CHN DGA(USA) FJI GUM HKG IND INS J KIR MAC MHL(USA) NZL PAK THA

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6 709	REG1	BEL BIH BLR CYP(G) G GEO HRV KAZ KEN LBY LSO MDA MLT MNE ROU RUS SOM SRB SVN UKR UZB
	REG2	ALS B CAN CUB HWA MDW PNR PTR SUR USA
	REG3	AUS BGD CHN CLN FJI GUM HKG IND INS J KIR MAC MHL(USA) NZL PAK PNG THA VTN
6 712	REG1	AFS ALG AUT AZE BLR CME COG CYP(G) D D(F) DJI(F) F G GEO ISL ISR KAZ LVA MDG MLI* MLT MTN OMA REU ROU RUS SEN* TCD TGO TJK TKM TUN TUR TUR(USA) UKR UZB
	REG2	B CAN HWA MEX PNR USA
	REG3	AUS BRM CHN IND J(USA) KOR PAK THA TLS VTN
6 715	REG1	AFS ALG AUT AZE BLR CME COG CTI D D(F) DJI(F) E F G G(USA) HNG ISR KAZ LVA MDG MLI MRC MTN* REU ROU RUS SEN* TCD TGO TJK TKM TUN TUR(USA) UAE UKR UZB
	REG2	B CAN GRL HWA MEX PNR SUR USA
	REG3	AUS BRM CHN FJI GUM IND INS J(USA) KOR NZL PAK PHL(USA) PNG THA TLS
6 718	REG1	AGL ALG CYP F HOL IRL MLT NIG ROU TUR TZA UZB YEM
	REG2	BAH
	REG3	IND NRU PAK
6 721	REGY	ATA(ARG) ATA(USA)
	REG1	AGL ARS AZR BHR(USA) F G GEO GRC(USA) HOL I I(USA) JOR KAZ LTU MDA MRC RUS SRL TJK TZA UKR UZB
	REG2	ALS ARG BER(USA) CAN CG7 HWA MDW MEX PNR PTR USA
	REG3	AUS CHN FJI GUM IND J(USA) MHL(USA) NZL SNG THA
6 724	REGY	ATA(ARG) ATA(USA)
	REG1	AFS ARS BHR(USA) CNR E EGY G GEO GRC GRC(USA) HRV I I(USA) KAZ LBR LTU MDA MNE MRC RUS SRB SVN TJK UKR UZB
	REG2	ALS ARG BER(USA) CG7 GRL HWA MDW MEX PNR PTR SUR USA
	REG3	AUS CHN FJI GUM IND J(USA) MHL(USA) MLA* NZL PNG SNG THA
6 727	REGY	ATA(ARG)
	REG1	AGL ALG ARS ARS(USA) AZR D(USA) ERI ETH G GRC KAZ LIE MOZ RUS STP TUR(USA) UKR UZB
	REG2	ALS ARG BER(USA) CAN CUB GRL GUY HWA JON MDW PNR USA
	REG3	AUS CHN GUM IND J MHL(USA) THA
6 730	REGY	ATA(ARG)
	REG1	AGL ALG ARM ARS ARS(USA) AZR CPV D D(USA) DNK E ERI ETH F G GNB GRC ISL KAZ MOZ NIG POR ROU RUS STP SYR TUR(USA) UKR UZB
	REG2	ALS ARG BER(USA) CAN CG7 CUB GRL GUY HWA JON MDW PNR USA
	REG3	AUS CHN GUM IND J J(USA) MHL(USA) MLA NZL PAK PNG SNG* THA
6 733	REG1	ALG ARM F G GUI I KEN NIG RUS SWZ TUR UAE YEM
	REG2	B
	REG3	IND J TUV VTN
6 736	REG1	AFS ARM ASC(USA) AZE CYP(G) CZE G GIB GRC I ISL KEN MLT MRC NMB(AFS) OMA ROU RUS SEY(USA) TJK TKM
	REG2	ALS B BER(USA) CAN CHL CLM GTM HWA PNR PTR URG USA
	REG3	AUS BRM CHN GUM J KOR MHL(USA) PAK SNG THA VTN
6 739	REG1	AFS ARM ASC(USA) AZE CYP(G) CZE EGY F G G(USA) I MLT NMB(AFS) ROU RUS TJK TKM TUR(USA) UKR YEM
	REG2	ALS BER(USA) CHL CLM GRL GTM HND HWA PNR PTR SUR URG USA
	REG3	AUS BRM CHN CLN GUM J(USA) KOR MHL(USA) MLA NZL PAK PNG THA VTN VUT

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6 742	REG1	BFA BLR CAF CME COG CYP(G) DJI(F) F FIN G GIB GRC KAZ LVA MDG MLI* NGR POL REU RUS SEN TCD TGO TUN TUR UKR
	REG2	ALS BER(USA) CAN CG7 CHL CUB GTM HWA JON MDW PNR PTR USA
	REG3	AUS CHN GUM HKG IND IRN J MHL(USA) NZL SNG THA VTN WAK
6 745	REG1	ALG ASC(USA) BFA BLR CAF CME CNR COG CTI CYP(G) CZE DJI(F) E EGY F FIN G GIB GRC HNG KAZ LVA MDG MLI MLT MRC NGR POL REU RUS SEN* SEY(USA) TCD TGO TUN UKR
	REG2	ALS BER(USA) BOL CAN CG7 CHL CUB GTM HWA JON MDW PNR PTR USA
	REG3	AUS BGD CBG CHN FJI GUM HKG IND IRN J LAO MHL(USA) NZL PNG SNG THA VTN WAK
6 748	REG1	BEL BUL CYP(G) E G GMB GRC KWT MLT POR REU RUS SDN UAE UKR ZWE
	REG2	ATG DMA GRD JMC KNA LCA VCT
	REG3	BGD BRU J TON
6 751	REG1	ASC(USA) BFA BUL CME COG COM CTI CYP(G) D DJI E F G HNG KGZ LVA MNE MTN OMA POR RUS SEN* SRB TCD TUN UAE UKR
	REG2	B CAN CHL HWA JON MEX USA
	REG3	AUS CHN FJI GUM IND INS J J(USA) MHL(USA) NZL THA VTN
6 754	REG1	ALG ASC(USA) BFA COG CTI D EGY ERI ETH F G GRC KGZ LVA MDG MRC NIG RUS SEN TCD TUN UAE UKR
	REG2	B BOL CAN CHL HWA JON MEX SUR USA
	REG3	AUS CBG FJI GUM IND INS J LAO MHL(USA) NZL THA VTN VUT
6 757	REGY	ATA(ARG)
	REG1	ARS AZE BLR COG F G GIB KAZ KGZ LVA MLT MWI RUS SEN SVK TCD TJK TKM TUN UKR
	REG2	ARG BER(USA) BES BOL CUW HWA JON SXM USA
	REG3	AUS BRM CHN GUM IND J MHL(USA) THA TLS
6 760	REGY	ATA(ARG)
	REG1	ALG ARS AZE BLR COG CTI F G ISL ISR KAZ KGZ LVA MDG MRC RUS SEN SVK TCD TJK TKM TUN UKR
	REG2	ALS ARG BER(USA) BES CUW HWA JON SXM USA
	REG3	AUS BRM CHN GUM IND J J(USA) MHL(USA) MLA NZL PNG SNG* THA TLS
8 965	REG1	AFS ASC(USA) CTI CYP(G) D EGY ERI ETH G GIB KEN NMB(AFS) RUS SMR TUR
	REG2	ALS B CAN GRL HWA MEX PNR USA
	REG3	AUS BRM FJI HKG J(USA) KRE MHL(USA) NZL PAK PNG
8 968	REG1	AFS ARS CYP(G) D G GIB HRV KEN LBY MLT MNE NIG NMB(AFS) OMA RUS SOM SRB SVN
	REG2	ALS B BOL CAN GRL HWA MEX PNR USA
	REG3	AUS BRM CLN FJI HKG INS J(USA) MHL(USA) MLA NZL PNG SNG*
8 971	REGY	ATA(ARG)
	REG1	ARS AZE AZR BHR(USA) BLR E F G GEO GRC(USA) HOL HRV I I(USA) ISL ISR KAZ KGZ LVA MRC RUS S TJK TKM UKR ZMB
	REG2	ALS ARG ATG(USA) BAH(USA) BER(USA) BES BOL BRB(USA) CG7 CUW DOM HWA MDW PNR PTR SXM TCA(USA) TRD(USA) USA
	REG3	AUS BRM CHN DGA(USA) GUM J(USA) MHL(USA) PNG VTN
8 974	REGY	ATA(ARG)
	REG1	AFS AZE AZR BLR E GEO GNE GRC(USA) HOL I I(USA) IRL ISL ISR KAZ KGZ LVA MRC RUS TJK TKM UKR YEM
	REG2	ALS ARG ATG(USA) BAH(USA) BER(USA) BES BRB(USA) CG7 CUW DOM HWA MDW PNR PTR SXM TCA(USA) USA
	REG3	AUS BRM CHN GUM J(USA) MHL(USA) NZL PNG VTN

1	2	
8 977	REG1	ALB ARS BHR(USA) G GRC(USA) I ISL MRC MWI OMA RUS UKR
	REG2	ALS BRB(USA) HWA MDW PNR PTR TRD(USA) USA
	REG3	AUS CBG CLN DGA(USA) GUM INS J(USA) LAO
8 980	REGY	ATA(ARG)
	REG1	ALB ALG ARS AZR BFA BHR(USA) CME COG CYP(G) D DJI(F) F G I KAZ LBN MDG REU RUS SEN TCD TGO TUN UZB
	REG2	ALS ARG ATG(USA) BAH(USA) BER(USA) BRB BRB(USA) CG7 HWA MDW PNR PTR TCA(USA) USA
	REG3	AUS CHN GUM HKG IND INS J(USA) MHL(USA)
8 983	REGY	ATA(ARG)
	REG1	ALG BFA BHR(USA) CME COG CYP(G) D DJI(F) F G HNG I KAZ LBN MDG MLT MNG MRC MTN OMA REU RUS SEN* TCD TGO TUN UZB
	REG2	ALS ARG BER(USA) BRB(USA) CG7 GRL HWA MDW PNR PTR USA
	REG3	AUS CBG CHN GUM IND J(USA) LAO MHL(USA) NZL PNG VTN
8 986	REG1	ALG BHR(USA) CYP(G) F G GRC KGZ MDG MLT ROU RUS TUR UKR YEM
	REG2	BRB(USA) CG7
	REG3	J J(USA) PHL TUV
8 989	REG1	AGL BEL BLR G KAZ KGZ LVA MCO MDA MOZ POL POR ROU RUS STP UKR UZB YEM
	REG2	ALS BER(USA) CAN GRL HWA MEX USA
	REG3	AUS BRM FJI IND J J(USA) NZL
8 992	REG1	AGL ASC(USA) BLR CPV F G GNB GRC ISL KAZ LVA MDA MOZ POL POR RUS S STP SSD UKR UZB
	REG2	ALS BER(USA) CAN CHL HWA MEX USA
	REG3	AUS BRM CHN FJI GUM IND J(USA) NZL PNG
8 995	REG1	ARS AZR COM CYP(G) G GIB GRC ISL LBR MLT MNG RUS UKR YEM
	REG2	BLZ
	REG3	BRU HKG TON
8 998	REGY	ATA(USA)
	REG1	AGL AZR BHR(USA) BLR COG F G GRC(USA) HOL ISL LVA MDG MTN NOR SEN* TUN UAE UKR
	REG2	ALS B BER(USA) CG7 CUB HWA MDW PNR PTR TRD(USA) USA
	REG3	AUS CHN GUM IND J(USA) MHL(USA) NZL
9 001	REGY	ATA(USA)
	REG1	AGL ALG ARM BHR(USA) BLR COG CTI CYP(G) EGY F G GRC(USA) HOL I(USA) ISL JOR LVA MDG MLT MRC MTN NOR SEN* TUN UKR
	REG2	ALS B BER(USA) CG7 CUB HWA MDW PNR PTR TRD(USA) USA
	REG3	AUS CHN DGA(USA) GUM HKG IND J(USA) MHL(USA) NZL
9 004	REG1	ARM BDI BEN BLR CYP(G) IRL ISL KWT LSO LUX MLT ROU
	REG2	B BAH
	REG3	HKG IRN J MLD NRU
9 007	REG1	AZR BUL CME COG G GIB GRC GRC(USA) I(USA) ISL KAZ MDG MLT MNE REU ROU RUS SEN SRB TCD
	REG2	ALS B CAN HWA MDW MEX PNR PTR USA
	REG3	AUS BRM CHN FJI GUM INS IRN J KIR VTN WAK
9 010	REG1	ARS AZR BEL BUL CME COG CTI G KAZ LIE MDG REU RUS SEN TCD TUR
	REG2	ALS ARG B CAN HWA MDW MEX PNR PTR USA VEN
	REG3	AUS BRM FJI GUM INS IRN J KIR NZL PAK VTN WAK
9 013	REG1	AFS ARS ERI ETH G GMB GRC HRV MLT MOZ RUS UKR
	REG2	ARG ATG DMA GRD GTM JMC KNA LCA VCT
	REG3	AUS FJI IND J

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9 016	REG1	AUT COG F G GIB HNG MDG RUS SEN TCD TUN TUR UKR
	REG2	BER(USA) CHL CUB
	REG3	AUS CHN FJI HKG IRN J(USA) NZL PAK SNG THA
9 019	REG1	ALG AUT CNR COG CTI E F G GIB GRC MDG MLT MRC NIG RUS SEN TCD TUN UKR
	REG2	ALS BER(USA) BOL CHL CUB HWA
	REG3	AUS CHN IRN J MLA* NZL PAK PNG SNG THA VUT
9 022	REGY	ATA(ARG)
	REG1	AFS ALG ARM AZE AZR COG CYP(G) CZE D(USA) EGY ERI ETH F G GEO KAZ MDG MLT REU RUS SEN SOM TJK TKM UZB
	REG2	ARG BER(USA) CAN GRL HWA JON PNR PTR USA
	REG3	AUS CHN GUM HKG IND J MHL(USA) NZL
9 025	REGY	ATA(ARG) ATA(NZL)
	REG1	AFS ALG ARM AZE AZR COG CYP(G) CZE D D(USA) E EGY G GEO GIB KAZ MDG MLT REU ROU RUS SEN TJK TKM UZB
	REG2	ARG BER(USA) CUB HWA JON MEX PNR PTR USA
	REG3	AUS CHN FJI GUM HKG IND J(USA) MHL(USA) NZL PAK PHL(USA) PNG SNG THA
9 028	REG1	COD E G G(USA) GIB GRC MLT MRC QAT ROU RUS UAE UZB
	REG2	ALS CAN CG7 CUB GRL HWA MEX USA
	REG3	AUS J MLA SMO
9 031	REGY	ATA(USA)
	REG1	CYP(G) G G(USA) GIB GRC(USA) I I(USA) MLT MRC POL RUS SVK SWZ TUR
	REG2	ALS BER(USA) CAN CHL CLM HWA MDW PNR PTR URG USA
	REG3	AUS BGD BRM CHN GUM J MHL(USA) MLA NZL PAK TLS WAK
9 034	REGY	ATA(USA)
	REG1	AUT DNK G G(USA) GHA GRC(USA) I I(USA) MRC NIG POL RUS SEY TUR YEM
	REG2	ALS BER(USA) CHL CLM EQA HWA MDW PNR PTR URG USA
	REG3	BGD BRM CHN GUM INS J MHL(USA) MLA NZL PAK SMO TLS WAK
9 037	REGY	ATA(USA)
	REG1	AUT CYP DJI G I I(USA) LTU MRC NMB RUS SRL TUR UAE
	REG2	ALS CAN HWA MDW PNR PTR USA
	REG3	AUS DGA(USA) GUM J(USA) MHL(USA) NPL WAK
11 175	REG1	ASC(USA) G GRC MLT SDN TUR(USA) UAE
	REG2	ALS HWA USA
	REG3	AUS GUM J(USA)
11 178	REGY	ATA(ARG)
	REG1	AGL G GRC MOZ NIG NOR POL POR RUS STP TUN TUR(USA)
	REG2	ALS ARG BES CLM CUW HWA JON SXM USA
	REG3	AUS CHN GUM IND INS J J(USA) MHL(USA) NZL
11 181	REGY	ATA(ARG)
	REG1	AGL AZR CPV E EGY G GNB ISL MOZ NOR POL POR RUS STP TUR TUR(USA)
	REG2	ALS ARG BES CLM CUW JON SXM USA
	REG3	AUS CHN GUM IND INS J(USA) MHL(USA) NZL
11 184	REG1	CYP(G) E G GNE ISL MKD MLT MNG ROU TUR
	REG2	BLZ
	REG3	J MLD TON

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11 187	REGY	ATA(USA)
	REG1	ALG BEL BHR(USA) BLR CME COG DJI(F) ERI ETH F GEO GRC(USA) ISL ISR KAZ LVA MDG ROU RUS SEN TCD TJK TKM UKR UZB
	REG2	ALS ATG(USA) BAH(USA) BER(USA) BRB(USA) CAN CHL HWA MDW MEX PNR PTR TCA(USA) TRD(USA) USA
	REG3	AUS CHN DGA(USA) GUM IRN J(USA) MHL(USA)
11 190	REGY	ATA(USA)
	REG1	ALG BHR(USA) BLR CME COG DJI(F) GEO GRC ISR KAZ LVA MDG MRC ROU RUS SEN TCD TJK TKM UKR UZB
	REG2	ALS ATG(USA) BAH(USA) BER(USA) BRB(USA) CAN CHL HWA MDW MEX PNR PTR TCA(USA) TRD(USA) USA
	REG3	AUS BRM CHN DGA(USA) GUM INS IRN J(USA) MHL(USA) NZL
11 193	REG1	CYP(G) G GRC MNG NIG RUS
	REG2	MEX URG
	REG3	IND PHL TUV
11 196	REG1	ARS BHR(USA) CYP(G) D G KEN RUS
	REG2	ALS ATG(USA) B BAH(USA) BER(USA) BRB(USA) CG7 HWA MDW PNR PTR TCA(USA) TRD(USA) URG USA
	REG3	AUS CHN GUM HKG J(USA) MHL(USA) WAK
11 199	REG1	ARS BHR(USA) CYP(G) D EGY G GIB I(USA) KEN LBY MLT MRC OMA RUS SOM
	REG2	ALS ATG(USA) B BAH(USA) BER(USA) BRB(USA) CG7 HWA MDW PNR PTR TCA(USA) TRD(USA) USA
	REG3	AUS CHN CLN GUM HKG IRN J(USA) MLA PNG SNG* WAK
11 202	REG1	BHR(USA) CYP IRL SMR TUN YEM
	REG2	ALS ATG(USA) BAH(USA) BER(USA) BRB(USA) CG7 HWA MDW PTR TCA(USA) TRD(USA) USA
	REG3	AUS GUM J(USA) WAK
11 205	REGY	ATA(ARG)
	REG1	AZR CME COG DJI(F) F G KAZ MDG MNG REU RUS SEN TGO TUN
	REG2	ALS ARG CAN CUB HWA JON MDW PNR PTR USA
	REG3	AUS GUM J WAK
11 208	REGY	ATA(ARG)
	REG1	ALG AZR CME COG CYP(G) DJI(F) F G GIB GRC(USA) HNG KAZ LBY MDG MRC REU RUS SEN TGO TUN TUR
	REG2	ALS ARG CAN CUB HWA JON MDW PNR PTR USA
	REG3	AUS CBG GUM IRN J LAO PNG VTN WAK
11 211	REG1	BEL E G OMA RUS SWZ TUN
	REG2	ALS HWA JON MDW PNR PTR
	REG3	GUM IRN J MHL(USA) WAK
11 214	REGY	ATA(ARG)
	REG1	AUT COG DJI(F) F G GAB GIB ISL MDG MLT REU RUS SEN TCD TUN
	REG2	ALS ARG BER(USA) CAN HWA MRT USA
	REG3	AUS BRU NCL NPL OCE
11 217	REGY	ATA(ARG)
	REG1	ASC(USA) AUT COG D DJI(F) F G GRC MDG MRC RUS SEN SEY(USA) TCD TUN
	REG2	ALS ARG BER(USA) CAN GRL HWA MRT USA
	REG3	AUS CHN NCL NZL OCE
11 220	REG1	BDI BEL GMB KWT ROU RUS
	REG2	CAN USA
	REG3	AUS CBG CHN J LAO VTN VUT

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11 223	REG1	BEN G MLT ROU S UKR YEM
	REG2	ALS ATG CAN DMA GRD JMC KNA LCA VCT
	REG3	AUS IRN J KRE
11 226	REG1	ARS(USA) AZR D D(USA) G MNE RUS SRB SRL TUR(USA) UKR
	REG2	ALS BER(USA) CHL CUB GRL HWA JON MDW PNR USA
	REG3	AUS BGD CHN GUM J(USA) MHL(USA) NZL PAK PHL(USA)
11 229	REG1	ARS(USA) AZR D D(USA) G MNE MRC RUS SRB TUR(USA)
	REG2	ALS BER(USA) CAN CG7 CUB GRL HWA JON MDW PNR USA
	REG3	AUS BGD CHN GUM J MHL(USA) NZL PAK
11 232	REG1	HOL IRL LIE NIG QAT RUS UAE YEM
	REG2	BAH CAN
	REG3	AUS J SNG
11 235	REG1	AFS ARM AZE BLR CYP(G) D F G KAZ KGZ LVA MNG RUS SEN TJK TKM TUN UKR UZB
	REG2	ALS ARG BER(USA) CAN GRL HWA MEX USA
	REG3	AUS BRM GUM J PNG SNG
11 238	REG1	ALG ARM AZE BLR D KAZ KGZ LSO LVA MRC RUS SEN TJK TKM TUN UKR UZB
	REG2	ALS ARG BER(USA) CAN HWA MEX
	REG3	AUS CHN IRN J J(USA) NZL
11 241	REG1	CYP(G) DJI G GIB LBR MLT RUS TUR(USA)
	REG2	USA
	REG3	CHN HKG NRU
11 244	REG1	ALG COM CYP(G) DNK G G(USA) GIB KAZ MNG RUS TUR(USA) UZB
	REG2	B BER(USA) CAN USA
	REG3	AUS FJI IRN J(USA) NZL PNG
11 247	REG1	ALG CYP(G) EGY G GIB KAZ LBY MLT RUS UZB ZMB
	REG2	B BER(USA) CAN HWA MEX
	REG3	AUS CHN CLN FJI GUM HKG J(USA) MLA NZL
11 250	REG1	ALG F G GIB GUI I NIG RUS SEY TUR
	REG2	CAN
	REG3	AUS CHN
11 253	REGY	ATA(USA)
	REG1	AZE AZR BHR(USA) BLR ERI ETH F G GRC(USA) I I(USA) KAZ MOZ MRC RUS TJK TKM UKR UZB
	REG2	ALS B BER(USA) BRB(USA) CG7 HWA MDW PNR PTR TRD(USA) USA
	REG3	CHN GUM J(USA) MHL(USA)
11 256	REGY	ATA(USA)
	REG1	AZE BHR(USA) BLR ERI ETH G GRC(USA) HOL I I(USA) ISL KAZ MRC RUS TJK TKM UKR UZB
	REG2	ALS B BRB(USA) CG7 HWA MDW PNR PTR TRD(USA) USA
	REG3	AUS BRM CHN FJI GUM INS IRN J(USA)
11 259	REGY	ATA(USA)
	REG1	AZR BHR(USA) CYP(G) G ISL MLT MWI UAE UKR
	REG2	ALS ATG(USA) BAH(USA) BER(USA) BRB(USA) CG7 HWA MDW PNR PTR TCA(USA) TRD(USA) USA
	REG3	GUM J(USA) SMO
11 262	REGY	ATA(ARG) ATA(USA)
	REG1	CZE D E G GRC(USA) I I(USA) ISL KAZ LTU MDA MRC RUS TUR UKR
	REG2	ALS ARG BER(USA) CAN CG7 HWA MDW PNR PTR USA
	REG3	AUS CHN DGA(USA) GUM IND J(USA) MHL(USA)

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11 265	REGY	ATA(ARG) ATA(USA)
	REG1	AZR BEL CZE D EGY GRC(USA) I I(USA) ISL KAZ LTU LVA MDA MNG MRC OMA POR RUS UKR UZB
	REG2	ALS ARG BER(USA) CAN CG7 HWA MDW PNR PTR USA
	REG3	CHN GUM IND J(USA) MHL(USA)
11 268	REGY	ATA(USA)
	REG1	ALG ARS BEL COG G ISL KAZ LVA MDG MLT REU RUS SEN SVN UZB
	REG2	ALS BER(USA) HWA MDW PNR PTR USA
	REG3	AUS GUM IRN J(USA) MHL(USA)
11 271	REG1	ALG ARS AZE BLR BUL COG F G GEO KAZ MDA MDG MLT MRC REU ROU RUS SEN TJK UKR UZB
	REG2	B CAN MEX
	REG3	AUS J(USA)
13 200	REG1	AFS ALG BEL CYP G GMB RUS UAE YEM
	REG2	ALS GRL HWA USA
	REG3	AUS J(USA) KRE NPL
13 203	REGY	ATA(ARG)
	REG1	ALG ARS CYP(G) D EGY G GIB KEN NIG ROU RUS SVN TUR TUR(USA) UZB
	REG2	ALS ARG BES CUW HWA JON MEX SXM USA
	REG3	AUS HKG IRN J J(USA) PNG
13 206	REGY	ATA(ARG)
	REG1	ALG ARS CYP(G) D E G GIB ISL KEN LBY MLT ROU RUS SOM SUI TUR TUR(USA) UZB
	REG2	ALS ARG BES CUW GRL HWA JON MEX SXM USA
	REG3	AUS CLN HKG IRN J MLA NZL SNG*
13 209	REG1	CYP(G) G GIB LIE LSO MLT MNG RUS SDN
	REG2	BAH
	REG3	HKG J MLD SMO
13 212	REGY	ATA(ARG)
	REG1	ARS(USA) AZR CAF CME COG CZE D(USA) ERI ETH GRC IRL MDG RUS SEN TUR(USA)
	REG2	ALS ARG BER(USA) CAN CUB GRL HWA JON PNR PTR USA
	REG3	AUS BGD CHN GUM J J(USA) MHL(USA) NZL PAK
13 215	REGY	ATA(ARG)
	REG1	ARS(USA) AZR CAF CME COG CZE D(USA) E EGY F G MDG MRC OMA RUS SEN TUR(USA)
	REG2	ALS ARG BER(USA) CAN CG7 CUB GRL HWA JON MEX PNR PTR USA
	REG3	AUS BGD CHN GUM IRN J(USA) MHL(USA) NZL PAK
13 218	REG1	CYP(G) DJI G KAZ LBR MLT MWI RUS SMR
	REG2	ALS CAN HWA MDW MEX URG USA
	REG3	AUS HKG J MHL(USA)
13 221	REG1	ALG AZE BLR CME COG D DJI(F) GEO GRC(USA) KAZ KGZ LVA MDG MLI REU RUS SEN* TCD TGO TJK TKM TUN UKR UZB
	REG2	ALS B CAN HWA MDW PNR PTR URG USA
	REG3	AUS CHN FJI GUM J(USA) KIR MHL(USA) NZL
13 224	REG1	ALG ASC(USA) AZE BLR CME COG CTI D DJI(F) F G GEO HNG JOR KAZ KGZ LVA MDG MLI MNG REU RUS S SEN* SEY(USA) TCD TGO TJK TKM TUN UKR UZB
	REG2	ALS B CAN CUB HWA MDW PNR PTR USA
	REG3	AUS CHN FJI GUM IRN J(USA) KIR MHL(USA) NZL PNG

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13 227	REG1	BEL COM GNE IRL KAZ MRC QAT RUS TUR
	REG2	ALS CAN CUB HWA MDW PNR PTR USA
	REG3	AUS CBG GUM HKG J(USA) LAO VTN
13 230	REG1	G GRC KAZ LTU MLT RUS SRL UAE YEM ZMB
	REG2	ALS CAN CG7 HWA MDW PNR PTR USA
	REG3	GUM J(USA) MHL(USA) PHL TON
13 233	REGY	ATA(ARG)
	REG1	AUT AZR CME COG D D(F) DJI(F) E F ISL KAZ MDG MLI MNG REU RUS SEN* TCD TGO TJK TKM TUN UZB
	REG2	ALS ARG BER(USA) CAN CG7 HWA MDW MRT PNR PTR USA
	REG3	CHN GUM J(USA) MHL(USA) NCL OCE
13 236	REGY	ATA(ARG)
	REG1	AUT AZR CME COG CTI D D(F) DJI(F) F G GRC(USA) I(USA) KAZ MDG MLI MRC NIG REU RUS SEN* TCD TGO TJK TKM TUN UZB
	REG2	ALS ARG BER(USA) CAN CG7 GRL HWA MDW MRT PNR PTR USA
	REG3	AUS CBG CHN GUM J(USA) LAO MHL(USA) NCL NZL OCE VTN VUT
13 239	REG1	AZR BEN G HOL KAZ KWT LUX NMB ROU RUS
	REG2	ATG DMA GRD JMC KNA LCA VCT
	REG3	BRU IRN J NRU
13 242	REG1	ALG ARM AZE BLR CAF CME COG F G G(USA) GEO KAZ MDG POL REU ROU RUS SEN TJK TKM TUN UKR UZB
	REG2	B BER(USA) HWA JON USA
	REG3	AUS CHN FJI GUM J(USA) MHL(USA) NZL OCE
13 245	REG1	ALG ARM ASC(USA) AZE BLR CAF CME COG E F G GEO GRC ISR KAZ MDG MNG POL REU RUS SEN TJK TKM TUN UKR UZB
	REG2	B BER(USA) CAN HWA JON USA
	REG3	AUS BRM CHN FJI GUM J J(USA) MHL(USA) NZL OCE VTN
13 248	REG1	ALG BLR COD CYP(G) G G(USA) MLT MNE RUS SRB UKR
	REG2	USA
	REG3	AUS HKG J SNG TUV
13 251	REGY	ATA(ARG) ATA(USA)
	REG1	AGL ALB AZR BHR(USA) BLR CYP(G) F GRC(USA) I I(USA) MOZ MRC NOR POR RUS STP UKR
	REG2	ALS ARG CAN CG7 HWA JON MDW MEX PNR PTR USA
	REG3	AUS CHN GUM IND IRN J(USA) NZL WAK
13 254	REGY	ATA(ARG) ATA(USA)
	REG1	AGL AZR BHR(USA) GRC(USA) HOL I I(USA) MNG MOZ MRC NOR POR RUS STP UZB
	REG2	ALS ARG BER(USA) CAN CG7 HWA JON MDW MEX PNR PTR USA
	REG3	AUS BRM CHN GUM IND J(USA) NZL WAK
13 257	REGY	ATA(USA)
	REG1	BEL BHR(USA) CPV G GNB HRV MRC ROU SWZ UZB
	REG2	CAN CG7 HWA JON MDW PTR USA
	REG3	AUS GUM INS J(USA) MHL(USA) WAK
15 010	REG1	BEL BEN DJI IRL MLT RUS
	REG2	BLZ CAN HWA
	REG3	AUS GUM KRE NPL

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15 013	REGY	ATA(ARG)
	REG1	D(USA) G GRC MLT NIG RUS TUR(USA) UZB
	REG2	ALS ARG BER(USA) CUB GRL HWA JON PNR USA
	REG3	GUM J J(USA) MHL(USA)
15 016	REGY	ATA(ARG)
	REG1	ASC(USA) CNR D(USA) E G MRC ROU RUS TUR(USA) UZB
	REG2	ALS ARG BER(USA) CAN CG7 CUB GRL HWA JON PNR PRU USA
	REG3	AUS CHN GUM IRN J(USA) MHL(USA) NZL PHL(USA)
15 019	REG1	ARS F LBR MLT ROU RUS UKR
	REG2	ALS CAN GRL URG USA
	REG3	AUS J
15 022	REGY	ATA(USA)
	REG1	AGL ALB ARS BHR(USA) BLR GEO ISL KAZ LVA MDA MOZ MRC POR RUS S STP TJK TUR UKR UZB
	REG2	ALS BRB(USA) CAN HWA MDW PNR PTR TRD(USA) URG USA
	REG3	AUS CHN DGA(USA) GUM IND IRN J(USA) MAC TLS WAK
15 025	REGY	ATA(USA)
	REG1	AGL ARS AZR BHR(USA) BLR CPV G GEO GNB ISL KAZ LVA MDA MLT MOZ MRC OMA POR RUS STP TJK TUR UKR UZB
	REG2	ALS ATG(USA) BAH(USA) BER(USA) BRB(USA) CHL HWA MDW MEX PNR PTR TCA(USA) TRD(USA) USA
	REG3	AUS FJI GUM IND J(USA) MAC NZL TLS WAK
15 028	REGY	ATA(USA)
	REG1	ALG BHR(USA) GRC(USA) ISL MLT RUS TJK
	REG2	ALS BRB(USA) HWA MDW PNR PTR TRD(USA) USA
	REG3	AUS GUM J(USA) WAK
15 031	REG1	ALG COM CYP(G) G MLT RUS TJK
	REG2	ATG CAN DMA GRD JMC KNA LCA VCT
	REG3	AUS J J(USA)
15 034	REG1	ALG ARS(USA) AZE AZR BLR CME COG D(USA) DJI(F) F G GEO GRC ISR KAZ LTU MDA MDG MLI REU RUS SEN* TCD TJK TKM TUR(USA) UKR UZB
	REG2	B CAN GRL HWA USA
	REG3	AUS GUM IRN NZL PHL
15 037	REG1	ALG ARS(USA) AZE AZR BLR CME COG CTI D(USA) G GEO KAZ LTU MDA MDG MLI MNE MRC REU RUS SEN* SRB TCD TJK TKM TUR(USA) UKR UZB
	REG2	ALS B CAN HWA MEX USA
	REG3	AUS J(USA)
15 040	REG1	CYP(G) G GUI LIE QAT RUS
	REG2	USA
	REG3	AUS J MLD NRU
15 043	REGY	ATA(ARG)
	REG1	CYP(G) DNK ERI ETH G GMB KAZ
	REG2	ALS ARG CUB
	REG3	AUS BGD FJI IRN J(USA) PAK
15 046	REGY	ATA(ARG)
	REG1	CYP(G) E ERI ETH G ISL KAZ MLT MNE RUS SRB SUI
	REG2	ALS ARG CUB USA
	REG3	AUS BGD FJI J NZL PAK PNG

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15 049	REG1	COD CYP(G) G GIB RUS SMR UAE
	REG2	USA
	REG3	AUS HKG J TUV
15 052	REGY	ATA(ARG)
	REG1	BHR(USA) G GRC(USA) I I(USA) MRC NOR RUS
	REG2	ALS ARG BER(USA) HWA MDW PNR PTR TRD(USA) USA
	REG3	CHN GUM IND J(USA) MHL(USA) NZL VTN
15 055	REGY	ATA(ARG)
	REG1	AFS ALG ARM BHR(USA) G G(USA) GRC(USA) I I(USA) ISL MRC NOR RUS
	REG2	ALS ARG BER(USA) HWA MDW PNR PTR TRD(USA) USA
	REG3	AUS CHN GUM IND J(USA) MHL(USA) NZL VTN
15 058	REG1	ALG ARM BHR(USA) G GRC(USA) I(USA) RUS SWZ
	REG2	ALS HWA MDW PNR PTR TRD(USA) USA
	REG3	AUS GUM J(USA) MHL(USA)
15 061	REG1	ALG CNR E F G GRC LSO RUS UZB
	REG2	ALS BRB(USA) CG7 HWA MDW PNR PTR USA
	REG3	AUS GUM J(USA) MHL(USA)
15 064	REG1	AZR CME COG DJI(F) F G GRC ISL KAZ KGZ MDG MLI* MTN REU RUS SEN* TCD TGO TJK TKM TUN UZB
	REG2	ALS ATG(USA) BAH(USA) BER(USA) BRB BRB(USA) CG7 CHL HWA MDW PNR PTR TCA(USA) USA
	REG3	AUS DGA(USA) GUM J(USA) PNG
15 067	REG1	ALG AZR CME COG CTI DJI(F) F KAZ KGZ MDG MLI* MRC REU RUS SEN TCD TGO TJK TKM TUN UZB
	REG2	ALS ATG(USA) BAH(USA) BER(USA) BRB BRB(USA) CG7 HWA MDW PNR PTR TCA(USA) USA
	REG3	AUS CBG GUM J(USA) LAO VTN
15 070	REG1	BEL BHR(USA) GEO RUS SRL TUR
	REG2	ALS HWA JON MDW PNR PTR USA
	REG3	AUS GUM J WAK
15 073	REGY	ATA(ARG)
	REG1	BHR(USA) COG D DJI(F) E F GEO GRC(USA) ISL MDG MNG RUS SEN TUN UKR
	REG2	ALS ARG BER(USA) CAN HWA JON MDW PNR PTR USA
	REG3	AUS CHN GUM IND J MHL(USA) NCL OCE WAK
15 076	REGY	ATA(ARG)
	REG1	AUT BHR(USA) COG CTI D DJI(F) F G MDG MRC RUS SEN TUN UKR
	REG2	ALS ARG BER(USA) HWA JON MDW PNR PTR USA
	REG3	AUS CBG CHN GUM IND IRN J LAO MHL(USA) NCL NZL OCE VTN VUT WAK
15 079	REG1	BDI E G GRC KWT ROU RUS TKM
	REG2	PTR USA
	REG3	BRU J TON
15 082	REG1	AZE BHR(USA) BLR CNR E GRC(USA) I I(USA) KAZ KGZ LVA MRC POL ROU RUS TJK TKM UKR
	REG2	ALS B BER(USA) BRB(USA) HWA MDW MEX PNR PTR USA
	REG3	AUS FJI GUM J(USA) KIR NZL
15 085	REG1	AZE BHR(USA) BLR CNR DNK E G GRC(USA) HOL I I(USA) KAZ KGZ LVA MNG MRC NIG POL RUS TJK TKM UKR
	REG2	ALS B BER(USA) BRB(USA) HWA MDW MEX PNR PTR TRD(USA) USA
	REG3	AUS CHN FJI GUM J(USA) KIR MHL(USA) NZL PNG

1	2	
15 088	REG1	BEL BHR(USA) BLR E RUS UAE
	REG2	ALS ATG(USA) BAH(USA) BER(USA) BRB(USA) HWA MDW PNR PTR TCA(USA) USA
	REG3	AUS GUM HKG J(USA)
15 091	REG1	E G HRV MLT RUS ZMB
	REG2	B MEX USA
	REG3	AUS HKG IRN J J(USA)
15 094	REGY	ATA(ARG)
	REG1	E HOL MLT MNG MWI RUS TUR
	REG2	ALS ARG BER(USA) BES CUW GTM HWA SXM USA
	REG3	AUS CHN GUM J
15 097	REG1	CYP IRL RUS SDN TUR
	REG2	ALS ARG BAH BER(USA)
	REG3	INS J SMO
17 970	REG1	AFS ALG CYP DJI G KWT MCO RUS
	REG2	ATG DMA GRD JMC KNA LCA VCT
	REG3	BRU PHL SMO
17 973	REGY	ATA(ARG)
	REG1	AGL ALG ARM ARS(USA) AZE AZR BLR CYP(G) D F G I KAZ LTU LVA MDA MNG MOZ NIG POR ROU RUS STP SVN TJK TKM UKR UZB
	REG2	ALS ARG BER(USA) GRL HWA JON USA
	REG3	AUS GUM IND IRN J(USA) MAC MHL(USA) TLS
17 976	REG1	CPV D G G(USA) I MNE MRC ROU RUS SRB SWZ TUR(USA) UAE UZB
	REG2	CAN GRL URG USA
	REG3	AUS J(USA) MLD
17 979	REG1	BHR(USA) CYP(G) E G GIB GRC(USA) I I(USA) LSO MRC RUS UZB
	REG2	ALS B BER(USA) CG7 HWA MDW PNR PTR TRD(USA) USA
	REG3	AUS BGD GUM HKG J(USA) NZL PAK
17 982	REG1	ARS AZR BHR(USA) CYP(G) EGY G GIB GRC(USA) I I(USA) ISL JOR KEN MLT MRC OMA RUS S UKR
	REG2	ALS B BER(USA) CAN CG7 HWA MDW PNR PTR TRD(USA) USA
	REG3	AUS BGD GUM HKG IRN J(USA) MHL(USA) NZL PAK PNG
17 985	REG1	BEN BHR(USA) D G ISL LBY MNG SOM UKR
	REG2	ALS BER(USA) CG7 HWA MDW PNR PTR TRD(USA) USA
	REG3	AUS CLN GUM J(USA) MLA SNG
17 988	REG1	CYP(G) G GIB LIE MLT NIG RUS TUN
	REG2	BAH
	REG3	AUS HKG IND J
17 991	REGY	ATA(ARG)
	REG1	AFS CME COG D D(F) DJI(F) F GAB GRC HOL ISL MDG MLI* MTN* REU RUS SEN TCD TGO TUN
	REG2	ALS ARG BER(USA) GRL HWA JON MRT USA
	REG3	AUS CHN FJI GUM J NCL NZL OCE
17 994	REGY	ATA(ARG)
	REG1	ALG AUT CME COG CTI D D(F) DJI(F) F ISR MDG MLI MNG MRC REU RUS SEN* TCD TGO TKM TUN UKR
	REG2	ALS ARG CAN GRL HWA JON MRT USA
	REG3	AUS CBG CHN FJI GUM IRN J LAO NCL NZL OCE VTN VUT
17 997	REG1	ALG CYP(G) G GIB LUX MLT MWI RUS TKM UKR
	REG3	HKG J TON

1	2	
18 000	REGY	ATA(ARG)
	REG1	ALG BLR G GEO GRC KAZ LVA POL RUS TJK TUR UKR UZB ZMB
	REG2	ARG CAN MEX USA
	REG3	AUS BGD J J(USA) NZL PAK
18 003	REGY	ATA(ARG)
	REG1	ALG BLR COM CYP(G) G GEO KAZ LVA MLT MNG POL RUS TJK TUR UAE UKR UZB
	REG2	ALS ARG MEX USA
	REG3	AUS J(USA) NZL PNG
18 006	REG1	BEL G HOL LBR MLT RUS SMR
	REG2	BLZ
	REG3	AUS IRN J(USA)
18 009	REGY	ATA(USA)
	REG1	BHR(USA) CME COG CYP(G) D DJI(F) E F G GRC(USA) I I(USA) ISL MDG MLI MLT MRC REU ROU RUS SEN* TCD TGO TUN
	REG2	ALS ATG(USA) BAH(USA) BER(USA) BRB BRB(USA) CAN CG7 HWA MDW PNR PTR TCA(USA) USA
	REG3	AUS CHN FJI GUM J MHL(USA) NZL
18 012	REGY	ATA(USA)
	REG1	BHR(USA) CME COG CTI D DJI(F) E F G GRC(USA) I I(USA) MDG MLI* MRC MTN REU ROU RUS SEN* TCD TGO TUN
	REG2	ALS BER(USA) BRB(USA) CAN CG7 CHL HWA MDW PNR PTR USA
	REG3	CHN FJI GUM J(USA) MHL(USA) NZL
18 015	REGY	ATA(USA)
	REG1	ALG BHR(USA) CNR E F G GRC(USA) I(USA) MNG MRC RUS UKR
	REG2	ALS BRB(USA) CAN CG7 GRL HWA MDW PNR PTR USA
	REG3	AUS CHN GUM HKG J(USA)
18 018	REG1	ASC(USA) E G G(USA) HRV RUS SRL UKR
	REG2	CAN
	REG3	AUS HKG IRN J(USA)
18 021	REG1	AZE BEL BLR E G GEO GHA GRC KAZ KGZ LVA OMA RUS TJK TKM UKR
	REG2	B BER(USA) USA
	REG3	GUM J TUV
18 024	REG1	AZE BLR E G GEO KAZ KGZ LVA MNG MOZ POR RUS S SUI TJK TKM TUR UKR
	REG2	B BER(USA) CAN GRL USA
	REG3	AUS FJI INS J(USA)
18 027	REG1	BEL G GMB NMB QAT RUS SSD TUR
	REG2	CAN USA
	REG3	AUS KRE NPL NRU

NOTES
ON THE CONCLUDED OPERATIONAL AGREEMENTS

1 The Administrations of Canada and the United States of America informed the Radiocommunication Bureau that they had concluded an operational agreement. The agreement constitutes a sharing arrangement between the two countries for use of all shared allotments appearing in the present version of Part III of this Appendix.

2 The Administrations of Mali, Mauritania and Senegal concluded an operational agreement whose terms of reference are given as follows:

2.1 the use of the following allotments by Mali is subject to coordination with the administrations of Mauritania and Senegal: 3 044, 3 047, 3 143, 3 149, 3 152, 3 900, 4 745, 5 702, 6 712, 6 742, 15 064, 15 067, 17 991 and 18 012 kHz;

2.2 the use of the following allotments by Mauritania is subject to coordination with the administrations of Mali and Senegal: 3 038, 5 708, 5 711, 6 715 and 17 991 kHz;

2.3 the use of the following allotments by Senegal is subject to coordination with the administrations of Mali and Mauritania: 3 044, 3 047, 3 050, 3 053, 3 056, 3 059, 3 140, 3 149, 3 903, 4 736, 4 739, 4 742, 5 702, 5 717, 5 723, 5 726, 6 712, 6 715, 6 745, 6 751, 8 983, 8 998, 9 001, 13 221, 13 224, 13 233, 13 236, 15 034, 15 037, 15 064, 17 994, 18 009 and 18 012 kHz.

3 The Administrations of Brunei Darussalam, Malaysia and Singapore concluded an operational agreement whose terms of reference are given as follows:

3.1 the use of the following allotments by Singapore is subject to coordination with the Administration of Malaysia: 3 074, 3 095, 3 101, 3 116, 4 718, 6 685, 6 694, 6 700, 6 730, 6 760, 8 968, 11 199 and 13 206 kHz;

3.2 the use of the following allotments by Malaysia is subject to coordination with the administration of Singapore: 3 080, 4 739, 6 724 and 9 019 kHz.

PART IV – Criteria for compatibility assessment

26/6 For assessment of the possibilities of sharing between the allotments contained in Part III of this Appendix, and any new assignment which is not covered by an appropriate allotment, the following criteria shall be used:

26/6.1 A new station, not covered by an allotment, which uses the standardized transmission characteristics (J3E, 36 dBW (PX)) shall be considered compatible with the Plan, if it fulfils the criterion of being separated from any point of any allotment area, indicated in the Plan on the given channel, by the repetition half distance, determined for the given conditions of operation (frequency band used, geographical position of the station, direction of propagation), which are given below:

Frequency band (kHz)	Repetition half-distance (km)			
	Northern hemisphere		Southern hemisphere	
	North-South	East-West	North-South	East-West
3 025- 3 155	550	600	550	600
3 900- 3 950	650	650	650	650
4 700- 4 750	725	775	725	775
5 680- 5 730	1 175	1 325	1 150	1 300
6 685- 6 765	1 350	1 600	1 225	1 425
8 965- 9 040	2 525	3 525	2 225	3 075
11 175-11 275	3 375	5 575	2 675	3 925
13 200-13 260	4 550	6 650	3 475	5 625
15 010-15 100	5 050	7 450	4 800	7 100
17 970-18 030	5 750	8 250	5 675	7 475

26/6.2 The relevant value of the repetition half distance for paths which are situated partly in the northern hemisphere and partly in the southern hemisphere shall be corrected using the linear interpolation procedure. This procedure shall be used to calculate the correction due to the azimuth of the propagation path with respect to true North.

26/6.3 The relevant value of the repetition half distance, obtained in accordance with No. **26**/6.2, shall be corrected, where necessary, to take into account the difference in the radiated power of the assignment with respect to the reference radiated power (30 dBW, mean radiated power) on the basis that a variation of 1 dB in the radiated power corresponds to a variation of 4% in the repetition distance.

PART V – Procedure for modification and maintenance of Part III

26/7 Part III will be updated by the Bureau in accordance with the following procedure:

26/7.1 *a)* when a country which has no allotment in Part III requests an allotment, the Bureau shall select an appropriate allotment on a priority basis and shall enter it in Part III;

26/7.2 *b)* when a request is submitted for an additional allotment, the Bureau shall apply the criteria of Part IV, and, where appropriate, enter the corresponding allotment in Part III;

26/7.3 *c)* when an administration informs the Bureau that it renounces the use of an allotment, the Bureau shall cancel the allotment concerned from Part III.

26/8 The Bureau shall maintain an up-to-date master copy of Part III, and shall periodically, but no less frequently than once a year, prepare recapitulative documents listing all amendments made to Part III.

26/9 The Secretary-General shall publish an up-to-date version of Part III in an appropriate form at least once every four years.

APPENDIX 27 (REV.WRC-23)*

Frequency allotment Plan for the aeronautical mobile (R) service and related information

(See Article **43**)

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* *Note by the Secretariat*: This edition of Appendix **27** incorporates editorial amendments to the Appendix **27** Aer2 as adopted by the WARC-Aer2.

The references in Appendix **27** now conform to the new numbering scheme of the Radio Regulations. In addition, the text of Appendix **27** contains updated definitions of the relevant aeronautical areas conforming with the new geographical situation reflecting the political changes since 1979. It also contains updated references to the classes of emissions in accordance with Article **2**. (WRC-03)

PART II – Plan for the allotment of frequencies for the aeronautical mobile (R) service in the exclusive bands between 2 850 and 22 000 kHz

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PART I – General provisions

Section I – Definitions

27/1 1 *Frequency allotment Plan*: A Plan which shows the frequencies to be used in particular areas without specifying the stations to which the frequencies are to be assigned.

27/2 2 The terms to express the different methods of frequency distribution as used in this Appendix have the following meanings:

Frequency distribution to	French	English	Spanish	Arabic	Chinese	Russian
Services	Attribution (attribuer)	Allocation (to allocate)	Atribución (atribuir)	توزيع (يوزع)	划分 (划分)	*Распределение* (распределить)
Areas or countries	Allotissement (allotir)	Allotment (to allot)	Adjudicación (adjudicar)	تعيين (يعين)	分配 (分配)	*Выделение* (выделить)
Stations	Assignation (assigner)	Assignment (to assign)	Asignación (asignar)	تخصيص (يخصص)	指配 (指配)	*Присвоение* (присвоить)

27/3 3 *A major world air route* is a long-distance route, made up of one or more segments, essentially international in character, extending through more than one country and requiring long-distance communication facilities.

27/4 4 *A major world air route area (MWARA)* is an area embracing a certain number of major world air routes, which generally follow the same traffic pattern and are so related geographically that the same frequency families may logically be applied.

27/5 5 *Regional and Domestic Air Route* are all those using the Aeronautical Mobile (R) Service not covered by the definition of a Major World Air Route in No. **27**/3.

27/6 6 *Regional and Domestic Air Route Area (RDARA)* is an area embracing a certain number of the air routes defined in No. **27**/5.

27/7 7 *A VOLMET Allotment Area* is an area encompassing all points where an HF broadcast facility might be required to operate on a family of frequencies common to the area.

27/8 8 *A VOLMET Reception Area* is an area within which aircraft should be able to receive broadcasts from one or more stations in the associated VOLMET Allotment Area.

27/9 9 *A World-Wide Allotment Area* is one in which frequencies are allotted to provide long-distance communication between an aeronautical station within that allotment area and aircraft operating anywhere in the world[1].

27/10 10 *Family of Frequencies in the Aeronautical Mobile (R) Service* contains two or more frequencies selected from different aeronautical mobile (R) bands and is intended to permit communication at any time within the authorized area of use (see Nos. **27**/213 to **27**/231) between aircraft stations and appropriate aeronautical stations.

Section II – Technical and operational principles used for the establishment of the Plan of allotment of frequencies in the aeronautical mobile (R) service

A – Channel characteristics and utilization

1 Frequency separation

27/11 1.1 The frequency separation between carrier (reference) frequencies shall be 3 kHz. This is adequate to permit communications using the classes of emission referred to in Nos. **27**/56 to **27**/59 in the frequency bands between 2 850 kHz and 22 000 kHz allocated exclusively to the aeronautical mobile (R) service. The carrier (reference) frequency of the channels in the Plan shall be an integral multiple of 1 kHz.

27/12 1.2 For radiotelephone emissions the audio frequencies will be limited to between 300 Hz and 2 700 Hz and the occupied bandwidth of other authorized emissions will not exceed the upper limit of J3E emissions. In specifying these limits, however, no restriction in their extension is implied in so far as emissions other than J3E are concerned, provided that the limits of unwanted emissions are met (see Nos. **27**/73 and **27**/74).

27/13 NOTE – For aircraft and aeronautical station transmitter types first installed before 1 February 1983, the audio frequencies will be limited to 3 000 Hz.

27/14 1.3 On account of the possibility of interference, a given channel should not be used in the same allotment area for radiotelephony and data transmissions.

27/15 1.4 The use of channels derived from the frequencies indicated in No. **27**/18 for the various classes of emissions other than J3E and H2B will be subject to special arrangements by the administrations concerned and affected in order to avoid harmful interference which may result from the simultaneous use of the same channel for several classes of emission.

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[1] **27**/9.1 The type of communication referred to in **27**/9 may be regulated by administrations.

27/16 1.5 To preclude the possibility of interference, adjacent channels in the list of frequencies in No. **27**/18 have not as a rule been allotted to the same MWARA, RDARA or VOLMET areas. However, to satisfy particular needs, the administrations concerned may conclude special arrangements for the assignment of adjacent channels derived from the frequencies in the Table.

27/17 1.6 The arrangements contemplated in Nos. **27**/15 and **27**/16 should be made under the Articles of the Constitution and Convention of the International Telecommunication Union and the Radio Regulations entitled "Special agreements"*. (WRC-03)

2 Frequencies allotted

27/18 The list of carrier (reference) frequencies allotted in the bands allocated exclusively to the aeronautical mobile (R) service, on the basis of the frequency separation provided for under No. **27**/11, will be found in the following Table[2].

* *Note by the Secretariat:* The relevant Article in the Radio Regulations is now Article **6** entitled "Special Agreements".

[2] **27**/18.1 To calculate the assigned frequency from a carrier (reference) frequency given in the table, reference should be made to Nos. **27**/75, **27**/77 and **27**/78.

2 850-3 025 kHz

2 851	2 938	57 channels
2 854	2 941	
2 857	2 944	
2 860	2 947	
2 863	2 950	
2 866	2 953	
2 869	2 956	
2 872	2 959	
2 875	2 962	
2 878	2 965	
2 881	2 968	
2 884	2 971	
2 887	2 974	
2 890	2 977	
2 893	2 980	
2 896	2 983	
2 899	2 986	
2 902	2 989	
2 905	2 992	
2 908	2 995	
2 911	2 998	
2 914	3 001	
2 917	3 004	
2 920	3 007	
2 923	3 010	
2 926	3 013	
2 929	3 016	
2 932	3 019	
2 935		
	3 023	(R) and (OR)

3 400-3 500 kHz

3 401	3 452	33 channels
3 404	3 455	
3 407	3 458	
3 410	3 461	
3 413	3 464	
3 416	3 467	
3 419	3 470	
3 422	3 473	
3 425	3 476	
3 428	3 479	
3 431	3 482	
3 434	3 485	
3 437	3 488	
3 440	3 491	
3 443	3 494	
3 446	3 497	
3 449		

4 650-4 700 kHz

4 651	4 675	16 channels
4 654	4 678	
4 657	4 681	
4 660	4 684	
4 663	4 687	
4 666	4 690	
4 669	4 693	
4 672	4 696	

5 450-5 480 kHz

Region2

5 451	5 466	9 channels
5 454	5 469	
5 457	5 472	
5 460	5 475	
5 463		

5 480-5 680 kHz

5 481	5 580	66 channels
5 484	5 583	
5 487	5 586	
5 490	5 589	
5 493	5 592	
5 496	5 595	
5 499	5 598	
5 502	5 601	
5 505	5 604	
5 508	5 607	
5 511	5 610	
5 514	5 613	
5 517	5 616	
5 520	5 619	
5 523	5 622	
5 526	5 625	
5 529	5 628	
5 532	5 631	
5 535	5 634	
5 538	5 637	
5 541	5 640	
5 544	5 643	
5 547	5 646	
5 550	5 649	
5 553	5 652	
5 556	5 655	
5 559	5 658	
5 562	5 661	
5 565	5 664	
5 568	5 667	
5 571	5 670	
5 574	5 673	
5 577	5 676	
	5 680	(R) and (OR)

6 525-6 685 kHz

6 526	6 607	53 channels
6 529	6 610	
6 532	6 613	
6 535	6 616	
6 538	6 619	
6 541	6 622	
6 544	6 625	
6 547	6 628	
6 550	6 631	
6 553	6 634	
6 556	6 637	
6 559	6 640	
6 562	6 643	
6 565	6 646	
6 568	6 649	
6 571	6 652	
6 574	6 655	
6 577	6 658	
6 580	6 661	
6 583	6 664	
6 586	6 667	
6 589	6 670	
6 592	6 673	
6 595	6 676	
6 598	6 679	
6 601	6 682	
6 604		

8 815 -8 965 kHz

8 816	8 891	49 channels
8 819	8 894	
8 822	8 897	
8 825	8 900	
8 828	8 903	
8 831	8 906	
8 834	8 909	
8 837	8 912	
8 840	8 915	
8 843	8 918	
8 846	8 921	
8 849	8 924	
8 852	8 927	
8 855	8 930	
8 858	8 933	
8 861	8 936	
8 864	8 939	
8 867	8 942	
8 870	8 945	
8 873	8 948	
8 876	8 951	
8 879	8 954	
8 882	8 957	
8 885	8 960	
8 888		

10 005-10 100 kHz

10 006	10 054	31 channels
10 009	10 057	
10 012	10 060	
10 015	10 063	
10 018	10 066	
10 021	10 069	
10 024	10 072	
10 027	10 075	
10 030	10 078	
10 033	10 081	
10 036	10 084	
10 039	10 087	
10 042	10 090	
10 045	10 093	
10 048	10 096	
10 051		

11 275-11 400 kHz

11 276	11 339	41 channels
11 279	11 342	
11 282	11 345	
11 285	11 348	
11 288	11 351	
11 291	11 354	
11 294	11 357	
11 297	11 360	
11 300	11 363	
11 303	11 366	
11 306	11 369	
11 309	11 372	
11 312	11 375	
11 315	11 378	
11 318	11 381	
11 321	11 384	
11 324	11 387	
11 327	11 390	
11 330	11 393	
11 333	11 396	
11 336		

13 260-13 360 kHz

13 261	13 312	33 channels
13 264	13 315	
13 267	13 318	
13 270	13 321	
13 273	13 324	
13 276	13 327	
13 279	13 330	
13 282	13 333	
13 285	13 336	
13 288	13 339	
13 291	13 342	
13 294	13 345	
13 297	13 348	
13 300	13 351	
13 303	13 354	
13 306	13 357	
13 309		

17 900-17 970 kHz

17 901	17 937	23 channels
17 904	17 940	
17 907	17 943	
17 910	17 946	
17 913	17 949	
17 916	17 952	
17 919	17 955	
17 922	17 958	
17 925	17 961	
17 928	17 964	
17 931	17 967	
17 934		

21 924-22 000 kHz

21 925	21 964	25 channels
21 928	21 967	
21 931	21 970	
21 934	21 973	
21 937	21 976	
21 940	21 979	
21 943	21 982	
21 946	21 985	
21 949	21 988	
21 952	21 991	
21 955	21 994	
21 958	21 997	
21 961		

27/18A Individual contiguous or non-contiguous channels complying with the provisions of the Plan[3] contained in this Appendix may be aggregated to provide wideband communication without changing the Plan of individual channels.

27/19 3 The International Civil Aviation Organization (ICAO) coordinates radiocommunications of the aeronautical mobile (R) service with international aeronautical operations and this Organization should be consulted in all appropriate cases in the operational use of the frequencies in the Plan.

3 Adaptation of allotment procedure

27/20 It is recognized that not all the sharing possibilities have been exhausted in the allotment Plan contained in this Appendix. Therefore, in order to satisfy particular operational requirements which are not otherwise met by this allotment Plan, Administrations may assign frequencies from the aeronautical mobile (R) bands in areas other than those to which they are allotted in this Plan. However, the use of the frequencies so assigned must not reduce the protection to the same frequencies in the areas where they are allotted by the Plan below that determined by the application of the procedure defined in Part I, Section II B of this Appendix.

27/21 5 When necessary to satisfy the needs of international air operations Administrations may adapt the allotment procedure for the assignment of aeronautical mobile (R) frequencies, which assignments shall then be the subject of prior agreement between Administrations affected.

27/22 6 The coordination described in No. **27**/19 shall be effected where appropriate and desirable for the efficient utilization of the frequencies in question, and especially when the procedures of No. **27**/21 are unsatisfactory.

B – Interference range contours

27/23 1 General provisions

27/24 1.1 Service range

Due to factors such as the power of the transmitter, propagation loss, noise level, etc., there is a limit to the distance at which reliable communications can be effected between an aeronautical station and an aircraft station. This limiting distance, based on the weakest path, is the service range. The boundary of the air route area is often assumed to be the limiting distance.

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[3] **27**/18A.1 In particular the provisions related to protection (Part I, Section II B), power limits (Nos. **27**/60 and **27**/61), class of emission (No. **27**/58), out-of-band spectrum mask (No. **27**/74), assigned frequency (No. **27**/75), and channel spacing (No. **27**/11).

27/25 **1.2 Interference range**

This is the minimum distance from the limit of the service range of a wanted station to a potentially interfering station needed to produce a protection ratio of 15 dB. This protection ratio is between the wanted signal at an aircraft station at the limit of the service range and the signal from a potentially interfering aeronautical station operating on the same frequency. The interference range has been calculated for different frequencies indicated on the data Tables contained in Nos. **27**/46 to **27**/55 for day and night conditions, for median latitudes, for conditions of median sunspot activity and for a mean effective radiated power of 1 kW at the aeronautical station.

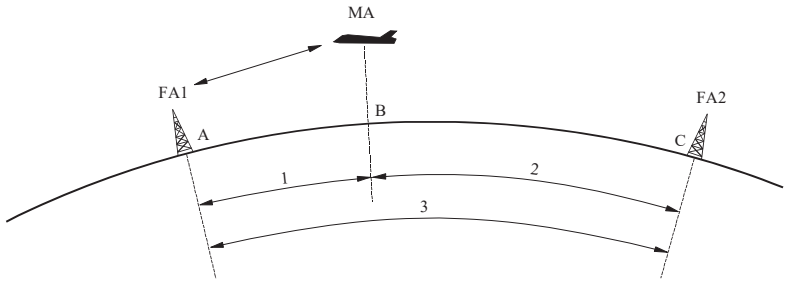
27/26 **1.3 Repetition distance**

This is the distance at which a frequency may be successfully shared and is equal to the sum of the service range and the interference range.

27/27 1.4 Figure 1 illustrates the use of the concept of interference range in frequency planning through the determination of repetition distance.

FIGURE 1

Service range, interference range, repetition distance



FA1 : aeronautical station in communication with aircraft station MA

FA2 : aeronautical station in communication with aircraft stations other than MA

MA : aircraft station in communication with aeronautical station FA1

1 : service range AB

2 : interference range CB

3 : repetition distance AC

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27/28 1.5 The transparencies associated with this Appendix show, for the frequencies stated, the interference range defined in No. **27**/25 between an interfering aeronautical station and an aircraft station operating at the limit of its service range. Because of the variability of propagation conditions not only from hour to hour within the daytime and night time periods but also from day to day, with season, with solar activity level and geographic location, the 15 dB protection ratio may be expected to have marked variations and accordingly a greater protection may be available much of the time, especially when the aircraft is not operating at the limit of its service range.

27/29 (SUP - WRC-03)

27/30 1.7 Two types of transparencies are provided for use respectively with the Mercator projection world maps and the Lambert azimuthal equal area of projection maps for the polar areas. The Mercator projection transparencies encompass the area between latitude 60° North and 60° South. The transparencies associated with the Polar area projections encompass the areas north of latitude 30° North and south of latitude 30° South. The Mercator projection overlaps the Polar projection maps between latitudes 30° and 60° North and 30° and 60° South. This overlap is intended to provide continuity between transparencies, of the two projections.

2 Type of maps used

27/31 The transparencies mentioned in Nos. **27**/28 and **27**/30, can be used only on a world or polar map of the projection and scales given on each transparency and will not be suitable for use on any other projection or scale. The world and polar maps associated with this Appendix, depicting MWARA, RDARA and VOLMET areas, are to the correct scale so that the transparencies carrying the interference range contours can be directly used on these maps. The auroral zones are marked on the polar maps.

3 Change of scale of projection

27/32 3.1 Should any other scale or projection be desired, then new interference range contours can be drawn to fit the new scales or projections by using the coordinates given in the Tables shown below.

27/33 3.2 When new transparencies are constructed, the intersection of the vertical line of symmetry, i.e., the meridian of longitude and the horizontal line of latitude should be at 00° latitude for the 00° contour, 20° N for the 20° contour, 40° N for 40° contour, etc.

27/34 3.3 The coordinates shown in the Tables under Nos. **27**/46 to **27**/55 are given with reference to the 180° meridian taken as the axis of symmetry for the construction of the contours.

4 Sharing conditions between areas

4.1 Frequency bands between 3 and 11.3 MHz

27/35 4.1.1 The transparencies are constructed on the basis of the following sharing conditions:

Areas	Bands between (MHz)	Sharing conditions
MWARA or VOLMET area to MWARA or VOLMET area	3 and 6.6 9 and 11.3	Night propagation Day propagation NOTE – 6.6 MHz and 5.6 MHz sharing conditions are considered to be the same.
MWARA or VOLMET area to RDARA	3 and 5.6 6.6 and 11.3	Night propagation Day propagation
RDARA to RDARA	3 and 4.7 5.6 and 11.3	Night propagation Day propagation

27/36 4.1.2 The additional "Day" contours included for 3 MHz, 3.5 MHz and 4.7 MHz are for determining daylight sharing possibilities.

4.2 Frequency bands between 13 and 22 MHz

27/37 4.2.1 The revised frequency allotment Plan for the 13 MHz, 18 MHz and 22 MHz bands is based on daytime protection only. This results in the following sharing possibilities:

27/38 4.2.2 for the 13 MHz band, the repetition factor is at least 3 whilst for the 18 and 22 MHz bands it is 4. It is to be noted that the longitudinal separation might be decreased to allow for a repetition of 4 (at 13 MHz) and 6 (at 18 and 22 MHz), taking into account operational and local circumstances;

27/39 4.2.3 the sharing takes into account the likely locations of the aeronautical stations rather than the area boundaries.

5 Method of use of the transparencies for the bands 3 to 11.3 MHz

27/40 5.1 Take the appropriate MWARA, RDARA or VOLMET area map associated with this Appendix and select the transparency for the frequency order and sharing conditions under consideration.

27/41 5.2 The equal area projections (Lambert) are applicable in the polar areas north of 60° N and south of 60° S; and the Mercator projections are applicable between 60° N and 60° S.

27/42 5.3 Place the centre of the transparency (i.e. the intersection of the axis of symmetry and the latitude line) over the boundary of the area (use the reception area boundary in the case of VOLMET) at the point on the boundary nearest to the potentially interfering transmitter or at the location of the interfering transmitter. Note the latitude of the selected point and use the interference range contour corresponding to this latitude.

27/43 5.4 A transmitter located at any point outside the contour will result, as defined in No. **27**/25, in a protection ratio of better than 15 dB.

27/44 5.5 A transmitter located at any point inside the contour will result in a protection ratio of less than 15 dB. However, if the transmitter is located inside the contour but the propagation path traverses an auroral zone, it is assumed that the signal attenuation within this zone will result in a protection ratio of better than 15 dB.

27/45 5.6 For the Northern Hemisphere the Mercator projection transparencies should be used in their natural position as published, but for the Southern Hemisphere the transparencies should be inverted. This point should be carefully observed when following the boundaries of areas which involve the transition of the equator.

6 Data for tracing interference contours

27/46 3.0 and 3.5 MHz day

Data for plotting 700 km interference contours

Latitude	00°		10°		20°		30°		40°	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	180.0	6.3	180.0	16.3	180.0	26.3	180.0	36.3	180.0	46.3
	178.9	6.2	178.9	16.2	178.8	26.2	178.6	36.2	178.4	46.2
	177.8	5.9	177.8	15.9	177.6	25.9	177.3	35.9	176.9	45.9
	176.8	5.5	176.7	15.4	176.5	25.4	176.1	35.4	175.5	45.4
	175.9	4.8	175.8	14.8	175.5	24.8	175.1	34.7	174.3	44.7
	175.2	4.0	175.0	14.0	174.7	24.0	174.2	33.9	173.3	43.9
	174.5	3.1	174.4	13.1	174.1	23.0	173.5	33.0	172.5	42.9
	174.1	2.2	173.9	12.1	173.6	22.0	173.0	32.0	172.0	41.9
	173.8	1.1	173.7	11.0	173.4	21.0	172.8	30.9	171.8	40.8
	173.7	0.0	173.6	9.9	173.3	19.9	172.7	29.8	171.8	39.7
	173.8	−1.1	173.7	8.8	173.4	18.8	172.9	28.7	172.0	38.6
	174.1	−2.2	174.0	7.8	173.8	17.7	173.3	27.7	172.5	37.6
	174.5	−3.1	174.5	6.8	174.3	16.8	173.9	26.7	173.2	36.6
	175.2	−4.0	175.2	5.9	175.0	15.9	174.6	25.8	174.1	35.8
	175.9	−4.8	175.9	5.2	175.8	25.1	175.5	25.1	175.1	35.1
	176.8	−5.5	176.8	4.5	176.8	14.5	176.5	24.5	176.2	34.5
	177.8	−5.9	177.8	4.1	177.8	14.1	177.6	24.1	177.4	34.0
	178.9	−6.2	178.9	3.8	178.9	13.8	178.8	23.8	178.7	33.8
	180.0	−6.3	180.0	3.7	180.0	13.7	180.0	23.7	180.0	33.7

Latitude	50°		60°		70°		80°		90°	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	180.0	56.3	180.0	66.3	180.0	76.3	180.0	86.3	All longitudes	83.7
	178.0	56.2	177.3	66.2	175.4	76.2	163.9	86.1		83.7
	176.2	55.9	174.7	65.8	171.2	75.8	152.2	85.4		83.7
	174.5	55.3	172.5	65.3	167.7	75.1	145.2	84.5		83.7
	173.0	54.6	170.6	64.5	164.9	74.3	141.9	83.4		83.7
	171.8	53.8	169.1	63.6	162.9	73.4	140.8	82.4		83.7
	171.0	52.8	168.1	62.7	161.8	72.3	141.3	81.3		83.7
	170.4	51.8	167.5	61.6	161.3	71.2	142.8	80.2		83.7
	170.2	50.7	167.3	60.5	161.5	70.1	144.9	79.2		83.7
	170.3	49.6	167.5	59.4	162.1	69.1	147.6	78.2		83.7
	170.6	48.5	168.1	58.3	163.2	68.0	150.5	77.3		83.7
	171.2	47.5	169.0	57.4	164.6	67.1	153.8	76.5		83.7
	172.1	46.6	170.1	56.4	166.4	66.2	157.3	75.8		83.7
	173.1	45.7	171.4	55.6	168.3	65.5	160.8	75.2		83.7
	174.3	45.0	172.9	55.0	170.4	64.9	164.6	74.6		83.7
	175.6	44.5	174.6	54.4	172.7	64.4	168.4	74.2		83.7
	177.0	44.0	176.3	54.0	175.1	64.0	172.2	739		83.7
	178.5	43.8	178.2	53.8	177.5	63.8	176.1	73.8		83.7
	180.0	43.7	180.0	53.7	180.0	63.7	180.0	73.7		83.7

27/47 3.0 MHz night

Data for plotting 3 500 km interference contours

Latitude	00°		10°		20°		30°		40°	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	180.0	31.5	180.0	41.5	180.0	51.5	180.0	61.5	180.0	71.5
	173.9	31.0	173.1	40.9	171.7	50.8	169.3	60.7	164.3	70.4
	168.2	29.4	166.7	39.2	164.2	48.9	160.1	58.4	152.1	67.5
	163.0	26.9	161.1	36.4	158.0	45.8	153.0	54.9	144.2	63.5
	158.5	23.6	156.4	32.8	153.2	41.9	148.0	50.6	139.7	58.7
	154.9	19.6	152.9	28.6	149.8	37.4	144.9	45.8	137.5	53.6
	152.0	15.1	150.3	23.9	147.6	32.5	143.3	40.7	137.0	48.4
	150.1	10.3	148.7	18.9	146.4	27.4	142.9	35.5	137.6	43.2
	148.9	5.2	148.0	13.7	146.3	22.1	143.4	30.3	139.1	38.1
	148.5	0.0	148.1	8.5	146.9	17.0	144.7	25.2	141.3	33.2
	148.9	−5.2	149.0	3.4	148.3	11.9	146.7	20.9	144.1	28.6
	150.1	−10.3	150.6	−1.6	150.3	7.1	149.3	15.8	147.4	24.3
	152.0	−15.1	152.9	−6.3	153.1	2.6	152.5	11.5	151.1	20.4
	154.9	−19.6	156.0	−10.5	156.4	−1.4	156.2	7.8	155.3	16.9
	158.5	−23.6	159.7	−14.2	160.3	−4.8	160.3	4.6	159.8	14.0
	163.0	−26.9	164.1	−17.3	164.7	−7.7	164.8	2.0	164.5	11.6
	168.2	−29.4	169.1	−19.6	169.6	−9.8	169.7	0.1	169.5	9.9
	173.9	−31.0	174.4	−21.0	174.7	−11.1	174.8	−1.1	174.7	8.9
	180.0	−31.5	180.0	−21.5	180.0	−11.5	180.0	−1.5	180.0	8.5

Latitude	50°		60°		70°		80°		90°	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	180.0	81.5	0	88.5	0	78.5	0	68.5	All longitudes	58.5
	149.5	79.7	78.0	84.7	25.3	77.7	14.2	68.3		58.5
	133.9	75.6	90.4	79.7	46.5	75.7	28.0	67.7		58.5
	127.6	70.7	97.5	74.7	62.9	72.9	41.3	66.7		58.5
	125.7	65.6	103.3	69.8	75.9	69.7	53.8	65.4		58.5
	126.0	60.3	108.7	65.0	86.6	66.4	65.5	63.9		58.5
	127.6	55.2	113.9	60.3	95.8	62.9	76.4	62.3		58.5
	129.9	50.2	118.9	55.9	104.1	59.6	86.7	60.5		58.5
	132.9	45.4	124.1	51.6	111.9	56.3	96.5	58.8		58.5
	136.4	40.8	129.2	47.6	119.2	53.2	105.8	57.1		58.5
	140.2	36.5	134.5	43.9	126.2	50.4	114.8	55.5		58.5
	144.4	32.6	139.8	40.5	133.1	47.7	123.4	54.0		58.5
	148.8	29.0	145.3	37.4	139.9	45.4	131.9	52.6		58.5
	153.6	25.9	150.8	34.8	146.6	43.3	140.1	51.4		58.5
	158.5	23.3	156.5	32.6	153.3	41.6	148.2	50.4		58.5
	163.7	21.2	162.3	30.8	160.0	40.3	156.2	49.6		58.5
	169.1	19.7	168.1	29.5	166.6	39.3	164.2	49.0		58.5
	174.5	18.8	174.1	28.8	173.3	38.7	172.1	48.6		58.5
	180.0	18.5	180.0	28.5	180.0	38.5	180.0	48.5		58.5

27/48 3.5 MHz night

Data for plotting 4 000 km interference contours

Latitude	00°		10°		20°		30°		40°	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	180.0	36.0	180.0	46.0	180.0	56.0	180.0	66.0	180.0	76.0
	172.8	35.4	171.7	45.3	169.7	55.1	166.1	64.9	157.6	74.5
	166.0	33.5	164.0	43.2	160.6	52.7	154.7	62.0	142.8	70.6
	160.0	30.6	157.5	39.9	153.4	49.0	146.6	57.7	134.9	70.6
	155.0	26.8	152.3	35.7	148.1	44.4	141.5	52.6	131.2	59.9
	150.9	22.2	148.4	30.8	144.5	39.2	138.7	47.0	129.9	54.0
	147.8	17.1	145.7	25.5	142.3	33.6	137.4	41.2	130.2	48.2
	145.7	11.6	144.1	19.8	141.4	27.7	137.4	35.4	131.6	42.4
	144.4	5.9	143.4	13.9	141.4	21.9	138.3	29.5	133.8	36.7
	144.0	0.0	143.6	8.1	142.3	16.1	140.0	23.9	136.5	31.3
	144.4	−5.9	144.6	2.3	143.9	10.4	142.4	18.4	139.8	26.2
	145.7	−11.6	146.4	−3.3	146.3	5.0	145.4	13.3	143.6	21.5
	147.8	−17.1	149.0	−8.6	149.4	0.0	149.0	8.6	147.8	17.2
	150.9	−22.2	152.4	−13.4	153.1	−4.5	153.2	4.4	152.4	13.3
	155.0	−26.8	156.6	−17.6	157.5	−8.4	157.8	0.8	157.4	10.1
	160.0	−30.6	161.6	−21.2	162.5	−11.6	162.9	−2.1	162.8	7.5
	166.0	−33.5	167.3	−23.8	168.0	−14.0	168.4	−4.2	168.3	5.6
	172.8	−35.4	173.5	−25.4	173.9	−15.5	174.1	−5.6	174.1	4.4
	180.0	−36.0	180.0	−26.0	180.0	−16.0	180.0	−6.0	180.0	4.0

Latitude	50°		60°		70°		80°		90°	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	180.0	86.0	0	84.0	0	74.0	0	64.0	All longitudes	54.0
	126.9	82.7	46.5	81.9	20.9	73.4	13.4	63.8		54.0
	115.7	77.1	69.8	77.6	39.7	71.6	26.5	63.2		54.0
	113.9	71.3	83.0	72.8	55.5	69.1	39.2	62.3		54.0
	114.9	65.4	92.2	67.8	68.8	66.1	51.3	61.0		54.0
	117.1	59.6	99.7	62.8	80.1	62.8	62.8	59.6		54.0
	120.1	54.0	106.4	57.9	90.1	59.4	73.7	58.0		54.0
	123.5	48.5	112.6	53.2	99.0	56.0	84.1	56.3		54.0
	127.4	43.3	118.6	48.7	107.3	52.7	93.9	54.5		54.0
	131.5	38.3	124.5	44.5	115.2	49.5	103.4	52.8		54.0
	135.9	33.7	130.4	40.5	122.8	46.5	112.6	51.2		54.0
	140.7	29.4	136.3	36.9	130.1	43.7	121.5	49.6		54.0
	145.7	25.5	142.3	33.6	137.4	41.3	130.2	48.2		54.0
	150.9	22.1	148.4	30.8	144.5	39.1	138.7	47.0		54.0
	156.4	19.3	154.6	28.4	151.6	37.3	147.1	45.9		54.0
	162.1	17.0	160.8	26.5	158.7	35.9	155.4	45.1		54.0
	168.0	15.3	167.2	25.1	165.8	34.8	163.6	44.5		54.0
	174.0	14.3	173.6	24.3	172.9	34.2	171.8	44.1		54.0
	180.0	14.0	180.0	24.0	180.0	34.0	180.0	44.0		54.0

27/49 4.7 MHz day

Data for plotting 1 200 km interference contours

Latitude	00°		10°		20°		30°		40°	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	180.0	10.8	180.0	20.8	180.0	30.8	180.0	40.8	180.0	50.8
	178.1	10.6	178.0	20.6	177.8	30.6	177.5	40.6	177.1	50.6
	176.3	10.1	176.1	20.1	175.8	30.1	175.2	40.1	174.3	50.0
	174.6	9.3	174.3	19.3	173.8	29.2	173.1	39.2	171.8	49.1
	173.0	8.3	172.7	18.2	172.2	28.1	171.2	38.0	169.7	47.8
	171.7	6.9	171.4	16.8	170.3	26.7	169.7	36.5	168.0	46.4
	170.6	5.4	170.3	15.2	169.7	25.1	168.6	34.9	166.8	44.7
	169.8	3.7	169.6	13.5	168.9	23.3	167.9	33.1	166.1	42.9
	169.4	1.9	169.1	11.7	168.6	21.5	167.5	31.3	165.8	41.0
	169.2	0.0	169.0	9.8	168.5	19.6	167.6	29.4	166.0	39.2
	169.4	−1.9	169.3	8.0	168.8	17.8	168.0	27.6	166.6	37.3
	169.8	−3.7	169.8	6.2	169.4	16.0	168.7	25.8	167.5	35.6
	170.6	−5.4	170.6	4.5	170.4	14.4	169.8	24.2	168.7	34.0
	171.7	−6.9	171.7	3.0	171.5	12.9	171.0	22.8	170.2	32.6
	173.0	−8.3	173.1	1.7	172.9	11.6	172.6	21.5	171.9	31.4
	174.6	−9.3	174.6	0.6	174.5	10.6	174.3	20.5	173.8	30.5
	176.3	−10.1	176.3	−0.2	176.3	9.8	176.1	19.8	175.8	29.8
	178.1	−10.6	178.1	−0.6	178.1	9.4	178.0	19.3	177.9	29.3
	180.0	−10.8	180.0	−0.8	180.0	9.2	180.0	19.2	180.0	29.2

Latitude	50°		60°		70°		80°		90°	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	180.0	60.8	180.0	70.8	180.0	80.8	0	89.2	All longitudes	79.2
	176.2	60.6	174.4	70.6	168.7	80.5	71.1	88.0		79.2
	172.6	60.0	169.3	69.8	159.4	79.5	87.5	86.3		79.2
	169.5	59.0	165.0	68.7	152.9	78.1	96.6	84.6		79.2
	167.0	57.6	161.8	67.3	149.1	76.4	103.6	82.9		79.2
	165.1	56.1	159.6	65.6	147.2	74.6	109.9	81.2		79.2
	163.8	54.4	158.4	63.8	146.8	72.8	115.8	79.6		79.2
	163.2	52.5	158.0	62.0	147.4	70.9	121.4	78.1		79.2
	163.1	50.7	158.3	60.1	148.9	69.1	126.9	76.7		79.2
	163.5	48.8	159.1	58.3	150.8	67.4	132.3	75.3		79.2
	164.3	47.0	160.4	56.6	153.3	65.8	137.7	74.1		79.2
	165.5	45.3	162.1	54.9	156.0	64.3	143.0	73.0		79.2
	167.0	43.8	164.2	53.5	159.1	63.0	148.3	72.0		79.2
	168.3	42.5	166.4	52.2	162.3	61.9	153.6	71.2		79.2
	170.3	41.3	168.9	51.2	165.7	60.9	158.9	70.5		79.2
	172.9	40.4	171.6	50.3	169.1	60.2	164.2	69.9		79.2
	175.8	39.7	174.3	49.7	172.7	59.6	169.4	69.5		79.2
	177.6	39.3	177.1	49.3	176.3	59.3	174.7	69.3		79.2
	180.0	39.2	180.0	49.2	180.0	59.2	180.0	69.2		79.2

27/50 4.7 MHz night and 10.0 MHz day

Data for plotting 5 500 km interference contours

Latitude	**00°**		**10°**		**20°**		**30°**		**40°**	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	180.0	49.5	180.0	59.5	180.0	69.5	180.0	79.5	178.7	89.5
	168.5	48.5	165.5	58.2	159.6	67.8	144.9	76.7	97.0	82.4
	158.2	45.6	153.2	54.7	144.6	63.3	128.3	70.7	98.4	74.8
	149.7	41.2	144.1	49.6	135.4	57.2	121.5	63.5	101.0	67.2
	143.0	35.6	137.8	43.3	130.1	50.3	119.0	56.0	104.1	59.7
	138.1	29.3	133.6	36.5	127.3	43.0	118.6	48.4	107.5	52.4
	134.6	22.3	131.1	29.2	126.1	35.4	119.5	40.8	111.0	45.1
	132.3	15.1	129.8	21.6	126.1	27.8	121.2	33.4	114.8	38.1
	130.9	7.6	129.5	14.1	127.0	20.3	123.5	26.0	118.9	31.2
	130.5	0.0	130.1	6.5	128.7	12.8	126.5	18.9	123.2	24.7
	130.9	−7.6	131.5	−1.0	131.2	5.6	130.0	12.1	127.9	18.4
	132.3	−15.1	133.8	−8.2	134.4	−1.3	134.1	5.7	132.9	12.6
	134.6	−22.3	137.0	−15.2	138.3	−7.8	138.8	−0.3	138.4	7.3
	138.1	−29.3	141.2	−21.6	143.2	−13.7	144.2	−5.7	144.3	2.5
	143.0	−35.6	146.6	−27.4	148.9	−19.0	150.2	−10.4	150.7	−1.6
	149.7	−41.2	153.2	−32.4	155.5	−23.4	156.9	−14.2	157.6	−5.0
	158.2	−45.6	161.2	−36.2	163.1	−26.7	164.2	−17.1	164.8	−7.5
	168.5	−48.5	170.3	−38.7	171.3	−28.8	172.0	−18.9	172.3	−9.0
	180.0	−49.5	180.0	−39.5	180.0	−29.5	180.0	−19.5	180.0	−9.5

Latitude	**50°**		**60°**		**70°**		**80°**		**90°**	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	0	80.5	0	70.5	0	60.5	0	50.5	All longitudes	40.5
	40.2	78.2	22.2	69.5	15.3	60.0	11.9	50.3		40.5
	63.5	73.1	41.5	66.9	30.1	58.7	23.8	49.8		40.5
	77.1	67.0	57.1	63.1	43.8	56.7	35.4	48.9		40.5
	86.6	60.7	69.8	58.6	56.4	54.0	46.7	47.8		40.5
	94.2	54.3	80.4	53.8	67.8	51.0	57.7	46.4		40.5
	100.8	47.9	89.6	48.8	78.4	47.8	68.3	44.9		40.5
	107.0	41.7	97.9	43.8	88.2	44.4	78.7	43.2		40.5
	112.9	35.6	105.7	38.9	97.5	41.0	88.7	41.5		40.5
	118.8	29.8	113.1	34.2	106.3	37.6	98.4	39.8		40.5
	124.7	24.4	120.4	29.8	114.8	34.4	108.0	38.1		40.5
	130.8	19.3	127.6	25.6	123.1	31.4	117.3	36.5		40.5
	137.1	14.7	134.8	21.9	131.3	28.7	126.5	35.0		40.5
	143.7	10.6	142.1	18.5	139.5	26.3	135.6	33.7		40.5
	150.5	7.1	149.5	15.7	147.6	24.3	144.5	32.6		40.5
	157.6	4.3	157.0	13.5	155.7	22.6	153.5	31.7		40.5
	164.9	2.2	164.6	11.8	163.8	21.5	162.3	31.0		40.5
	172.4	0.9	172.3	10.8	171.9	20.7	171.2	30.6		40.5
	180.0	0.5	180.0	10.5	180.0	20.5	180.0	30.5		40.5

27/51 5.6 MHz day

Data for plotting 1 500 km interference contours

Latitude	00°		10°		20°		30°		40°	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	180.0	13.5	180.0	23.5	180.0	33.5	180.0	43.5	180.0	53.5
	177.6	13.3	177.5	23.3	177.2	33.3	176.8	43.3	176.1	53.2
	175.3	12.7	175.0	22.6	174.6	32.6	173.8	42.5	172.5	52.5
	173.2	11.7	172.8	21.6	172.1	31.5	171.0	41.4	169.3	51.3
	171.2	10.3	170.8	20.2	170.0	30.0	168.7	39.9	166.6	49.6
	169.6	8.6	169.1	18.5	168.3	28.3	166.9	38.0	164.6	47.7
	168.3	6.7	167.8	16.5	167.0	26.2	165.5	36.0	163.2	45.6
	167.3	4.6	166.9	14.3	166.1	24.1	164.7	33.7	162.4	43.3
	166.7	2.3	166.4	12.1	165.7	21.8	164.4	31.4	162.3	41.0
	166.5	0.0	166.3	9.7	165.7	19.4	164.5	29.1	162.6	38.7
	166.7	−2.3	166.6	7.4	166.1	17.1	165.1	26.8	163.4	36.4
	167.3	−4.6	167.3	5.2	166.9	14.9	166.0	24.6	164.6	34.3
	168.3	−6.7	168.3	3.1	168.0	12.9	167.3	22.6	166.1	32.4
	169.6	−8.6	169.7	1.2	169.5	11.0	169.0	20.9	168.0	30.7
	171.2	−10.3	171.4	−0.4	171.2	9.5	170.8	19.3	170.1	29.2
	173.2	−11.7	173.3	−1.7	173.2	8.2	172.9	18.1	172.4	28.0
	175.3	−12.7	175.4	−2.7	175.4	7.3	175.2	17.2	174.8	27.2
	177.6	−13.3	177.7	−3.3	177.7	6.7	177.6	16.7	177.4	26.7
	180.0	−13.5	180.0	−3.5	180.0	6.5	180.0	16.5	180.0	26.5

Latitude	50°		60°		70°		80°		90°	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	180.0	63.5	180.0	73.5	180.0	83.5	0	86.5	All longitudes	76.5
	174.8	63.2	172.0	73.1	160.8	82.9	35.2	86.0		76.5
	170.1	62.4	164.9	72.1	147.7	81.4	59.4	84.7		76.5
	166.1	61.0	159.4	70.6	140.7	79.4	75.5	83.1		76.5
	162.9	59.3	155.6	68.7	137.6	77.1	87.2	81.4		76.5
	160.7	57.3	153.3	66.5	137.0	74.8	96.7	79.6		76.5
	159.3	55.1	152.3	64.2	137.8	72.5	104.9	77.9		76.5
	158.7	52.8	152.3	61.9	139.6	70.2	112.4	76.3		76.5
	158.8	50.4	153.0	59.6	142.0	68.1	119.3	74.7		76.5
	159.5	48.1	154.4	57.4	144.9	66.0	125.9	73.3		76.5
	160.7	46.0	156.2	55.3	148.2	64.1	132.2	71.9		76.5
	162.3	43.9	158.4	53.3	151.7	62.4	138.4	70.7		76.5
	164.2	42.1	161.0	51.6	155.4	60.9	144.5	69.6		76.5
	166.4	40.4	163.8	50.1	159.3	59.6	150.5	68.7		76.5
	168.9	39.0	166.8	48.8	163.3	58.5	156.5	67.9		76.5
	171.5	37.9	170.0	47.8	167.4	57.6	162.4	67.3		76.5
	174.3	37.1	173.3	47.1	171.6	57.0	168.3	66.9		76.5
	177.1	36.7	176.6	46.6	175.8	56.6	174.1	66.6		76.5
	180.0	36.5	180.0	46.5	180.0	56.5	180.0	66.5		76.5

27/52 5.6 and 6.6 MHz night

Data for plotting 6 500 km interference contours

Latitude	00°		10°		20°		30°		40°	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	180.0	58.5	180.0	68.5	180.0	78.5	180.0	88.5	0	81.5
	164.2	57.1	158.1	66.6	144.0	75.4	102.4	81.3	46.7	78.3
	150.8	53.2	142.2	61.6	126.6	68.7	100.1	72.8	68.5	71.7
	140.8	47.6	132.2	54.9	119.2	60.8	101.1	64.3	80.1	64.4
	133.6	40.8	126.2	47.2	116.0	52.4	102.9	55.8	88.0	56.7
	128.7	33.2	122.7	39.1	114.9	43.9	105.3	47.4	94.2	49.1
	125.3	25.2	120.8	30.7	115.1	35.4	108.0	39.1	99.7	41.5
	123.1	17.0	120.1	22.2	116.0	26.9	110.9	30.9	104.9	34.0
	121.9	8.5	120.2	13.7	117.7	18.5	114.3	22.9	110.0	26.7
	121.5	0.0	121.1	5.2	119.9	10.3	118.0	15.1	115.1	19.6
	121.9	−8.5	122.8	−3.2	122.8	2.3	122.1	7.6	120.5	12.9
	123.1	−17.0	125.2	−11.3	126.4	−5.5	126.8	0.5	126.3	6.5
	125.3	−25.2	128.6	−19.2	130.8	−12.8	132.0	−6.2	132.4	0.5
	128.7	−33.2	133.0	−26.7	136.1	−19.7	138.0	−12.3	139.0	−4.8
	133.6	−40.8	138.9	−33.5	142.5	−25.8	144.9	−17.7	146.2	−9.5
	140.8	−47.6	146.4	−39.5	150.2	−31.0	152.6	−22.2	154.0	−13.3
	150.8	−53.2	156.0	−44.3	159.1	−35.0	161.1	−25.6	162.3	−16.1
	164.2	−57.1	167.4	−47.4	169.2	−37.6	170.4	−27.8	171.0	−17.9
	180.0	−58.5	180.0	−48.5	180.0	−38.5	180.0	−28.5	180.0	−18.5

Latitude	50°		60°		70°		80°		90°	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	0	71.5	0	61.5	0	51.5	0	41.5	All longitudes	31.5
	25.7	70.1	17.6	60.7	13.6	51.1	11.4	41.3		31.5
	46.4	66.2	34.0	58.6	26.9	49.9	22.7	40.8		31.5
	61.7	61.0	43.4	55.3	39.6	48.0	33.8	40.0		31.5
	73.3	55.1	61.0	51.2	51.6	45.6	44.8	38.9		31.5
	82.7	48.8	71.9	46.6	62.8	42.7	55.5	37.6		31.5
	90.7	42.4	81.7	41.7	73.8	39.6	66.0	36.1		31.5
	98.0	36.0	90.6	36.7	83.2	36.2	76.2	34.4		31.5
	104.8	29.7	99.0	31.8	92.7	32.8	86.2	32.7		31.5
	111.6	23.6	107.0	26.9	101.8	29.4	96.1	31.0		31.5
	115.1	17.8	114.9	22.2	110.7	26.1	105.7	29.3		31.5
	124.9	12.3	122.7	17.9	119.5	23.0	115.3	27.6		31.5
	131.8	7.3	130.5	13.8	128.1	20.2	124.7	26.1		31.5
	139.2	2.7	138.4	10.3	136.7	17.7	134.0	24.9		31.5
	146.8	−1.1	146.5	7.2	145.3	15.5	143.3	23.6		31.5
	154.7	−4.3	154.7	4.8	154.0	13.8	152.5	22.7		31.5
	162.9	−6.6	163.0	3.0	162.6	12.5	161.7	22.1		31.5
	171.4	−8.0	171.5	1.9	171.3	11.8	170.8	21.6		31.5
	180.0	−8.5	180.0	1.5	180.0	11.5	180.0	21.5		31.5

27/53 6.6 MHz day

Data for plotting 1 900 km interference contours

Latitude	00°		10°		20°		30°		40°	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	180.0	17.1	180.0	27.1	180.0	37.1	180.0	47.1	180.0	57.1
	176.9	16.8	176.7	26.8	176.3	36.8	175.7	46.8	174.7	56.7
	174.0	16.0	173.6	26.0	172.9	35.9	171.7	45.8	169.7	55.7
	171.3	14.8	170.7	24.6	169.7	34.5	168.1	44.3	165.5	54.0
	168.8	13.0	168.2	22.8	167.0	32.6	165.2	42.3	162.2	51.9
	166.7	10.9	166.1	20.6	164.9	30.3	162.9	39.9	159.8	49.4
	165.1	8.5	164.5	18.1	163.3	27.7	161.3	37.2	158.2	46.6
	163.9	5.8	163.3	15.4	162.3	24.9	160.4	34.4	157.5	43.7
	163.1	2.9	162.7	12.5	161.8	22.0	160.2	31.5	157.5	40.8
	162.9	0.0	162.7	9.6	161.9	19.1	160.4	28.5	158.1	37.9
	163.1	−2.9	163.1	6.6	162.4	16.2	161.3	25.7	159.3	35.1
	163.9	−5.8	163.9	3.8	163.5	13.4	162.5	23.0	160.9	32.5
	165.1	−8.5	165.2	1.2	165.0	10.9	164.2	20.5	162.9	30.1
	166.7	−10.9	167.0	−1.2	166.8	8.6	166.3	18.3	165.2	28.0
	168.8	−13.0	169.1	−3.2	169.0	6.6	168.6	16.4	167.8	26.2
	171.3	−14.8	171.5	−4.9	171.5	5.0	171.2	14.9	170.7	24.8
	174.0	−16.0	174.2	−6.1	174.2	3.9	174.1	13.8	173.7	23.7
	176.9	−16.8	177.1	−6.8	177.1	3.1	177.0	13.1	176.8	23.1
	180.0	−17.1	180.0	−7.1	180.0	2.9	180.0	12.9	180.0	22.9

Latitude	50°		60°		70°		80°		90°	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	180.0	67.1	180.0	77.1	180.0	87.1	0	82.9	All longitudes	72.9
	172.6	66.7	167.3	76.5	137.0	85.7	23.2	82.5		72.9
	166.0	65.5	157.1	75.0	123.8	83.1	43.5	81.6		72.9
	160.7	63.6	150.3	72.8	120.8	80.1	60.0	80.2		72.9
	156.8	61.3	146.2	70.1	121.4	77.2	73.5	78.6		72.9
	154.4	58.6	144.4	67.3	123.5	74.3	84.9	76.9		72.9
	153.1	55.8	144.0	64.3	126.5	71.5	94.8	75.2		72.9
	152.8	52.8	144.7	61.4	130.1	68.8	103.6	73.5		72.9
	153.3	49.9	146.3	58.6	133.9	66.3	111.8	71.8		72.9
	154.4	47.1	148.4	55.9	138.0	63.9	119.4	70.3		72.9
	156.1	44.4	151.0	53.3	142.3	61.7	126.8	68.8		72.9
	158.2	41.9	153.9	51.0	146.7	59.7	133.8	67.5		72.9
	160.7	39.6	157.2	49.0	151.3	58.0	140.7	66.3		72.9
	163.5	37.6	160.7	47.2	155.9	56.5	147.4	65.3		72.9
	166.5	36.0	164.3	45.7	160.7	55.2	154.0	64.4		72.9
	169.7	34.6	168.1	44.5	165.4	54.2	160.6	63.8		72.9
	173.1	33.7	172.0	43.6	170.3	53.5	167.1	63.3		72.9
	176.5	33.1	176.0	43.1	175.1	53.0	173.5	63.0		72.9
	180.0	32.9	180.0	42.9	180.0	52.9	180.0	62.9		72.9

27/54 9.0 MHz day

Data for plotting 3 800 km interference contours

Latitude	00°		10°		20°		30°		40°	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	180.0	34.2	180.0	44.2	180.0	54.2	180.0	64.2	180.0	74.2
	173.3	33.6	172.3	43.5	170.6	53.4	167.5	63.2	160.6	72.9
	166.9	31.9	165.1	41.6	162.1	51.2	157.0	60.6	146.8	69.4
	161.2	29.1	158.9	38.5	155.3	47.8	149.3	56.6	138.8	64.8
	156.4	25.5	154.0	34.6	150.2	43.4	144.2	51.9	134.6	59.5
	152.5	21.2	150.2	30.0	146.6	38.5	141.2	46.6	133.0	53.9
	149.5	16.3	147.6	24.9	144.4	33.2	139.8	41.1	132.9	48.3
	147.4	11.1	145.9	19.4	143.4	27.6	139.6	35.5	134.0	42.8
	146.2	5.6	145.2	13.9	143.3	22.0	140.3	29.9	135.9	37.3
	145.8	0.0	145.4	8.3	144.1	16.4	141.9	24.4	138.4	32.1
	146.2	−5.6	146.3	2.7	145.7	11.0	144.1	19.2	141.5	27.2
	147.4	−11.1	148.1	−2.6	147.9	5.9	147.0	14.3	145.1	22.6
	149.5	−16.3	150.6	−7.7	150.9	1.1	150.4	9.8	149.1	18.4
	152.5	−21.2	153.9	−12.3	154.5	−3.2	154.4	5.8	153.6	14.8
	156.4	−25.5	157.9	−16.3	158.7	−7.0	158.8	2.3	158.4	11.6
	161.2	−29.1	162.6	−19.6	163.4	−10.1	163.7	−0.5	163.5	9.1
	166.9	−31.9	168.0	−22.1	168.7	−12.3	168.9	−2.5	168.8	7.3
	173.3	−33.6	173.9	−23.7	174.2	−13.7	174.4	−3.8	174.4	6.2
	180.0	−34.2	180.0	−24.2	180.0	−14.2	180.0	−4.2	180.0	5.8

Latitude	50°		60°		70°		80°		90°	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	180.0	84.2	0	85.8	0	75.8	0	65.8	All longitudes	55.8
	137.8	81.6	56.0	83.2	22.4	75.1	13.7	65.6		55.8
	123.5	76.7	77.1	78.6	42.0	73.3	27.0	65.0		55.8
	119.5	71.2	88.4	73.7	58.2	70.7	39.9	64.0		55.8
	119.2	65.6	96.4	68.7	71.4	67.6	52.2	62.8		55.8
	120.6	60.0	103.2	63.8	82.5	64.3	63.8	61.3		55.8
	123.0	54.5	109.3	59.0	92.2	60.8	74.7	59.7		55.8
	126.0	49.2	115.1	54.3	101.0	57.5	85.1	58.0		55.8
	129.5	44.1	120.7	49.9	109.1	54.2	94.9	56.2		55.8
	133.4	39.3	126.3	45.7	116.7	51.0	104.3	54.5		55.8
	137.6	34.8	132.0	41.9	124.1	48.1	113.4	52.9		55.8
	142.1	30.7	137.7	38.3	131.3	45.4	122.2	51.4		55.8
	146.9	26.9	143.5	35.2	138.3	42.9	130.8	50.0		55.8
	152.0	23.7	149.3	32.4	145.3	40.8	139.2	48.7		55.8
	157.2	20.9	155.3	30.1	152.3	39.0	147.5	47.7		55.8
	162.7	18.7	161.4	28.2	159.2	37.6	155.7	46.9		55.8
	168.4	17.1	167.6	26.9	166.1	36.6	163.8	46.3		55.8
	174.2	16.1	173.3	26.1	173.1	36.0	171.9	45.9		55.8
	180.0	15.8	180.0	25.8	180.0	35.8	180.0	45.8		55.8

27/55 11.3 MHz day

Data for plotting 6 000 km interference contours

Latitude	00°		10°		20°		30°		40°	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	180.0	54.0	180.0	64.0	180.0	74.0	180.0	84.0	0	86.0
	166.6	52.8	162.3	62.5	153.3	71.8	128.2	79.7	66.2	81.2
	154.8	49.5	148.2	58.3	136.6	66.3	115.0	72.2	82.1	73.8
	145.5	44.5	138.5	52.4	127.7	59.3	111.4	64.2	90.0	66.1
	138.5	38.3	132.2	45.4	123.2	51.6	111.0	58.2	95.7	58.5
	133.5	31.3	128.2	37.9	121.1	43.6	111.9	48.1	100.6	50.9
	130.0	23.9	126.0	30.0	120.6	35.5	113.6	40.1	105.2	43.4
	127.7	16.1	124.9	22.0	121.1	27.5	116.0	32.2	109.7	36.1
	126.4	8.1	124.8	13.9	122.3	19.5	118.8	24.6	114.3	29.0
	126.0	0.0	125.6	5.9	124.3	11.6	122.2	17.1	119.1	22.2
	126.4	−8.1	127.1	−2.1	127.0	4.0	126.0	9.9	124.2	15.7
	127.7	−16.1	129.5	−9.8	130.4	−3.4	130.4	3.1	129.6	9.5
	130.0	−23.9	132.8	−17.2	134.6	−10.3	135.4	−3.2	135.4	3.9
	133.5	−31.3	137.2	−24.2	139.7	−16.7	141.1	−9.0	141.7	−1.2
	138.5	−38.3	142.9	−30.5	145.8	−22.4	147.6	−14.1	148.5	−5.6
	145.5	−44.5	150.0	−36.0	152.9	−27.2	154.8	−18.2	155.6	−9.1
	154.8	−49.5	158.7	−40.3	161.2	−30.9	162.7	−21.4	163.6	−11.8
	166.6	−52.8	163.9	−43.0	170.3	−33.2	171.2	−23.3	171.7	−13.4
	180.0	−54.0	180.0	−44.0	180.0	−34.0	180.0	−24.0	180.0	−14.0

Latitude	50°		60°		70°		80°		90°	
	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
Coordinates for plotting contours	0	76.0	0	66.0	0	56.0	0	46.0	All longitudes	36.0
	31.1	74.2	19.5	65.1	14.4	55.6	11.6	45.8		36.0
	53.5	69.9	37.2	62.8	28.3	54.3	23.2	45.3		36.0
	68.6	64.2	52.3	59.2	41.5	52.4	34.5	44.5		36.0
	79.4	58.1	65.0	55.0	53.7	49.8	45.7	43.4		36.0
	88.1	51.7	75.8	50.3	65.1	46.9	56.5	42.0		36.0
	95.5	45.3	85.4	45.3	75.7	43.7	67.1	40.5		36.0
	102.3	38.9	94.1	40.3	85.6	40.3	77.4	38.3		36.0
	108.7	32.7	102.2	35.4	95.0	36.9	87.4	37.1		36.0
	115.0	26.3	110.0	30.6	104.0	33.5	97.2	35.4		36.0
	121.4	21.1	117.5	26.0	112.7	30.3	106.8	33.7		36.0
	127.8	15.8	125.1	21.8	121.2	27.2	116.2	32.1		36.0
	134.5	11.0	132.6	17.9	129.7	24.5	125.5	30.6		36.0
	141.4	6.7	140.2	14.4	138.1	22.0	134.7	29.2		36.0
	148.6	3.0	148.0	11.5	146.4	19.9	143.9	28.1		36.0
	156.1	−0.0	155.8	9.1	154.8	18.2	152.9	27.2		36.0
	163.9	−2.2	163.8	7.4	163.2	17.0	162.0	26.5		36.0
	171.0	−3.5	171.9	6.4	171.6	16.3	171.0	26.1		36.0
	180.0	−4.0	180.0	6.0	180.0	16.0	180.0	26.0		36.0

C – Classes of emission and power

1 Classes of emission

27/56 In the aeronautical mobile (R) service the use of emissions listed below is permissible subject to compliance with the special provisions applicable to each case and provided that such use does not cause harmful interference to other users of the channel concerned.

27/57 **1.1 Telephony – amplitude modulation:**

– double sideband A3E*

– single sideband, full carrier H3E*

– single sideband, suppressed carrier J2E, J3E, J7E, J9E

1.2 Telegraphy and data transmission

27/58 **1.2.1 Amplitude modulation:**

– telegraphy without the use of a modulating audio frequency (by on-off keying) A1A, A1B**

– telegraphy by the on-off keying of an amplitude modulating audio frequency or audio frequencies or by the on-off keying of the modulated emission and including selective calling, single sideband, full carrier H2B

– multichannel voice frequency telegraphy, single sideband, suppressed carrier J7A

– telegraphy or data transmissions using any other single sideband, suppressed carrier modulation, under the condition that the reference frequency of the transmission concerned corresponds to the list of carrier (reference) frequencies (No. **27**/18) and its occupied bandwidth does not exceed the upper limit of J3E emissions (No. **27**/12), i.e. 2 800 Hz for each individual channel J2B, J2D, J7B, J7D, J9B, J9D

27/59 **1.2.2 Frequency modulation:**

– telegraphy by frequency shift keying without the use of a modulating audio frequency, one of two frequencies being emitted at any instant F1B**

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* A3E and H3E to be used only on 3 023 kHz and 5 680 kHz.

** A1A, A1B and F1B are permitted provided they do not cause harmful interference to the classes of emission H2B, J2B, J2D, J2E, J3E, J7A, J7B, J7D, J7E, J9B, J9D and J9E. In addition, A1A, A1B and F1B emissions shall be in accordance with the provisions in Nos. **27**/70 to **27**/74 and care should be taken to place these emissions at or near the centre of the channel. However, a modulating audio frequency is permitted with single sideband transmitters, where the carrier is suppressed in accordance with No. **27**/69.

2 Power

27/60 2.1 Unless otherwise specified in Part II of this Appendix, the peak envelope powers supplied to the antenna transmission line shall not exceed the maximum values indicated in the Table below; the corresponding peak effective radiated powers being assumed to be equal to two-thirds of these values.

Class of emission	Stations	Maximum peak envelope power
H2B, J2B, J2D, J2E, J3E, J7A, J7B, J7D, J7E, J9B, J9D, J9E, A3E*, H3E*	Aeronautical stations Aircraft stations	6 kW 400 W (100% modulation)**
Other emissions such as A1A, A1B, F1B	Aeronautical stations Aircraft stations	1.5 kW 100 W

* A3E and H3E to be used only on 3 023 kHz and 5 680 kHz.

** "100% modulation" implies that during measurement or calculation, the modulation depth should be adjusted to produce the maximum peak envelope power.

27/61 2.2 It is assumed that the maximum peak envelope powers specified above for aeronautical stations will produce the mean effective radiated power of 1 kW used as a basis for the interference range contours.

27/62 2.3 In order to provide satisfactory communication with aircraft, aeronautical stations serving MWARA, VOLMET and world-wide allotment areas may exceed the power limits specified in No. **27**/60, except in the case of 3 023 kHz and 5 680 kHz which are subject to the special provisions of Nos. **27**/232 to **27**/238. In each such case, the administration having jurisdiction over the aeronautical station shall note No. **15.2** and ensure:

27/63 *a)* that when there is any possibility of harmful interference coordination is effected with the administrations concerned;

27/64 *b)* that harmful interference is not caused to stations using frequencies in accordance with the applicable provisions of the allotment Plan;

27/65 *c)* that in other MWARAs, RDARAs or VOLMET areas allotted the same frequencies, the specified protection ratios within the boundaries of those areas shall be maintained;

27/66 *d)* that the directional characteristics of the antenna are such as to minimize radiation in unnecessary directions, particularly towards other MWARAs, RDARAs or VOLMET areas which have been allotted the same frequencies;

27/67 *e)* that, in accordance with the Radio Regulations, all details of the assignment(s), including the transmitting antenna characteristics shall be notified to the Radiocommunication Bureau.

27/68 2.4 It is recognized that the power employed by aircraft transmitters may, in practice, exceed the limits specified in No. **27**/60. However, the use of such increased power (which normally should not exceed 600 W PX) shall not cause harmful interference to stations using frequencies in accordance with the technical principles on which the allotment Plan is based.

D – Limits to the power levels of unwanted emissions

1 Technical provisions relating to the use of single-sideband emissions

27/69 **1.1 Definitions carrier modes:**

Carrier mode	Level N (dB) of the carrier with respect to peak envelope power
Full carrier (for example H2B)	$0 \geq N \geq -6$
Suppressed carrier (for example J3E)	Aircraft stations $N < -26$ Aeronautical stations $N < -40$

2 Tolerance for levels of emission outside the necessary bandwidth

27/70 2.1 In a single-sideband transmission, the mean power of any emission supplied to the antenna transmission line of an aeronautical or aircraft station on any discrete frequency, shall be less than the mean power (PY) of the transmitter in accordance with the Table in No. **27**/71.

27/71 2.2 For aircraft station transmitter types first installed before 1 February 1983:

Frequency separation Δ from the assigned frequency (kHz)	Minimum attenuation below mean power (PY) (dB)
$2 \leq \Delta < 6$	25
$6 \leq \Delta < 10$	35
$10 \leq \Delta$	Aircraft stations: 40 Aeronautical stations: $43 + 10 \log_{10}$ (PY) (W)

27/72 NOTE – All transmitters first placed in operation after 1 February 1983 shall comply with the specifications contained in No. **27**/74.

27/73 2.3 In a single-sideband transmission, the peak envelope power (PX) of any emission supplied to the antenna transmission line of an aeronautical or aircraft station on any discrete frequency, shall be less than the peak envelope power (PX) of the transmitter in accordance with the Table in No. **27**/74.

27/74 2.4 For aircraft station transmitters first installed after 1 February 1983 and for aeronautical station transmitters in use after 1 February 1983:

Frequency separation Δ from the assigned frequency (kHz)	**Minimum attenuation below peak envelope power (PX) (dB)**
$1.5 \leq \Delta < 4.5$	30
$4.5 \leq \Delta < 7.5$	38
$7.5 \leq \Delta$	Aircraft stations: 43 Aeronautical stations: *

* For transmitter power up to and including 50 W: $43 + 10 \log_{10}$ (PX) (W). For transmitter powers more than 50 W, the attenuation shall be at least 60 dB.

E – Other technical provisions

1 Assigned frequencies

27/75 1.1 For single-sideband emissions, except the class of emission H2B, the assigned frequency shall be at a value 1 400 Hz above the carrier (reference) frequency.

27/76 1.2 For aeronautical stations equipped with selective calling systems, the class of emission H2B shall be indicated in the Supplementary Information column of the form of notice (see Appendix **4**).

27/77 1.3 For classes of emission A1A, A1B and F1B the assigned frequency shall be chosen in accordance with the provisions of the footnote to Nos. **27**/58 and **27**/59.

27/78 1.4 The assigned frequency of a station employing double sideband emissions (A3E) shall be at the carrier (reference) frequency.

PART II – Plan for the allotment of frequencies for the aeronautical mobile (R) service in the exclusive bands between 2 850 and 22 000 kHz

Section I – Description of the boundaries of the areas and sub-areas

27/79 1 The boundary descriptions which follow delineate the areas to which frequencies are allotted under the frequency allotment Plan.

27/80 2 These areas are shown graphically on the maps associated with this Appendix. If there is any difference between the areas as shown on the maps and as described, the written description is to be considered correct.

27/81 3 References to the name of a country or of a geographical area in the descriptions or on the maps and the borders shown on the maps do not imply the expression of any opinion whatsoever on the part of the ITU concerning the political status of such a country or geographical area or any official recognition of these borders.

27/82 4 In the description of the Major World Air Route Areas (MWARAs) all lines between points not otherwise specified are defined as great circles.

27/83 In the description of the Regional and Domestic Air Route Areas (RDARAs) and Sub-Areas all lines between points not otherwise specified are defined as straight lines on a Mercator Projection map.

27/84 In the description of the VOLMET areas all lines between points are defined as great circles.

ARTICLE 1

Description of the boundaries of the major world air route areas (MWARAs)

27/85 *Major World Air Route Area – CARIBBEAN* (MWARA-CAR)

From the point 20° N 120° W through the points 35° N 120° W, 35° N 85° W, 43° N 74° W, 40° N 60° W, 00° 48° W, 00° 80° W, to the point 20° N 120° W.

27/86 *Major World Air Route Area – CENTRAL EAST PACIFIC* (MWARA-CEP)

From the point 50° N 122° W through the points 38° N 120° W, 15° N 110° W, 20° S 145° W, 20° S 152° W, 30° N 165° W, to the point 50° N 122° W.

27/87 *Major World Air Route Area – CENTRAL WEST PACIFIC* (MWARA-CWP)

From the point 40° N 117° E through the points 25° N 155° W, 17° N 155° W, 00° 165° W, 00° 170° E, 12° S 165° E, 12° S 136° E, 09° N 115° E, 23° N 114° E, to the point 40° N 117° E.

27/88 *Major World Air Route Area – EUROPE* (MWARA-EUR)

From the point 33° N 12° W through the points 54° N 12° W, 70° N 00°, 74° N 40° E, 74° N 52° E, 60° N 52° E, 40° N 36° E, 29° N 35° 30' E, 32° N 13° E, to the point 33° N 12° W.

27/89 *Major World Air Route Area – INDIAN OCEAN* (MWARA-INO)

From the South Pole through the points 30° S 26° E, 20° N 35° E, 30° N 60° E, 30° N 90° E, 30° S 120° E, 40° S 160° E to the South Pole.

27/90 *Major World Air Route Area – MIDDLE EAST* (MWARA-MID)

From the point 51° N 30° E through the points 57° N 37° E, 50° N 80° E, 44° N 94° E, 08° N 76° E, 11° 45' N 42° E, 16° N 42° E, 30° N 30° E, to the point 51° N 30° E.

27/91 *Major World Air Route Area – NORTH ATLANTIC* (MWARA-NAT)

From the North Pole through the points 60° N 135° W, 49° N 120° W, 49° N 74° W, 39° N 78° W, 18° N 66° W, 05° N 55° W, 16° N 26° W, 32° N 08° W, 44° N 02° E, 60° N 20° E, to the North Pole.

27/92 *Major World Air Route Area – NORTH CENTRAL ASIA* (MWARA-NCA)

From the North Pole through the points 75° N 10° E, 60° N 25° E, 30° N 25° E, 30° N 73° E, 37° N 73° E, 49° N 85° E, 42° N 97° E, 42° N 110° E, 45° N 113° E, 46° 30' N 120° E, 49° N 116° E, 54° N 123° E, 45° N 133° E, 40° N 124° E, 30° N 124° E, 25° N 135° E, 65° N 170° W, to the North Pole.

27/93 *Major World Air Route Area – NORTH PACIFIC* (MWARA-NP)

From the North Pole through the points 60° N 135° W, 47° N 118° W, 30° N 165° W, 30° N 115° E, 41° N 116° E, 55° N 135° E to the North Pole.

27/94 *Major World Air Route Area – AFRICA* (MWARA-AFI)

From the point 40° N 35° W, through the points 37° N 03° W, 37° N 44° E, the border between Iraq and the Islamic Republic of Iran, the points 29° N 48° E, 26° N 56° E, 20° N 62° E, 22° S 60° E, 35° S 30° E, 35° S 16° E, 05° N 03° W, 05° N 35° W, to the point 40° N 35° W.

27/95 *Major World Air Route Area – SOUTH ATLANTIC* (MWARA-SAT)

From the South Pole through the points 30° S 75° W, 19° S 53° W, 00° 60° W, 20° N 60° W, 25° N 25° W, 41° N 15° W, 41° N 03° W, 15° N 03° W, 20° S 32° E to the South Pole.

27/96 *Major World Air Route Area – SOUTH AMERICA* (MWARA-SAM)

From the South Pole through the points 15° N 125° W, 15° N 60° W, 10° N 60° W, 05° S 30° W, 36° S 52° W, to the South Pole.

27/97 *Major World Air Route Area – SOUTH EAST ASIA* (MWARA-SEA)

From the point 26° N 130° E, through the points 00° 130° E, 00° 135° E, 12° S 145° E, 12° S 160° E, 25° S 155° E, 40° S 150° E, 35° S 115° E, 18° N 62° E, 26° N 65° E, to the point 26° N 130° E.

27/98 *Major World Air Route Area – SOUTH PACIFIC* (MWARA-SP)

From the South Pole through the points 38° S 145° E, 00° 167° E, 00° 175° W, 22° N 158° W, 22° N 156° W, 00° 120° W to the South Pole.

27/99 *Major World Air Route Area – EAST ASIA* (MWARA-EA)

From the point 55° N 124° E through the points 37° N 145° E, 26° N 130° E, 00° 130° E, 00° 80° E, 18° N 62° E, 37° N 67° E, 55° N 80° E to the point 55° N 124° E.

ARTICLE 2

Description of the boundaries of the regional and domestic air route areas (RDARAs)

27/100 *Regional and Domestic Air Route Area – 1* (RDARA-1)

From the North Pole along the 15° W meridian to the point 72° N 15° W, then through the points 40° N 50° W, 30° N 39° W, 30° N 10° W, 31° N 10° W, to the point 31° N 10° E. Then along the Libya-Tunisia border to the Mediterranean, thence along the coast of Libya and Egypt to Alexandria. Thence to Cairo, eastward along the Cairo parallel to intersect the 40° E meridian, and north along the 40° E meridian to the intersection with the border between the Syrian Arabic Republic and Iraq and along this border up to the Turkish border. Then along the border between Türkiye and the following countries: Iraq, Islamic Republic of Iran, Armenia and Georgia, up to the Black Sea Coast. Thence along the Black Sea Coast of Türkiye to intersect the 30° E meridian, then along the 30° E meridian to the border of Romania and Ukraine. Thence along the borders between Romania and Ukraine, Romania and Moldova, Romania and Ukraine. Thence along the border of Ukraine, and the following countries: Hungary, Slovakia and Poland. Thence along the border of Poland and the following countries: Belarus, Lithuania and the Russian Federation. Thence northeastward along the Baltic Sea coast, to the border between Finland and the Russian Federation, and between Norway and the Russian Federation, to the point 70° N 32° E, and along the 32° E meridian to the North Pole. (WRC-23)

27/101 *Sub-Area 1A*

From the point 65° N 26° W, and through the points 40° N 50° W, 40° N 20° W, 60° N 20° W, 60° N 26° W, to the point 65° N 26° W.

27/102 *Sub-Area 1B*

From the North Pole along the 15° W meridian to the point 72° N 15° W, then through the points 65° N 26° W, 60° N 26° W, 60° N 20° W to the points 50° N 20° W and 50° N 10° W, thence east along the territorial waters between the Channel Islands and the French coastline, reaching the latter at the meridian 03° W. Thence following the French coastline northeastward and the frontier of France with Belgium, Luxembourg and Germany. Thence along the border between Germany and the following countries: Switzerland, Austria, the Czech Rep. and Poland towards the Baltic Sea. Then west along the coastline of Germany to the border between the latter and Denmark. Along this border to the North Sea. Thence along the 55° N parallel to the point 55° N 04° E, then through the points 56° N 03° E, 59° N 02° E, 62° N 01° E. Thence along the 01° E meridian to the North Pole.

27/103 *Sub-Area 1C*

From the North Pole along the meridian 01° E to the point 62° N 01° E. Thence through the points 59° N 02° E, 56° N 03° E, 55° N 04° E and then east along the 55° N parallel and the border between Denmark and Germany to the Baltic Sea and along the Baltic Sea coast of Germany to the border between Germany and Poland. Along this border and continuing along the western borders of the Czech Rep. and Austria to the borders between Austria and Switzerland, Austria and Liechtenstein and Austria and Switzerland. Thence eastward along the southern borders of Austria and Hungary, thence along the border between Hungary and Romania. Thence, along the border between Ukraine and the following countries: Hungary, Slovakia and Poland. Thence along the border of Poland and the following countries: Belarus, Lithuania and the Russian Federation to the Baltic Sea. Thence northeastward along the Baltic Sea coast, along the borders between Finland and the Russian Federation and between Norway and the Russian Federation to the point 70° N 32° E, then along the 32° E meridian to the North Pole.

27/104 *Sub-Area 1D*

From the junction of the borders of Ukraine, Hungary and Romania, westward along the southern borders of Hungary and Austria to the border between Switzerland and Italy, and the border between France and Italy to the Mediterranean Sea. Thence to 43° N 10° E to 41° N 10° E to 41° N 07° E, thence along the 07° E meridian to the North African coast. Then along the North African coast including Tunis, Tripoli, Benghazi, to the coastal border between Libya and Egypt. Thence along the coast to Alexandria, then to Cairo, and along the Cairo parallel to the 40° E meridian. North along the 40° E meridian to the intersection with the border between Syrian Arab Republic and Iraq and along this border up to the Turkish border. Then along the border between Türkiye and the following countries: Iraq, Islamic Republic of Iran, Armenia and Georgia, up to the Black Sea Coast. Thence along the Black Sea Coast of Türkiye to intersect the 30° E meridian. Along the 30° E meridian to the border of Romania and Ukraine, thence along the borders between Romania and Ukraine, Romania and Moldova, Romania and Ukraine to the junction of the borders of Ukraine, Hungary and Romania. (WRC-23)

27/105 *Sub-Area 1E*

From the point 50° N 20° W, through the points 40° N 20° W, 40° N 50° W, 30° N 39° W, 30° N 10° W, 31° N 10° W, to the point 31° N 10° E. Then along the border between Libya and Tunisia to the Mediterranean, thence along the Tunisian coast to intersect the 10° E meridian. Thence along this meridian to the point 43° N 10° E; thence to the borders between Italy and France and between Italy and Switzerland, Austria and Switzerland, Austria and Liechtenstein, Austria and Switzerland, Switzerland and Germany, and between France and Germany, France and Luxembourg, and France and Belgium to the Channel coast. Thence west through the territorial waters between the Channel Islands and the French coast to the points 50° N 10° W and 50° N 20° W.

27/106 *Regional and Domestic Air Route Area – 2* (RDARA-2)

From the North Pole along the 32° E meridian to the 70° N parallel. Then along the border between Norway and the Russian Federation and Finland and the Russian Federation to the Baltic coast. Thence southwestward along the Baltic coast to the border between the Russian Federation and Poland. Thence along the border between Poland and the following countries: the Russian Federation, Lithuania, Belarus and Ukraine. Thence along the border between Ukraine and the following countries: Poland, Slovakia, Hungary and Romania, to the junction of the borders of Ukraine, Romania and Moldova. Thence along the borders of Romania and Moldova, Romania and Ukraine, to the Black Sea coast at the intersection of the 30° E meridian. Then along the 30° E meridian to the Black Sea coast of Türkiye. Along the Black Sea coast of Türkiye to the junction of the borders of Türkiye and Georgia. Thence along borders between Türkiye and the following countries: Georgia, Armenia and Azerbaijan, to the junction of the borders between the Islamic Republic of Iran and Azerbaijan. Then along the northern border of the Islamic Republic of Iran to Caspian Sea. Then along the Iran Caspian Sea coast to the border of Turkmenistan. Thence eastward along the southern borders of Turkmenistan, Uzbekistan, Tajikistan and Kyrgyzstan, and the eastern border of Kazakhstan, to the junction of the borders of Kazakhstan, the Russian Federation and China. Then along the border between the Russian Federation and China to the intersection of the Mongolia-China-Russian Federation borders at approximately 49° N 88° E. Then along the 88° E meridian to 55° N. Then along the 55° N parallel to 60° E, and along the 60° E meridian to the North Pole. (WRC-23)

27/107 *Sub-Area 2A*

From the North Pole along the 32° E meridian to 70° N. Then along the border between Norway and the Russian Federation, and Finland and the Russian Federation to the Baltic coast, and southwestward along the Baltic coast to the point 55° N 20° E, and thence to Moscow. Then to 55° N 60° E, and along the 60° E meridian to the North Pole.

27/108 *Sub-Area 2B*

From the point 55° N 88° E and through the point 55° N 60° E to the point 47° N 53° E. Thence along the east coast of the Caspian Sea to the Iranian coast. Then along the Islamic Republic of Iran Caspian Sea coast to the border of Turkmenistan. Thence eastward along the southern borders of Turkmenistan, Uzbekistan, Tajikistan and Kyrgyzstan, and the eastern border of Kazakhstan, to the junction of the borders of Kazakhstan, the Russian Federation and China. Then along the border between the Russian Federation and China to the intersection of the Mongolia-China-Russian Federation borders at approximately 49° N 88° E; thence along the 88° E meridian to 55° N 88° E.

27/109 *Sub-Area 2C*

From the point 55° N 60° E, to Moscow, to 55° N 20° E. Thence south along the borders between Poland and the following countries: Russian Federation, Lithuania, Belarus and Ukraine. Thence along the border between Ukraine and the following countries: Poland, Slovakia, Hungary and Romania, to junction of the borders of Ukraine, Romania and Moldova. Thence along the borders of Romania and Moldova, Romania and Ukraine to the Black Sea coast at the meridian 30° E. Along the meridian 30° E to the Black Sea coast of Türkiye. Along this coastline to the junction of the border between Türkiye and Georgia. Thence along the borders between Türkiye and the following countries: Georgia, Armenia and Azerbaijan, to the junction of the borders between the Islamic Republic of Iran and Azerbaijan. Then along the northern borders of the Islamic Republic of Iran to the Caspian Sea, then along the south coast of the Caspian Sea and thence north along the East Caspian Sea coast and through the point 47° N 53° E to 55° N 60° E. (WRC-23)

27/110 *Regional and Domestic Air Route Area – 3* (RDARA-3)

From the North Pole to the point 55° N 60° E, thence along the 55° N parallel to 88° E. Then along the 88° E meridian to the intersection of the Mongolia-China-Russian Federation borders at approximately 49° N 88° E. Then along the borders between Mongolia and China, and the Russian Federation and China, to the coast. Between the territorial waters of the Russian Federation and Japan to the point 43° N 147° E and through the point 50° N 164° E to 65° N 170° W. Then along the 170° W meridian to the North Pole.

27/111 *Sub-Area 3A*

From the North Pole along the 60° E meridian to 55° N. Then along the 55° N parallel to 88° E. Then through the point 60° N 88° E to 60° N 110° E, and along the 110° E meridian to the North Pole.

27/112 *Sub-Area 3B*

From the North Pole along the 110° E meridian to 60° N 110° E, and through the points 60° N 147° E, 43° N 147° E, 50° N 164° E, to 65° N 170° W. Then along the 170° W meridian to the North Pole.

27/113 *Sub-Area 3C*

From the point 60° N 88° E to the intersection of Mongolia-China-the Russian Federation borders at approximately 49° N 88° E. Along the borders between Mongolia and China, and the Russian Federation and China, to the coast. Between the territorial waters of the Russian Federation and Japan to the point 43° N 147° E. Then through the point 60° N 147° E to the point 60° N 88° E.

27/114 *Regional arid Domestic Air Route Area – 4* (RDARA-4)

From the point 30° N 39° W, and through the points 10° N 20° W, 05° S 20° W, to the point 05° S 12° E. Thence along the border between the Rep. of the Congo and Angola, then along the northern border of the Dem. Rep. of the Congo, and the borders of the Rep. of the Congo, of the Central African Republic and South Sudan. Thence north along the western borders of South Sudan and the Sudan. Along the western border of Egypt, northwards to the Mediterranean and along the Mediterranean and Atlantic coasts of North Africa to the point 30° N 10° W. West along the 30° N parallel to close the area at 30° N 39° W. (WRC-19)

27/115 *Sub-Area 4A*

From the point 30° N 39° W to 21° N 31° W. Thence to Gao and to Zinder. From Zinder, along the northern border of Nigeria, to the junction of the borders of Nigeria, Chad and Cameroon. Then along the border between Chad and Cameroon to a point west of N'Djamena. Then along the parallel to 12° N 22° E. Thence north along the western border of the Sudan, and along the western border of Egypt to the Mediterranean. Along the North African Mediterranean coast and Atlantic coast to a point 30° N 10° W. Thence along the 30° N parallel to close the sub-area at 30° N 39° W.

27/116 *Sub-Area 4B*

From the point 21° N 31° W, through the points 10° N 20° W, 05° S 20° W to 05° S 12° E. Thence along the southern border of the Rep. of the Congo and the Central African Republic to the junction between the Dem. Rep. of the Congo, South Sudan and the Central African Republic. Along the western border of South Sudan and the Sudan to the point 12° N 22° E. Thence along the N'Djamena parallel to the Nigerian border. Then westward along this border to the point 13° 12' N 10° 45' E, through Zinder and Gao, to the point 21° N 31° W. (WRC-19)

27/117 *Regional and Domestic Air Route Area – 5* (RDARA-5)

From the point 41° N 40° E to the point 37° N 40° E. Then along the border between Türkiye and Syrian Arab Republic to the Mediterranean coast. Thence to the common border of Libya and Egypt on the North African coast excluding Cyprus. Southward along the western border of Egypt, the Sudan and South Sudan to the border of Kenya. Thence east along the northern border of Kenya, then south along the border between Kenya and Somalia and to the East African coast at 02° S 41° E. Then through the point 02° S 73° E to 37° N 73° E. Then east along the border between Afghanistan and Pakistan, and west along the northern borders of Afghanistan and the Islamic Republic of Iran to the Caspian Sea. Then along the northern border of the Islamic Republic of Iran and Türkiye to close the area at 41° N 40° E. (WRC-23)

27/118 *Sub-Area 5A*

From the point 37° N 40° E, along the border between Türkiye and the Syrian Arab Republic to the Mediterranean coast. Thence to the Libyan -Egyptian border on the North African coast, excluding Cyprus. Southward, along the western border of Egypt and east along the common border of Egypt and the Sudan to 24° N 37° E. Then through the points 11° 45' N 42° E, 11° 45' N 55° E, 20° N 52° E, to the point 26° N 52° E. Thence along the border between Islamic Republic of Iran and Iraq, and the border between Iraq and Türkiye, to the point 37° N 40° E. (WRC-23)

27/119 *Sub-Area 5B*

From the point 41° N 40° E to 37° N 40° E. Thence east along the borders between Türkiye and Syrian Arab Republic and Türkiye and Iraq, and along the border between Iraq and the Islamic Republic of Iran to the point 30° N 49° E. Thence along the middle of the Gulf through the points 26° N 52° E and 24° N 60° E, to Mumbai. Then to 37° N 73° E. Then east along the border between Afghanistan and Pakistan, then west along the northern borders of Afghanistan and the Islamic Republic of Iran, to the Caspian Sea. Then along the northern border of the Islamic Republic of Iran and Türkiye to close the sub-area at 41° N 40° E. (WRC-23)

27/120 *Sub-Area 5C*

From the point 26° N 52° E, and through the points 13° N 52° E, 13° N 54° E, 02° S 54° E, 02° S 73° E, to Mumbai. Then to 24° N 60° E. Then along the middle of the Gulf to 26° N 52° E.

27/121 *Sub-Area 5D*

From the junction of Egypt, Libya and the Sudan southward along the western border of the Sudan and South Sudan to the border of Kenya. Thence along the northern border of Kenya. Then south along the border between Kenya and Somalia to the east African coast, at the point 02° S 42° E. Then through the points 02° S 54° E, 13° N 54° E, 13° N 52° E to the point 12° N 44° E. Thence northwest along the middle of the Red Sea to 24° N 37° E. Thence along the southern border of Egypt to close the sub-area. (WRC-19)

27/122 *Regional and Domestic Air Route Area – 6* (RDARA-6)

From approximately 49° N 88° E, eastward along the border between China and the following countries: the Russian Federation, Kazakhstan, Kyrgyzstan, Tajikistan and Afghanistan. Then along the border between Afghanistan and Pakistan, and the Islamic Republic of Iran and Pakistan to the point 23° N 61° E. Thence to Mumbai. Then along the 73° E meridian to the point 02° S 73° E, and through the points 02° S 92° E, 10° S 92° E, 10° S 141° E, 00° 141° E, 00° 160° E, 03° 30' N 160° E, 03° 30' N 170° W, 10° N 170° W, 50° N 164° E, to the point 43° N 147° E. Thence west between the territorial waters of Japan and the Russian Federation and along the north-eastern and northern border of China to approximately 49° N 88° E.

27/123 *Sub-Area 6A*

From the point 37° N 75° E, along the border between Pakistan and Afghanistan, and the Islamic Republic of Iran and Pakistan to the point 23° N 61° E. Thence to Mumbai. From Mumbai to 24° N 80° E. Thence to Calcutta. Thence along the coast of Bangladesh and Myanmar to reach the border between Myanmar and Thailand. North along this border and that between Myanmar and Lao (P.D.R.). Thence along the border between China and Myanmar. Thence westward along the southern border of China to the point 37° N 75° E.

27/124 *Sub-Area 6B*

From the point 39° 49' 41" N 124° 10' 06" E, through the points 39° 31' 51" N 124° 06' 31" E, 39° N 124° E to the point 32° 30' N 124° E. Between the point 32° 30' N 124° E and the point 25° N 123° E, the limit of this Sub-Area is undefined. From the point 25° N 123° E, through the points 21° N 121° 30' E, 20° N 120° E, 20° N 176° W, 50° N 164° E, 43° N 147° E, thence west between the territorial waters of Japan and the Russian Federation and along the border between the Dem. People's Rep. of Korea and the Russian Federation, and then the border between China and the Dem. People's Rep. of Korea, to the point 39° 49' 41" N 124° 10' 06" E.

27/125 *Sub-Area 6C*

From the point 20° N 130° E through the point 04° N 130° E to 04° N 118° E. Thence along the southern borders of Sabah and Sarawak to the coast and then southward along the west coast of Borneo to the 110° E meridian. Thence along 110° E meridian to the point 10° S 110° E. Thence through the points 10° S 141° E, 00° 141° E, 00° 160° E, 03° 30' N 160° E, 03° 30' N 170° W, 10° N 170° W, 20° N 176° W to 20° N 130° E.

27/126 *Sub-Area 6D*

From the junction of the borders of China, India and Myanmar, south along the India-Myanmar and Bangladesh-Myanmar borders to the Bay of Bengal. Along the coast of Myanmar to its southernmost point, then to Weh Island (off the north coast of Sumatra). Then to the point 02° S 92° E, and through the point 10° S 92° E to 10° S 110° E. Then eastward to 10° S 141° E extending northward to 00° 141° E and then to 04° N 130° E through the point 20° N 130° E to 20° N 113° E. Thence, south around the Island of Hainan, and along the border between China, Viet Nam, the Lao (P.D.R.) and Myanmar, to close the Sub-Area at the junction of the borders of China, India and Myanmar.

27/127 *Sub-Area 6E*

From the point 20° N 73° E, and through the points 02° S 73° E, 02° S 92° E, through Weh Island (off the north coast of Sumatra) to 10° N 97° E. Thence along the coasts of Myanmar, Bangladesh and India to Calcutta. Then through the points 24° N 80° E to 20° N 73° E.

27/128 *Sub-Area 6F*

From the point 25° N 123° E, 21° N 121° 30' E, 20° N 120° E, 20° N 113° E, thence south around the Island of Hainan and along China-Viet Nam, China-Lao (P.D.R.) and China-Myanmar borders to the junction of the borders of China, India and Myanmar, south along the India-Myanmar and Bangladesh-Myanmar borders to the Bay of Bengal. Along the coast of Myanmar to its southernmost point then to Weh Island (off the north coast of Sumatra). Then to the point 02° S 92° E and through the point 10° S 92° E to 10° S 110° E. Then northward along 110° E meridian, thence along the boundary of Sub-Area 6C to the points 20° N 130° E, 43° N 147° E, thence westward between the territorial waters of Japan and the Russian Federation and along the border between the Dem. People's Rep. of Korea and the Russian Federation, then the border between China and the Dem. People's Rep. of Korea, to the points 39° 49' 41" N 124° 10' 06" E, 39° 31' 51" N 124° 06' 31" E, 39° N 124° E, then to the point 32° 30' N 124° E.

Between the points 32° 30' N 124° E and 25° N 123° E, the limit of this Sub-Area is undefined.

27/129 *Sub-Area 6G*

From the point 32° 30' N 124° E northward to 39° N 124° E, 39° 31' 51" N 124° 06' 31" E then to 39° 49' 41" N 124° 10' 06" E on the border between China and the Dem. People's Rep. of Korea. Then along the border of China to the junction of the border with India and Myanmar. Thence southward along the India-Myanmar and Bangladesh-Myanmar borders to the Bay of Bengal. Along the coast of Myanmar to its southernmost point. Then to Weh Island (off the north coast of Sumatra). Then to the point 02° S 92° E and through the point 10° S 92° E to 10° S 110° E. Then eastward to 10° S 141° E extending northward to 00° 141° E and then to 04° N 130° E through the point 20° N 130° E to 20° N 120° 40' E. Thence northward to the points 21° N 121° 30' E and 25° N 123° E.

Between the points 25° N 123° E and the point 32° 30' N 124° E, the limit of this Sub-Area is undefined.

In the area where Sub-Areas 6D, 6F and 6G are common, the frequencies allotted to Sub-Area 6G shall be used only by the aeronautical stations of China; the frequencies allotted to Sub-Areas 6D and 6F will be used only by the aeronautical stations of the other administrations in the common area. Also in this common area, the operational use by China of the frequencies allotted to Sub-Area 6G shall be within the area defined by a line starting at 21° 32' 52" N 108° E, passing through the points 20° N 108° E, 20° N 107° E, 18° N 107° E, 18° N 108° E, 15° N 110° E, 10° N 110° E, 06° N 108° E, 03° 30' N 112° E, 04° N 113° E, 08° N 116° E, 10° N 118° E, 14° N 119° E, 18° N 119° E to 20° N 120° 40' E and thence along the limit of Sub-Area 6D to 21° 32' 52" N 108° E.

27/130 *Regional and Domestic Air Route Area – 7* (RDARA-7)

From the South Pole along the 20° W meridian to 05° S. Then along the 05° S parallel to 12° E. Thence along the border between the Rep. of the Congo and Angola, then along the northern border of the Dem. Rep. of the Congo, along the border between Uganda and South Sudan, and the borders between Kenya and South Sudan, Ethiopia and Somalia, to the point 02° S 42° E. Then to 02° S 60° E and along the 60° E meridian to 11° S, then through the points 11° S 65° E, 40° S 65° E, 40° S 60° E to the South Pole. (WRC-19)

27/131 *Sub-Area 7A*

From the South Pole along the 20° W meridian to 05° S. Then through the points 05° S 10° E, 40° S 10° E, to 40° S 60° E. Then along the 60° E meridian to the South Pole.

27/132 *Sub-Area 7B*

From the point 05° S 10° E to 05° S 12° E. Thence along the border between the Rep. of the Congo and Angola, then along the northern border of the Dem. Rep. of the Congo, to the junction of the borders of Uganda, the Dem. Rep. of the Congo and South Sudan. Thence along the eastern borders of the Dem. Rep. of the Congo, Rwanda, Burundi, and the Dem. Rep. of the Congo. Thence along the southern borders of the Dem. Rep. of the Congo and Angola to the coast of the South Atlantic. Thence to the point 17° S 10° E, and then to the point 05° S 10° E. (WRC-19)

27/133 *Sub-Area 7C*

From the junction of the borders of Uganda, the Dem. Rep. of the Congo and South Sudan along the western borders of Uganda and Tanzania, and then along the southern border of Tanzania to the coast. Thence through the points 11° S 41° E, 11° S 60° E, 02° S 60° E, to 02° S 41° E and thence to the east coast of Africa. Then north along the eastern border of Kenya, then west along the northern borders of Kenya and Uganda to close the sub-area at the junction of the borders of the Dem. Rep. of the Congo, South Sudan and Uganda. (WRC-19)

27/134 *Sub-Area 7D*

From the border between Tanzania and Mozambique on Lake Nyasa, south along the west border of Mozambique to the east coast of Africa, then through the points 27° S 33° E, 40° S 33° E, 40° S 65° E, 11° S 65° E to 11° S 41° E. Thence along the northern border of Mozambique to Lake Nyasa.

27/135 *Sub-Area 7E*

From the point 17° S 10° E, and through the points 40° S 10° E, 40° S 33° E, to 27° S 33° E. Thence along the west border of Mozambique and the part of the western border of Tanzania as far as the northern point of Lake Nyasa. Thence along the borders between Malawi and Tanzania and between Zambia and Tanzania and along the borders between the Dem. Rep. of the Congo and Zambia, Angola and Zambia, and Angola and Namibia to the coast at the point 17° S 10° E.

27/136 *Sub-Area 7F*

From the point 05° S 10° E to 05° S 12° E, along the border between the Rep. of the Congo and Angola to the junction point of the borders of the Rep. of the Congo, Angola, and the Dem. Rep. of the Congo. Thence along the border between Angola and the Dem. Rep. of the Congo until the coast of the Atlantic, along the coastline until the Zaire River and thence along the northern, eastern and southern border of Angola to the coast of the South Atlantic. Thence to the point 17° S 10° E and then to the point 05° S 10° E.

27/137 *Regional and Domestic Air Route Area – 8* (RDARA-8)

From the South Pole along the 60° E meridian to 40° S then through the points 40° S 65° E, 11° S 65° E, 11° S 60° E, 02° S 60° E, 02° S 92° E, 10° S 92° E, to 10° S 110° E. Then along the 110° E meridian to the South Pole.

27/138 *Regional and Domestic Air Route Area – 9* (RDARA-9)

From the South Pole along the 160° E meridian to 27° S. Then through the points 19° S 153° E, 10° S 145° E, 10° S 141° E, 00° 141° E, 00° 160° E, 03° 30' N 160° E, 03° 30' N 120° W. Then along the 120° W meridian to the South Pole.

27/139 *Sub-Area 9B*

From the point 00° 141° E through points 10° S 141° E, 10° S 145° E, 27° S 160° E, 27° S 157° W, 03° 30' N 157° W, 03° 30' N 160° E, 00° 160° E to the point 00° 141° E.

27/140 *Sub-Area 9C*

From the South Pole along the 170° W meridian to 03° 30' N. Then through the point 03° 30' N 120° W and along the 120° W meridian to the South Pole.

27/141 *Sub-Area 9D*

From the South Pole along the 160° E meridian to 27° S. Then through the point 27° S 170° W and along the 170° W meridian to the South Pole.

27/142 *Regional and Domestic Air Route Area – 10* (RDARA-10)

From the point 50° N 164° E to 66° N 169° W. Then along the 169° W meridian to the North Pole. Then through the points 82° N 30° E, 82° N 00°, 73° N 00°, 73° N 15° W. Then along the 15° W meridian to 72° N. Then through the points 40° N 50° W, 40° N 65° W to 44° 30' N 73° W, 41° N 81° W, 41° N 88° W. 48° N 91° W, 48° N 127° W, 50° N 130° W, then westward to the point 50° N 164° E.

27/143 *Sub-Area 10A*

From the point 50° N 164° E to 66° N 169° W, along the 169° W meridian to the North Pole, along the 130° W meridian to 50° N, then westward to the point 50° N 164° E.

27/144 *Sub-Area 10B*

From the point 57° N 140° W, along the 140° W meridian to the North Pole. Then along the 91° W meridian to 48° N. Thence through the points 48° N 127° W, 57° N 139° W, to 57° N 140° W.

27/145 *Sub-Area 10C*

From the point 57° N 140° W, and through the points 60° N 140° W, 60° N 91° W, 48° N 91° W, 48° N 127° W, 57° N 139° W, to 57° N 140° W.

27/146 *Sub-Area 10D*

From the point 48° N 98° W, along the 98° W meridian to the North Pole. Then along the 45° W meridian to 69° N. Then through the points 61° N 70° W, 45° N 72° W, 41° N 81° W, 41° N 88° W, 48° N 91° W, to 48° N 98° W.

27/147 *Sub-Area 10E*

From the point 45° N 74° W, and through the point 61° N 72° W to 69° N 47° W. Then along the 47° W meridian to the North Pole. Then along the 15° W meridian to 72° N. Then through the points 40° N 50° W, 40° N 65° W, to close the sub-area at 45° N 74° W.

27/148 *Sub-Area 10F*

From the North Pole through the points 82° N 30° E, 82° N 00°, 73° N 00°, 73° N 20° W, 70° N 20° W, 63° 30' N 39° W, 58° 30' N 43° W, 58° 30' N 50° W, 63° 30' N 55° 44' W, 65° 30' N 58° 39' W, 74° N 68° 18' W, 76° N 76° W, 78° N 75° W, 82° N 60° W to the North Pole.

27/149 *Regional and Domestic Air Route Area – 11* (RDARA-11)

From the point 29° N 180° through the points 50° N 164° E, 50° N 127° W. Then along the border between the United States of America and Canada to 46° N 67° W, then to 40° N 65° W, 40° N 50° W, 25° N 35° W, 25° N 98° W, 33° N 119° W, 33° N 153° W, 29° N 153° W to the point 29° N 180°.

27/150 *Sub-Area 11A*

From the point 29° N 180°, through the points 50° N 164° E, 50° N 130° W, 33° N 130° W, 33° N 153° W, 29° N 153° W, to the point 29° N 180°.

27/151 *Sub-Area 11B*

From the point 50° N 130° W and through the points 33° N 130° W, 33° N 119° W, 25° N 98° W, 25° N 65° W, 40° N 65° W, 46° N 67° W. Then along the border between the United States of America and Canada through 50° N 127° W, to the point 50° N 130° W.

27/152 *Sub-Area 11C*

From the point 25° N 65° W and through the points 40° N 65° W, 40° N 50° W, 25° N 35° W, to the point 25° N 65° W.

27/153 *Regional and Domestic Air Route Area – 12* (RDARA-12)

From the point 03° 30' N 170° W to the point 10° N 170° W, then along the boundary between ITU Regions 2 and 3 to 29° N 180°, and thence to 29° N 153° W, 33° N 153° W, through the points 33° N 120° W, 35° N 120° W, 32° N 104° W, 25° N 91° W, 26° N 91° W, 26° N 79° W, 27° N 79° W, 27° N 76° 30' W, 25° N 70° W, 25° N 35° W and along the boundary between ITU Regions 1 and 2 to 00° 20° W. Thence through the points 00° 44° W, 04° 24' N 50° 39' W. Then along the boundaries between Brazil and the French Guiana, Surinam, Guyana, Venezuela, Colombia to the junction of Brazil, Peru and Colombia then along the boundaries between Peru and Colombia and Peru and Ecuador to the point 04° S 93° W. Then to the point 05° S 93° W and through the points 05° S 120° W, 03° 30' N 120° W to the point 03° 30' N 170° W.

27/154 *Sub-Area 12A*

From the point 03° 30' N 170° W to the point 10° N 170° W, then along the boundary between ITU Regions 2 and 3 to 29° N 180°, and thence through the points 29° N 153° W, 03° 30' N 153° W to the point 03° 30' N 170° W.

27/155 *Sub-Area 12B*

From the point 03° 30' N 153° W to 33° N 153° W, through the points 33° N 120° W, 17° N 115° W, 14° N 93° W, 02° N 86° W, 02° N 93° W, 05° S 93° W, 05° S 120° W, 03° 30' N 120° W, to the point 03° 30' N 153° W.

27/156 *Sub-Area 12C*

From the point 33° N 120° W, through the points 35° N 120° W, 32° N 104° W, 25° N 91° W, 23° N 83° W, 22° N 83° W, 13° N 90° W, 16° N 116° W, to the point 33° N 120° W.

27/157 *Sub-Area 12D*

From the point 20° N 91° W, through the points 26° N 91° W, 26° N 79° W, 27° N 79° W, 27° N 76° 30' W, 26° N 73° W, 17° N 58° W, to 10° N 58° W. Thence through Panama City, Colon, Swan Island, and Belize City to the point 20° N 91° W.

27/158 *Sub-Area 12E*

From the point 15° N 95° W and through 23° N 92° W, 23° N 85° W, 19° N 85° W, 09° N 77° W, 02° N 79° W. Thence to 01° N 75° W along the eastern and southern border of Ecuador to the point 04° S 81° W, and from there to 02° N 81° W and 02° N 86° W, 14° N 93° W to close the sub-area at 15° N 95° W.

27/159 *Sub-Area 12F*

From the point 02° N 79° W to the point 08° N 83° W, then along the border between Panama and Costa Rica, through the points 10° N 83° W, 13° N 83° W, 13° N 70° W, 08° N 70° W, 06° N 67° W and 01° N 66° W. Then along the border between Brazil and Colombia to 04° S 70° W. Thence along the border between Colombia and Peru, continuing along the border between Colombia and Ecuador, to the point 02° N 79° W.

27/160 *Sub-Area 12G*

From the point 07° N 73° W, through the points 14° N 73° W, 14° N 58° W, 01° 31' N 58° W and along the borders of Brazil with Guyana, Venezuela, Colombia through the points 01° 57' N 68° W, 05° N 69° W, to the point 07° N 73° W.

27/161 *Sub-Area 12H*

From the point 05° N 70° W, through the points 08° 45' N 60° W, 08° N 58° W, 08° N 49° W, 04° 10' N 51° 36' W, and along the borders of Brazil with French Guiana, Surinam, Guyana, Venezuela and Colombia to the junction of the borders of Brazil, Colombia and Peru, to the point 05° N 70° W.

27/162 *Sub-Area 12I*

From the point 25° N 70° W, through the point 25° N 35° W and along the boundary between ITU Regions 1 and 2, to 00° 20° W. Thence through the points 00° 44° W, 08° N 54° W, 08° N 58° W, 17° N 58° W, to the point 25° N 70° W.

27/163 *Sub-Area 12J*

From the point 04° S 93° W, through the points 02° N 93° W, 02° N 79° W. Then along the border between Ecuador and Colombia to the junction with the borders of Colombia, Peru and Ecuador. Thence along the border between Peru and Ecuador to the point 04° S 93° W.

27/164 *Regional and Domestic Air Route Area – 13* (RDARA-13)

From the South Pole along the 120° W meridian to 05° S. Then through the points 05° S 93° W, 04° S 82° W, and along the southern border of Ecuador, Colombia, Venezuela, Guyana, Surinam, the French Guiana, to the point 04° 24' N 50° 39' W. Then through the points 04° 24' N 47° W, 00° 32° W to the point 00° 20° W, and along the 20° W meridian to the South Pole.

27/165 *Sub-Area 13A*

From the point 05° S 120° W through the points 05° S 93° W, 04° S 82° W, 19° S 81° W, 57° S 81° W, to 57° S 90° W. Thence to the South Pole to the point 05° S 120° W.

27/166 *Sub-Area 13B*

From the point 29° S 111° W, through the points 24° S 111° W, 24° S 104° W, 29° S 104° W, to the point 29° S 111° W.

27/167 *Sub-Area 13C*

From the point 15° S 47° W, through the points 20° S 44° W, 23° 19' S 42° W, 25° S 45° W, 22° 30' S 50° 39' W, 19° 52' S 58° W, and along the borders of Brazil with Paraguay, Bolivia, Peru, Colombia, Venezuela, Guyana, Surinam and French Guiana to 04° 24' N 50° 39' W, 04° 24' N 47° W, to the point 15° S 47° W.

27/168 *Sub-Area 13D*

From 11° S 69° 30' W along the border between Bolivia and Brazil and through the point 20° 10' S 58° W, along the border between Bolivia and Paraguay to 22° 30' S 62° 30' W. Then along the border between Bolivia and Argentina and through the point 23° S 67° W along the border between Bolivia and Chile and through the point 16° 30' S 69° 30' W following the border between Bolivia and Peru to the point 11° S 69° 30' W.

27/169 *Sub-Area 13M*

From the point 19° S 81° W, through the points 04° S 82° W, 03° S 80° W, following the boundaries between Peru and Ecuador, Colombia and Brazil to the point 11° S 69° 30' W, along the border of Peru with Bolivia to 17° 30' S 69° 30' W, then along the border of Peru with Chile to the point 19° S 81° W.

27/170 *Sub-Area 13N*

From the point 22° 30' S 62° 30' W along the border of Paraguay with Bolivia to 20° 10' S 58° W, along the border of Paraguay with Brazil to 25° 50' S 54° 30' W and thence along the border of Paraguay with Argentina to the point 22° 30' S 62° 30' W.

27/171 *Sub-Area 13E*

From the point 32° S 81° W through the point 19° S 81° W, up to the intersection of the coast with the border between Chile and Peru, Bolivia and Argentina, to the point of intersection with 32° S and then to the point 32° S 81° W.

27/172 *Sub-Area 13F*

From the point 57° S 81° W, through the point 32° S 81° W to the intersection of 32° S with the border between Chile and Argentina, through the points 52° S 67° W, 57° S 67° W, 57° S 40° W to the South Pole to the point 57° S 81° W.

27/173 *Sub-Area 13G*

From the point 36° S 55° W to the intersection of 32° S with the border between Argentina and Chile, then north along the borders of Argentina with Bolivia. Paraguay, Brazil and Uruguay to the point 36° S 55° W.

27/174 *Sub-Area 13H*

From the point 57° S 90° W and through the point 57° S 70° W to 52° S 70° W. Then along the border between Chile and Argentina to its intersection by 32° S and through the points 36° S 55° W, 57° S 55° W, 57° S 25° W to the South Pole and then to the point 57° S 90° W.

27/175 *Sub-Area 13I*

From the point 40° S 50° W through the point 36° S 55° W and along the borders of Uruguay with Argentina and Brazil, then through the point 35° S 45° W to the point 40° S 50° W.

27/176 *Sub-Area 13J*

From the point 15° S 47° W through the points 20° S 44° W, 23° l9' S 42° W, 29° S 40° W, 35° S 45° W, and thence along the borders of Brazil with Uruguay, Argentina, Paraguay and Bolivia to the point 19° 52' S 58° W, then through the point 18° S 57° 37' W to the point 15° S 47° W.

27/177 *Sub-Area 13K*

From the point 22° 30' S 50° 39' W and through the points 25° S 45° W, 29° S 40° W, 20° S 32° W, 00° 32° W, 04° 24' N 47° W, 04° 24' N 50° 39' W to the point 22° 30' S 50° 39' W.

27/178 *Sub-Area 13L*

From the point 00° 32° W through the points 00° 20° W, the South Pole, 57° S 55° W, 36° S 55° W, 40° S 50° W, 20° S 32° W, to the point 00° 32° W.

27/179 *Regional and Domestic Air Route Area – 14* (RDARA-14)

From the South Pole along the 110° E meridian to 10° S. Then through the points 10° S 145° E, 19° S 153° E, 27° S 160° E. Then along the 160° E meridian to the South Pole.

27/180 *Sub-Area 14A*

From the South Pole along the 110° E meridian to 19° S. Then through the points 19° S 118° E, 24° S 120° E, 24° S 131° E. Then along the 131° E meridian to the South Pole.

27/181 *Sub-Area 14B*

From the point 19° S 110° E to the point 10° S 110° E, thence through 10° S 131° E, 24° S 131° E, 24° S 120° E, 19° S 118° E to the point 19° S 110° E.

27/182 *Sub-Area 14C*

From the point 24° S 131° E to the point 10° S 131° E, thence through 10° S 139° E, 24° S 139° E to the point 24° S 131° E

27/183 *Sub-Area 14D*

From the South Pole along the 131° E meridian to 24° S, then through the points 24° S 139° E, 27° S 139° E, 27° S 142° E, 34° S 142° E, 34° S 139° E. Then along the 139° E meridian to the South Pole.

27/184 *Sub-Area 14E*

From the point 24° S 139° E along the 139° E meridian to 10° S, then through the points 10° S 145° E, 19° S 153° E to the point 24° S 139° E.

27/185 *Sub-Area 14F*

From the point 27° S 139° E along the 139° E meridian to 24° S, then through the points 19° S 153° E, 27° S 160° E to the point 27° S 139° E.

27/186 *Sub-Area 14G*

From the South Pole along the 139° E meridian to 34° S, then through the points 34° S 142° E, 27° S 142° E, 27° S 160° E. Then along the 160° E meridian to the South Pole.

ARTICLE 3

Description of the boundaries of the VOLMET allotment areas and VOLMET reception areas

VOLMET Area - AFRICA-INDIAN OCEAN (AFI-MET)

27/187 *The AFI-MET allotment area is* defined by a line drawn from the point 29° N 20° W, through the points 37° N 03° W, 37° N 36° E, 30° N 35° E, 10° N 52° E, 22° S 60° E, 35° S 35° E, 35° S 15° E, 08° S 15° W, 12° N 20° W, to the point 29° N 20° W.

27/188 *The AFI-MET reception area is* defined by a line drawn from the point 37° N 03° W, through the points 37° N 36° E, 30° N 35° E, 10° N 52° E, 10° N 100° E, the South Pole, the points 29° N 40° W, 29° N 20° W, to the point 37° N 03° W.

VOLMET Area - NORTH ATLANTIC (NAT-MET)

27/189 The *NAT-MET allotment area is* defined by a line drawn from the point 41° N 78° W, through the points 51° N 55° W, 24° N 50° W, 24° N 74° W, to the point 41° N 78° W.

27/190 The *NAT-MET reception area is* defined by a line drawn from the point 24° N 97° W, through the points 24° N 85° W, 75° N 85° W, 75° N 20° W, 00° 20° W, 00° 95° W, to the point 24° N 97° W.

VOLMET Area - EUROPE (EUR-MET)

27/191 The *EUR-MET allotment area is* defined by a line drawn from the point 33° N 12° W, through the points 54° N 12° W, 70° N 00°, 74° N 40° E, 40° N 36° E, 29° N 35° 30' E, 32° N 13° E, to the point 33° N 12° W.

27/192 The *EUR-MET reception area is* defined by a line drawn from the point 15° N 20° W, through the points 40° N 50° W, 75° N 50° W, 75° N 45° E, 15° N 45° E, to the point 15° N 20° W.

VOLMET Area - MIDDLE EAST (MID-MET)

27/193 The *MID-MET allotment area is* defined by a line drawn from the point 50° N 80° E, through the points 29° N 80° E, 27° N 85° E, 16° N 78° E, 22° N 56° E, 16° N 42° E, 30° N 30° E, 51° N 30° E, 57° N 37° E, to the point 50° N 80° E.

27/194 The *MID-MET reception area is* defined by a line drawn from the point 50° N 80° E, through the points 50° N 90° E, 35° N 90° E, 27° N 85° E, 16° N 78° E, 22° N 56° E, 16° N 42° E, 30° N 30° E, 51° N 30° E, 57° N 37° E, to the point 50° N 80° E.

VOLMET Area - NORTH CENTRAL ASIA (NCA-MET)

27/195 The *NCA-MET allotment area is* defined by a line drawn from the point 76° N 32° E, through the points 80° N 90° E, 75° N 168° W, 66° N 168° W, 48° N 160° E, 42° N 135° E, 50° N 130° E, 50° N 90° E, 35° N 70° E, 45° N 30° E, 60° N 20° E, to the point 76° N 32° E.

27/196 The *NCA-MET reception area is* defined by a line drawn from the North Pole, through the points 40° N 168° W, 30° N 140° E, 35° N 70° E, 30° N 20° E, to the North Pole.

VOLMET Area - PACIFIC (PAC-MET)

27/197 The *PAC-MET allotment area is* defined by a line drawn from the point 52° N 132° E, through the points 63° N 149° W, 38° N 120° W, 50° S 120° W, 50° S 145° E, 28° S 145° E, 03° S 129° E, 22° N 112° E to the point 52° N 132° E.

27/198 The *PAC-MET reception area is* defined by a line drawn from the point 60° N 100° E through the points 75° N 160°W, 75° N 110° W, 65° S 110° W, 65° S 145° E, 28° S 145° E, 03° S 129° E, 05° N 80° E, 40° N 80° E, to the point 60° N 100° E.

VOLMET Area - SOUTH EAST ASIA (SEA-MET)

27/199 The *SEA-MET allotment area is* defined by a line drawn from the point 55° N 75° E, through the points 55° N 135° E, 45° N 135° E, 35° N 130° E, 10° N 130° E, 10° S 155° E, 35° S 155° E, 35° S 116° E, 08° N 75° E, 26° N 65° E, to the point 55° N 75° E.

27/200 The *SEA-MET reception area is* defined by a line drawn from the point 55° N 50° E, through the points 55° N 180°, 50° S 180°, 50° S 70° E, 08° N 70° E, 08° N 50° E, to the point 55° N 50° E.

VOLMET Area - CARIBBEAN (CAR-MET)

27/201 The *CAR-MET allotment area is* defined by a line drawn from the point 30° N 110° W, through the points 30° N 75° W, 00° 50° W, following the equator to 00° 80° W to the point 30° N 110° W.

27/202 The *CAR-MET reception area is* defined by a line drawn from the point 40° N 120° W, through the points 40° N 20° W, 25° S 20° W, 25° S 120° W, to the point 40° N 120° W.

VOLMET Area - SOUTH AMERICA (SAM-MET)

27/203 The *SAM-MET allotment area is* defined by a line drawn from the point 15° N 83° W, through the points 15° N 60° W, 05° S 35° W, 55° S 60° W, 55° S 83° W, to the point 15° N 83° W.

27/204 The *SAM-MET reception area is* defined by a line drawn from the point 30° N 120° W through the point 30° N 00°, the South Pole, to the point 30° N 120° W.

ARTICLE 4

World-wide allotment areas

27/205 *World-wide Area I*

The boundaries of this allotment area comprise those of RDARAs 1, 2 and 3.

27/206 *World-wide Area II*

The boundaries of this allotment area comprise those of RDARAs 10, 11 12A, 12B, 12C, and 12D.

27/207 *World-wide Area III*

The boundaries of this allotment area comprise those of RDARAs 6, 8, 9 and 14.

27/208 *World-wide Area IV*

The boundaries of this allotment area comprise those of RDARAs 12E to 12J inclusive and 13.

27/209 *World-wide Area V*

The boundaries of this allotment area comprise those of RDARAs 4, 5 and 7.

Section II – Allotment of frequencies in the aeronautical mobile (R) service

ARTICLE 1

27/210 Frequency allotment Plan by areas

27/211 NOTE *a)* * = For the exact nature of a restriction on the use of the frequency concerned, refer to column 3 of the frequency allotment Plan in numerical order of frequencies (Nos. **27**/218 to **27**/231).

27/212 NOTE *b)* The following list does not include the world-wide common (R) and (OR) frequencies of 3 023 kHz and 5 680 kHz. The allotment of these frequencies is shown in Article 2.

27/213 (WRC-2000)

Area	Frequency bands (MHz)										
	3	**3.5**	**4.7**	**5.4 (Reg. 2)**	**5.6**	**6.6**	**9**	**10**	**11.3**	**13.3**	**18**
	kHz	**kHz**	**kHz**	**kHz**	**kHz**	**kHz**	**kHz**	**kHz**	**kHz**	**kHz**	**kHz**
AFI	2 851 2 878	3 419 3 425 3 467	4 657		5 493 5 652 5 658	6 559 6 574 6 673	8 894 8 903		11 300 11 330	13 273 13 288 13 294	17 961
CAR	2 887	3 455			5 520 5 550	6 577 6 586	8 846 8 918		11 387 11 396	13 297	17 907
CEP	2 869	3 413	4 657		5 547 5 574	6 673	8 843	10 057	11 282	13 300	17 904
CWP	2 998	3 455	4 666		5 652 5 661	6 532 6 562	8 903	10 081	11 384	13 300	17 904
EA	3 016	3 485 3 491			5 655 5 670	6 571	8 897	10 042	11 396	13 297 13 303 13 309	17 907
EUR		3 479			5 661	6 598		10 084		13 288	17 961
INO		3 476			5 634		8 879			13 306	17 961

(See cont.)

(Cont.)

Area	Frequency bands (MHz)										
	3	3.5	4.7	5.4 (Reg. 2)	5.6	6.6	9	10	11.3	13.3	18
	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz
MID	2 944 2 992	3 467 3 473	4 669		5 658 5 667	6 625 6 631	8 918 8 951	10 018	11 375	13 288 13 312	17 961
NAT	2 872 2 889 2 962 2 971 3 016	3 476	4 675		5 598 5 616 5 649	6 622 6 628	8 825 8 831 8 864 8 879 8 891 8 906		11 279 11 309 11 336	13 291 13 306	17 946
NCA	3 004 3 019		4 678		5 646 5 664	6 592		10 096		13 303 13 315	17 958
NP	2 932				5 628	6 655 6 661		10 048	11 330	13 300	17 904
SAM	2 944	3 479	4 669		5 526	6 649	8 855	10 024 10 096	11 360	13 297	17 907
SAT	2 854 2 935	3 452			5 565	6 535	8 861		11 291	13 315 13 357	17 955
SEA		3 470 3 485			5 649 5 655	6 556	8 942	10 066	11 396	13 309 13 318	17 907
SP		3 467			5 559 5 643		8 867	10 084	11 327	13 300	17 904
1						6 556		10 021	11 363		
1B	2 860* 2 881* 2 890	3 458* 3 473* 3 488*			5 484 5 568	6 550 6 595		10 066			
1C	2 977 2 983	3 464 3 470	4 666		5 577 5 595	6 544	8 840		11 366		
1D	2 974 2 980 2 989	3 410 3 416 3 446	4 651		5 622 5 628 5 637	6 604 6 610	8 828	10 060	11 384		
1E	2 965	3 491			5 583	6 667		10 036			
2	2 938 2 950		4 696		5 556	6 583 6 601	8 846 8 855 8 888	10 015 10 045	11 297 11 360 11 390	13 321 13 357	17 964
2A	2 851* 2 863 2 869 2 875 2 881 2 887* 2 896 2 917 2 926 2 932 2 941	3 416* 3 422 3 434 3 440 3 455	4 657* 4 672 4 690		5 481 5 490 5 496 5 502 5 523 5 547 5 559 5 604	6 526 6 532 6 547 6 553 6 559 6 565 6 574 6 673	8 822* 8 876 8 909 8 939	10 048 10 054	11 276 11 285 11 294		

* See No. **27**/211.

(See cont.)

(Cont.)

Area	Frequency bands (MHz)										
	3	3.5	4.7	5.4 (Reg. 2)	5.6	6.6	9	10	11.3	13.3	18
	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz
2B	2 857 2 869 2 875 2 881 2 887* 2 896 2 902 2 908 2 914 2 920 2 929	3 401 3 407 3 416* 3 422 3 428 3 449	4 660 4 672 4 681 4 690 4 693		5 490 5 496 5 502 5 508 5 520 5 526 5 550 5 574 5 595 5 607 5 613 5 619	6 526 6 532 6 562 6 568 6 577 6 655 6 661 6 667	8 819 8 834 8 864	10 009 10 024	11 279 11 333 11 339		
2C	2 857 2 863 2 866 2 884 2 893 2 902 2 908 2 914 2 920 2 926 2 932	3 401 3 407 3 428 3 434 3 440 3 449 3 455	4 657* 4 660 4 681 4 693		5 481 5 487 5 508 5 514 5 520 5 526 5 550 5 562 5 574 5 586 5 604	6 535 6 541 6 547 6 553 6 562 6 568 6 577 6 586	8 819 8 834 8 882 8 939	10 009 10 024 10 054	11 276 11 333 11372		
3	2 893 2 935		4 693		5 556	6 583 6 589	8 846 8 954	10 087	11 318 11 336 11 360	13 267 13 321	17 952
3A	2 854 2 860 2 869 2 875 2 881 2 887* 2 896 2 905 2 911* 2 923* 2 959	3 404 3 416* 3 422 3 431* 3 443 3 452	4 672 4 684 4 690		5 484 5 490 5 496 5 502 5 511 5 517 5 568 5 580 5 601 5 625	6 526 6 532 6 538 6 544 6 550 6 556 6 607 6 613 6 619 6 649	8 837 8 861 8 900 8 942	10 045 10 057	11 309 11 324 11 330		
3B	2 851 2 854 2 872 2 878 2 884* 2 902 2 908 2 914 2 968*	3 401 3 407 3 413 3 419 3 425 3 431* 3 437* 3 443	4 657 4 681		5 493 5 499 5 505 5 514 5 520 5 526 5 550 5 562 5 580 5 601	6 529 6 538 6 544 6 559 6 568 6 577 6 595 6 625 6 631	8 822 8 852 8 861 8 879 8 957	10 024 10 039	11 285 11 291 11 327 11 372		

(See cont.)

(Cont.)

Area	Frequency bands (MHz)										
	3	3.5	4.7	5.4 (Reg. 2)	5.6	6.6	9	10	11.3	13.3	18
	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz
3C	2 851 2 860 2 866* 2 878 2 905 2 950 2 974 2 980 2 986	3 404 3 410 3 419 3 425 3 452	4 684		5 484 5 514 5 562 5 568 5 586 5 637 5 643	6 550 6 556 6 595 6 658 6 664 6 670	8 837 8 852 8 894 8 915	10 039	11 291 11 303 11 324 11 378		
4						6 565	8 873			13 300	17 904
4A	2 926* 2 953	3 437 3 491	4 672*		5 547 5 559	6 526 6 532 6 616	8 816 8 837 8 858	10 039 10 081	11 282 11 318		
4B	2 866 2 893	3 443			5 481 5 574 5 604	6 553 6 577 6 598		10 063	11 324		
5							8 870 8 885	10 012	11 312 11 327	13 354	17 949 17 967
5A	2 986	3 452			5 577 5 583	6 544 6 664	8 822 8 915		11 288		
5B	2 911 2 968	3 431 3 488			5 511 5 568 5 625	6 550 6 595	8 912	10 093			
5C	2 905	3 452			5 583	6 544	8 822				
5D	2 899 2 971	3 482			5 526 5 550	6 535 6 547	8 843	10 048			
6							8 840		11 381	13 291	17 943
6A	2 872 2 923 2 947 3 001	3 479	4 657* 4 675		5 484 5 580 5 601	6 607 6 613 6 658	8 891 8 906 8 948	10 006 10 051 10 081*	11 321 11 357		
6B	2 857 2 920	3 479 3 488			5 502 5 595 5 625	6 607 6 613 6 619	8 864 8 885	10 021 10 093	11 339 11 366		17 955
6C	2 881 2 956	3 473	4 651		5 550 5 580	6 544 6 631	8 834 8 918	10 015			
6D	2 866 2 884	3 416			5 490 5 520 5 568 5 574 5 631	6 550 6 568 6 577 6 595	8 882 8 957		11 309 11 372		

(See cont.)

(Cont.)

Area	Frequency bands (MHz)										
	3	3.5	4.7	5.4 (Reg. 2)	5.6	6.6	9	10	11.3	13.3	18
	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz
6E	2 854 2 872 2 917 3 001	3 443	4 657* 4 675		5 514 5 526 5 550	6 583 6 655 6 661	8 861* 8 906 8 909	10 036 10 051 10 084	11 357 11 363		
6F	2 926 2 941	3 434 3 440			5 496 5 508	6 526 6 667	8 864 8 939	10 060	11 279 11 366		
6G	2 869* 2 875* 2 890 2 896* 2 899 2 902* 2 911* 2 917* 2 938 2 953 2 962 2 968* 2 971 2 977 2 983 2 989 2 995	3 413* 3 422* 3 431* 3 437 3 446 3 449* 3 464 3 482	4 651* 4 663* 4 669* 4 672* 4 690* 4 696*		5 481 5 487 5 493* 5 499* 5 505* 5 511* 5 517* 5 523 5 547 5 553 5 559 5 565 5 571 5 577 5 583 5 592 5 598 5 604 5 610 5 616 5 622 5 628* 5 634* 5 640*	6 529 6 535 6 541 6 547 6 553 6 559 6 565 6 574 6 580 6 586 6 598 6 604 6 610 6 616 6 622 6 628 6 634 6 649 6 652 6 673 6 682	8 816 8 825 8 831 8 843 8 858 8 867 8 870* 8 873 8 888* 8 912* 8 960	10 018* 10 054* 10 063*	11 276* 11 282* 11 288 11 294* 11 300* 11 306 11 315 11 369	13 270 13 276	17 913
7					5 508	6 586	8 888		11 285	13 354	
7B	2 863 2 965	3 455			5 577 5 583	6 652	8 906	10 009			
7C	2 950	3 407			5 592	6 568 6 604	8 834	10 081	11 294		
7D	2 998				5 481			10 096			
7E	2 887	3 485			5 520	6 580 6 628	8 864		11 306		
7F	2 956	3 461			5 547 5 568	6 622	8 846 8 960				
9			4 696		5 583	6 553	8 846 8 852	10 018	11 339		

(See cont.)

(Cont.)

Area	Frequency bands (MHz)										
	3	3.5	4.7	5.4 (Reg. 2)	5.6	6.6	9	10	11.3	13.3	18
	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz
9B	2 860 2 905 2 929*	3 401* 3 419 3 425 3 476*	4 660		5 484 5 508 5 523 5 565	6 538 6 547 6 598 6 622	8 819 8 837 8 861 8 906	10 009 10 024 10 039	11 393		
9C	2 851	3 404 3 461	4 675		5 481	6 580	8 873	10 042	11 279 11 312		
9D	3 016	3 404			5 592	6 535	8 873		11 312		
10			4 696	5 454	5 604	6 553	8 819 8 834	10 006 10 012	11 333 11 390	13 285	17 910
10A	2 866 2 875 2 911 2 944 2 956 2 992	3 449 3 470		5 472 5 475	5 484 5 490 5 496 5 565 5 631	6 535 6 580 6 604	8 855 8 876	10 066	11 357 11 363 11 375		
10B	2 854 2 860	3 404 3 467 3 488	4 651 4 666 4 681 4 690 4 693	5 460 5 466	5 553 5 568 5 583	6 547 6 574 6 598	8 837 8 903 8 939				
10C	2 926 2 965	3 491	4 660 4 669	5 457	5 481 5 487 5 502 5 562 5 595	6 541 6 556 6 568	8 867				
10D	2 893 2 935	3 419 3 425 3 458	4 666 4 669 4 678	5 472 5 475	5 484 5 490 5 496 5 586 5 625	6 535 6 544 6 562	8 858 8 900				
10E	2 869 2 944 2 992	3 446 3 473	4 651 4 666 4 684	5 460	5 481 5 559 5 577	6 547 6 598	8 843 8 954		11 276		
10F	2 950		4 663	5 451	5 526	6 673	8 945	10 042			
11B	2 851 2 878 3 004 3 019	3 410 3 428 3 434 3 443	4 672	5 451 5 463 5 469	5 508 5 514 5 523 5 571	6 538 6 550 6 559 6 565	8 822 8 885 8 912	10 045 10 093	11 288 11 306	13 312	17 964
12		3 440			5 568			10 054			17 901
12A	2 950				5 604						

(See cont.)

(Cont.)

Area	Frequency bands (MHz)										
	3	3.5	4.7	5.4 (Reg. 2)	5.6	6.6	9	10	11.3	13.3	18
	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz
12C	2 920 2 980	3 401 3 464	4 693	5 460	5 484 5 490 5 496 5 502 5 589 5 613	6 535 6 571 6 592 6 622 6 628	8 816 8 948 8 957	10 021 10 039	11 324		
12D		3 407			5 562	6 673	8 876	10 015			
12E	2 860 2 956 2 998	3 461 3 488	4 681	5 454 5 475	5 481 5 487 5 583 5 595 5 604	6 547 6 553 6 598	8 852 8 873	10 063 10 090	11 381 11 393		
12F	2 893 2 956 2 965 2 998	3 461 3 488		5 451 5 475	5 508 5 556 5 583 5 604	6 532 6 553	8 873 8 894	10 090	11 297		
12G	2 875 2 956 2 998	3 461 3 488			5 484 5 523 5 559 5 646	6 526 6 616					
12H	2 956 2 998	3 461 3 488		5 451	5 583						
12J	2 860 2 902 2 926 2 965	3 419			5 481 5 496 5 619	6 535 6 547	8 954		11 381 11 384		
13										13 318	17 913
13A								10 048			17 967
13B								10 048			17 967
13C	2 863 2 869 2 992	3 413 3 458 3 473			5 490 5 514 5 553 5 571 5 577	6 541 6 556 6 562 6 568 6 580	8 819 8 834 8 843 8 939	10 042	11 327 11 375	13 309	
13D	2 914 2 983	3 425 3 467	4 660	5 460	5 562	6 622 6 628 6 673	8 867 8 912 8 957	10 084	11 318		
13E	2 851	3 491	4 651 4 663		5 481 5 583 5 604	6 553 6 577	8 858		11 303		17 967
13F	2 851 2 956 2 998	3 446 3 476	4 651 4 663	5 454	5 481 5 583 5 604	6 547 6 553	8 831 8 858 8 864	10 081	11 321 11 330		17 967

(See cont.)

(Cont.)

Area	Frequency bands (MHz)										
	3	3.5	4.7	5.4 (Reg. 2)	5.6	6.6	9	10	11.3	13.3	18
	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz
13G	2 872 2 971 3 016	3 434 3 470	4 675*	5 469 5 475	5 574	6 586 6 613	8 822 8 885 8 900	10 006 10 021 10 036	11 369		
13H	2 899 2 965	3 455 3 485	4 657	5 463 5 472	5 484 5 547	6 598	8 825 8 906	10 036 10 045	11 282 11 300	13 267	
13I	2 860 2 878 2 887	3 419	4 678 4 693	5 451 5 466	5 496 5 523	6 574	8 873	10 051			
13J	2 857 2 863 2 878 2 890 2 920	3 410 3 428 3 458	4 684 4 696	5 451 5 454	5 559 5 568 5 577	6 550 6 559 6 580	8 816 8 843	10 012 10 018 10 042	11 276		
13K	2 863 2 932 3 004 3 019	3 401 3 458 3 464	4 663 4 672	5 463	5 481 5 547 5 577 5 604	6 547 6 553 6 580	8 843 8 849 8 945	10 009 10 018 10 042 10 060	11 339 11 366	13 309	
13M	2 908 2 977	3 437 3 449	4 660 4 690	5 463	5 502	6 574 6 628	8 837 8 867 8 903	10 066	11 378		
13N	2 986	3 443		5 457	5 508	6 604	8 828	10 093			
14	2 851 2 878	3 446 3 461 3 479			5 526 5 604	6 580 6 628	8 822 8 855 8 870	10 045 10 087	11 360	13 264	17 946
14A	2 950	3 413	4 678*			6 547 6 553	8 816 8 894				
14B		3 488	4 684*			6 535 6 604 6 673	8 900 8 954				
14C	2 887	3 452	4 684*			6 541 6 586	8 885 8 912				
14D	2 950	3 407	4 693*		5 481	6 559 6 574	8 843 8 858				
14E		3 413				6 565 6 616	8 891 8 945				
14F		3 488				6 526 6 610	8 825 8 831				
14G	2 869 2 944		4 678*		5 481 5 550 5 580		8 876 8 957				
VAFI	2 860	3 404			5 499	6 538	8 852	10 057		13 261	
VCAR	2 950				5 580				11 315		

(See cont.)

(Cont.)

Area	Frequency bands (MHz)											
	3	3.5	4.7	5.4 (Reg. 2)	5.6	6.6	9	10	11.3	13.3	18	22
	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz
VEUR	2 998	3 413			5 640	6 580	8 957		11 378	13 264		
VMID	2 956				5 589		8 945			11 393		
VNAT	2 905	3 485			5 592	6 604	8 870	10 051		13 270 13 276		
VNCA		3 461	4 663		5 676			10 090		13 279		
VPAC	2 863					6 679	8 828			13 282		
VSAM	2 881				5 601			10 087		13 279		
VSEA	2 965	3 458			5 673	6 676	8 849		11 387	13 285		
W I	3 010		4 654 4 687		5 529 5 532 5 535 5 541	6 637 6 643	8 921 8 924 8 930 8 936	10 027 10 030 10 069 10 072 10 078	11 345 11 351	13 324 13 327 13 333 13 336 13 342 13 345 13 351	17 916 17 922 17 931	21 940 21 946 21 952 21 958 21 967 21 973 21 979 21 988 21 997
W II	3 007 3 013	3 494 3 497	4 654 4 687		5 529 5 538 5 544	6 637 6 640 6 646	8 927 8 933 8 936	10 027 10 033 10 075	11 342 11 348 11 354	13 330 13 339 13 348	17 919 17 925 17 934 17 940	21 964 21 985
W III	3 007		4 687			6 637	8 921 8 930	10 072 10 078	11 342 11 351	13 324 13 333 13 342 13 351	17 916 17 922 17 928 17 934 17 940	21 949 21 970
W IV	3 010				5 535 5 541	6 643	8 924	10 030 10 069	11 345	13 327 13 336 13345	17 919 17 928 17937	21 955 21 976 21 991
W V	3 013				5 532 5 538 5 544	6 640 6 646	8 927 8 933	10 033 10 075	11 348 11 354	13 330 13 339 13 348	17 925 17 931 17 937	21 943 21 961 21 982 21 994

ARTICLE 2

Frequency allotment Plan
(in numerical order of frequencies)

General Notes:

27/214 1 Class of stations: FD

Classes of emission: see Nos. **27**/56 to **27**/59.

Power: Unless otherwise indicated in the Plan, the power values for aeronautical and aircraft stations are those shown in Nos. **27**/60 to **27**/68.

Hours: H24, unless otherwise indicated.

27/215 2 A frequency allotted on a "day-time basis" may be used during the period one hour after sunrise to one hour before sunset

27/216 3 A "common channel" is a channel allotted in common to two or more areas within interference distance of each other and its use is subject to agreement between the administrations concerned.

27/217 4 The world-wide frequency allotments appearing in the Tables at No. **27**/213 and Nos. **27**/218 to **27**/231, except for carrier (reference) frequencies 3 023 kHz and 5 680 kHz, are reserved for assignment by administrations to stations operating under authority granted by the administration concerned, for the purpose of serving one or more aircraft operating agencies. Such assignments are to provide communications between an appropriate aeronautical station and an aircraft station anywhere in the world for exercising control over regularity of flight and for safety of aircraft. World-wide frequencies are not to be assigned by administrations for MWARA, RDARA and VOLMET purposes. Where the operational area of an aircraft lies wholly within a RDARA or Sub-RDARA boundary, frequencies allotted to those RDARAs and Sub-RDARAs shall be used.

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
2 851	M AFI R 2A 3B 3C 9C 11B 13E 13F 14	CC 3B 3C CC 13E 13F C001/2A
2 854	M SAT R 3A 3B 6E 10B	CC 3A 3B
2 857	R 2B 2C 6B 13J	CC 2B 2C
2 860	R 1B 3A 3C 9B 10B 12E 12J 13I V VAFI	CC 3A 3C CC 12E 12J C001/1B
2 863	R 2A 2C 7B 13C 13J 13K V VPAC	CC 2A 2C CC 13C 13J 13K
2 866	R 2C 3C 4B 6D 10A	C001/3C
2 869	M CEP R 2A 2B 3A 6G 10E 13C 14G	CC 2A 2B 3A C009/6G
2 872	M NAT R 3B 6A 6E 13G	CC 6A 6E
2 875	R 2A 2B 3A 6G 10A 12G	CC 2A 2B 3A C009/6G
2 878	M AFI R 3B 3C 11B 13I 13J 14	CC 3B3C CC 13I 13J
2 881	R 1B 2A 2B 3A 6C V VSAM	CC 2A 2B 3A C001/lB
2 884	R 2C 3B 6D	C001/3B
2 887	M CAR R 2A 2B 3A 7E 13I 14C	CC 2A2B 3A C001/2A 2B 3A
2 890	R 1B 6G 13J	
2 893	R 2C 3 4B 10D 12F	CC 2C 3
2 896	R 2A 2B 3A 6G	CC 2A 2B 3A C009/6G
2 899	M NAT R 5D 6G 13H	
2 902	R 2B 2C 3B 6G 12J	CC 2B 2C 3B C009/6G
2 905	R 3A 3C 5C 9B V VNAT	CC 3A 3C
2 908	R 2B 2C 3B 13M	CC 2B 2C 3B

* See page AP27-75.

(See cont.)

Band **2 850-3 025 kHz** **3 MHz**

(Cont.)

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
2 911	R 3A 5B 6G 10A	C001/3A C010/6G
2 914	R 2B 2C 3B 13D	CC 2B 2C 3B
2 917	R 2A 6E 6G	C010/6G
2 920	R 2B 2C 6B 12C 13J	CC 2B 2C
2 923	R 3A 6A	C001/3A
2 926	R 2A 2C 4A 6F 10C 12J	CC 2A 2C C001/4A
2 929	R 2B 9B	C001/9B
2 932	M NP R 2A 2C 13K	CC 2A 2C
2 935	M SAT R 3 l0D	
2 938	R 2 6G	C009/6G
2 941	R 2A 6F	
2 944	M MID SAM R l0A l0E 14G	
2 947	R 6A	
2 950	R 2 3C 7C l0F 12A 14A 14D V VCAR	CC 2 3C CC 14A 14D
2 953	R 4A 6G	
2 956	R 6C 7F 10A 12E 12F 12G 12H 13F V VMID	CC 12E 12F 12G 12H
2 959	R 3A	
2 962	M NAT R 6G	
2 965	R 1E 7B l0C 12F 12J 13H V VSEA	CC 12F 12J
2 968	R 3B 5B 6G	C001/3B C009/6G
2 971	M NAT R 5D 6G 13G	
2 974	R 1D 3C	
2 977	R 1C 6G 13M	

* See page AP27-75.

(See cont.)

Band **2 850-3 025 kHz** **3 MHz**

(Cont.)

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
2 980	R 1D 3C 12C	
2 983	R 1C 6G 13D	
2 986	R 3C 5A 13N	
2 989	R 1D 6G	
2 992	M MID R 10A l0E 13C	
2 995	R 6G	
2 998	M CWP R 7D 12E 12F 12G 12H 13F V VEUR	CC 12E 12F 12G 12H
3 001	R 6A 6E	CC 6A 6E
3 004	M NCA R 11B 13K	
3 007	W WORLDWIDE	C100/II III
3 010	W WORLDWIDE	C100/I IV
3 013	W WORLDWIDE	C100/II V
3 016	M EANAT R 9D 13G	
3 019	M NCA R 11B 13K	

27/219

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
3 023	W WORLDWIDE (R) and (OR)	See Part II, Section II, Article 3

* See page AP27-75.

27/220 Band **3 400-3 500 kHz** **3.5 MHz**

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
3 401	R 2B 2C 3B 9B 12C 13K	CC 2B 2C 3B C001/9B
3 404	R 3A 3C 9C 9D 10B V VAFI	CC 3A 3C CC 9C 9D
3 407	R 2B 2C 3B 7C 12D 14D	CC 2B 2C 3B
3 410	R 1D 3C 11B 13J	
3 413	M CEP R 3B 6G 13C 14A 14E V VEUR	CC 14A 14E C009/6G
3 416	R 1D 2A 2B 3A 6D	CC 2A 2B 3A C001/2A 2B 3A
3 419	M AFI R 3B 3C 9B 10D 12J 13I	CC 3B 3C
3 422	R 2A 2B 3A 6G	CC 2A 2B 3A C001/6G C004/6G
3 425	M AFI R 3B 3C 9B 10D 13D	CC 3B 3C
3 428	R 2B 2C 11B 13J	CC 2B 2C
3 431	R 3A 3B 5B 6G	CC 3A 3B C001/3A 3B C009/6G
3 434	R 2A 2C 6F 11B 13G	CC 2A 2C
3 437	R 3B 4A 6G 13M	C001/3B
3 440	R 2A 2C 6F 12	CC 2A 2C
3 443	R 3A 3B 4B 6E 11B 13N	CC 3A 3B
3 446	R 1D 6G 10E 13F 14	
3 449	R 2B 2C 6G 10A 13M	CC 2B 2C C001/6G C004/6G
3 452	M SAT R 3A 3C 5A 5C 14C	CC 3A 3C CC 5A 5C
3 455	M CAR CWP R 2A 2C 7B 13H	CC 2A 2C
3 458	R 1B 10D 13C 13J 13K V VSEA	CC 13C 13J 13K C001/1B
3 461	R 7F 9C 12E 12F 12G 12H 14 V VNCA	CC 12E 12F 12G 12H
3 464	R 1C 6G 12C 13K	

* See page AP27-75. (See cont.)

Band **3 400-3 500 kHz** **3.5 MHz**

(Cont.)

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
3 467	M AFI MID SP R 10B 13D	CC AFI MID
3 470	M SEA R 1C 10A 13G	
3 473	M MID R 1B 6C 10E 13C	C001/1B
3 476	M INO NAT R 9B 13F	C001/9B
3 479	M EUR SAM R 6A 6B 14	
3 482	R 5D 6G	
3 485	M EA SEA R 7E 13H V VNAT	CC EA SEA
3 488	R 1B 5B 6B 10B 12E 12F 12G 12H 14B 14F	CC 12E 12F 12G 12H CC 14B 14F C001/lB
3 491	M EA R 1E 4A 10C 13E	CC 1E 4A
3 494	W WORLDWIDE	C100/II
3 497	W WORLDWIDE	C100/II

* See page AP27-75.

27/221 Band **4 650-4 700 kHz** **4.7 MHz**

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
4 651	R 1D 6C 6G 10B 10E 13E 13F	CC 13E 13F C001/6G
4 654	W WORLDWIDE	C100/I II
4 657	M AFI CEP R 2A 2C 3B 6A 6E 13H	CC 2A 2C C001/2A 2C CC 6A 6E C001/6A 6E
4 660	R 2B 2C 9B 10C 13D 13M	CC 2B 2C CC 13D 13M
4 663	R 6G 10F 13E 13F 13K V VNCA	CC 13E 13F 13K C001/6G
4 666	M CWP R 1C 10B 10D 10E	CC 10B 10D 10E
4 669	M MID SAM R 6G 10C 10D	CC 10C 10D C001/6G
4 672	R 2A 2B 3A 4A 6G 11B 13K	CC 2A 2B 3A C001/4A C001/6G
4 675	M NAT R 6A 6E 9C 13G	CC 6A 6E C001/13G
4 678	M NCA R 10D 13I 14A 14G	CC 14A 14G C001/14A 14G
4 681	R 2B 2C 3B 10B 12E	CC 2B 2C 3B
4 684	R 3A 3C 10E 13J 14B 14C	CC 3A 3C CC 14B 14C C001/14B 14C
4 687	W WORLDWIDE	C100/I II III
4 690	R 2A 2B 3A 6G 10B 13M	CC 2A 2B 3A C001/6G
4 693	R 2B 2C 3 10B 12C 13I 14D	CC 2B 2C 3 C001/14D
4 696	R 2 6G 9 10 13J	C001/6G

* See page AP27-75.

27/222 (WRC-2000) Band **5 450-5 480 kHz (Reg. 2)** **5.4 MHz**

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
5 451	R l0F 11B 12F 12H 13I 13J	CC 12F 12H CC 13I 13J
5 454	R 10 12E 13F 13J	
5 457	R l0C 13N	
5 460	R l0B l0E 12C 13D	
5 463	R 11B 13H 13K 13M	
5 466	R l0B 13I	
5 469	R 11B 13G	
5 472	R l0A l0D 13H	
5 475	R l0A l0D 12E 12F 13G	CC 12E 12F

27/223 Band **5 480-5 680 kHz** **5.6 MHz**

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
5 481	R 2A 2C 4B 6G 7D 9C l0C l0E 12E 12J 13E 13F 13K 14D 14G	CC 2A 2C CC 10C 10E CC 12E 12J CC 13E 13F CC 14D 14G
5 484	R 1B 3A 3C 6A 9B 10A 10D 12C 12G 13H	CC 3A 3C
5 487	R 2C 6G 10C 12E	
5 490	R 2A 2B 3A 6D 10A 10D 12C 13C	CC 2A 2B 3A
5 493	M AFI R 3B 6G	C002/6G
5 496	R 2A 2B 3A 6F 10A 10D 12C 12J 13I	CC 2A 2B 3A
5 499	R 3B 6G V VAFI	C002/6G
5 502	R 2A 2B 3A 6B 10C 12C 13M	CC 2A 2B 3A
5 505	R 3B 6G	C003/6G
5 508	R 2B 2C 6F 7 9B 11B 12F 13N	CC 2B 2C
5 511	R 3A 5B 6G	C002/6G

* See page AP27-75. (See cont.)

Band **5 480-5 680 kHz** **5.6 MHz**

(Cont.)

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
5 514	R 2C 3B 3C 6E 11B 13C	CC 3B 3C
5 517	R 3A 6G	C002/6G
5 520	M CAR R 2B 2C 3B 6D 7E	CC 2B 2C 3B
5 523	R 2A 6G 9B 11B 12G 13I	
5 526	M SAM R 2B 2C 3B 5D 6E 10F 14	CC 2B 2C 3B
5 529	W WORLDWIDE	C100/I II
5 532	W WORLDWIDE	C100/I V
5 535	W WORLDWIDE	C100/I IV
5 538	W WORLDWIDE	C100/II V
5 541	W WORLDWIDE	C100/I IV
5 544	W WORLDWIDE	C100/II V
5 547	M CEP R 2A 4A 6G 7F 13H 13K	
5 550	M CAR R 2B 2C 3B 5D 6C 6E 14G	CC 2B 2C 3B
5 553	R 6G 10B 13C	
5 556	R 2 3 12F	CC 2 3
5 559	M SP R 2A 4A 6G 10E 12G 13J	
5 562	R 2C 3B 3C 10C 12D 13D	CC 3B 3C
5 565	M SAT R 6G 9B 10A	
5 568	R 1B 3A 3C 5B 6D 7F 10B 12 13J	CC 3A 3C
5 571	R 6G 11B 13C	
5 574	M CEP R 2B 2C 4B 6D 13G	CC 2B 2C
5 577	R 1C 5A 6G 7B 10E 13C 13J 13K	CC 13C 13J 13K
5 580	R 3A 3B 6A 6C 14G V VCAR	CC 3A 3B
5 583	R 1E 5A 5C 6G 7B 9 10B 12E 12F 12H 13E 13F	CC 5A 5C CC 12E 12F 12H CC 13E 13F
5 586	R 2C 3C 10D	

* See page AP27-75.

(See cont.)

Band **5 480-5 680 kHz** **5.6 MHz**

(Cont.)

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
5 589	R 12C V VMID	
5 592	R 6G 7C 9D V VNAT	
5 595	R 1C 2B 6B 10C 12E	
5 598	M NAT R 6G	
5 601	R 3A 3B 6A V VSAM	CC 3A 3B
5 604	R 2A 2C 4B 6G 10 12A 12E 12F 13E 13F 13K 14	CC 2A 2C CC 12E 12F CC 13E 13F
5 607	R 2B	
5 610	R 6G	
5 613	R 2B 12C	
5 616	M NAT R 6G	
5 619	R 2B 12J	
5 622	R 1D 6G	
5 625	R 3A 5B 6B 10D	
5 628	M NP R 1D 6G	C003/6G
5 631	R 6D 10A	
5 634	M INO R 6G	C002/6G
5 637	R 1D 3C	
5 640	R 6G V VEUR	C002/6G
5 643	M SP R 3C	
5 646	M NCA R 12G	
5 649	M NAT SEA	
5 652	M AFI CWP	
5 655	M EA SEA	CC EA SEA
5 658	M AFI MID	CC AFI MID

* See page AP27-75.

(See cont.)

Band **5 480-5 680 kHz** **5.6 MHz**

(Cont.)

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
5 661	M CWP EUR	
5 664	M NCA	
5 667	M MID	
5 670	M EA	
5 673	V VSEA	
5 676	V VNCA	

27/224

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
5 680	W WORLDWIDE (R) and (OR)	See Part II, Section II, Article 3

27/225 Band **6 525-6 685 kHz** **6.6 MHz**

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
6 526	R 2A 2B 3A 4A 6F 12G 14F	CC 2A 2B 3A
6 529	R 3B 6G	
6 532	M CWP R 2A 2B 3A 4A 12F	CC 2A 2B 3A
6 535	M SAT R 2C 5D 6G 9D 10A 10D 12C 12J 14B	
6 538	R 3A 3B 9B 11B V VAFI	CC 3A 3B
6 541	R 2C 6G 10C 13C 14C	
6 544	R 1C 3A 3B 5A 5C 6C 10D	CC 3A 3B CC 5A 5C

* See page AP27-75.

(See cont.)

Band **6 525-6 685 kHz** **6.6 MHz**

(Cont.)

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
6 547	R 2A 2C 5D 6G 9B 10B 10E 12E 12J 13F 13K 14A	CC 2A 2C CC 12E 12J
6 550	R 1B 3A 3C 5B 6D 11B 13J	CC 3A 3C
6 553	R 2A 2C 4B 6G 9 10 12E 12F 13E 13F 13K 14A	CC 2A 2C CC 12E 12F CC 13E 13F
6 556	M SEA R 1 3A 3C 10C 13C	CC 3A 3C
6 559	M AFI R 2A 3B 6G 11B 13J 14D	
6 562	M CWP R 2B 2C 10D 13C	CC 2B 2C
6 565	R 2A 4 6G 11B 14E	
6 568	R 2B 2C 3B 6D 7C 10C 13C	CC 2B 2C 3B
6 571	M EA R 12C	
6 574	M AFI R 2A 6G 10B 13I 13M 14D	
6 577	M CAR R 2B 2C 3B 4B 6D 13E	CC 2B 2C 3B
6 580	R 6G 7E 9C 10A 13C 13J 13K 14 V VEUR	CC 13C 13J 13K
6 583	R 2 3 6E	CC 2 3
6 586	M CAR R 2C 6G 7 13G 14C	
6 589	R 3	
6 592	M NCA R 12C	
6 595	R 1B 3B 3C 5B 6D	CC 3B 3C
6 598	M EUR R 4B 6G 9B 10B 10E 12E 13H	
6 601	R 2	
6 604	R 1D 6G 7C 10A 13N 14B V VNAT	
6 607	R 3A 6A 6B	
6 610	R 1D 6G 14F	
6 613	R 3A 6A 6B 13G	

* See page AP27-75.

(See cont.)

Band **6 525-6 685 kHz** **6.6 MHz**

(Cont.)

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
6 616	R 4A 6G 12G 14E	
6 619	R 3A 6B	
6 622	M NAT R 6G 7F 9B 12C 13D	
6 625	M MID R 3B	
6 628	M NAT R 6G 7E 12C 13D 13M 14	CC 13D 13M
6 631	M MID R 3B 6C	
6 634	R 6G	
6 637	W WORLDWIDE	C100/I II III
6 640	W WORLDWIDE	C100/II V
6 643	W WORLDWIDE	C100/I IV
6 646	W WORLDWIDE	C100/II V
6 649	M SAM R 3A 6G	
6 652	R 6G 7B	
6 655	M NP R 2B 6E	
6 658	R 3C 6A	
6 661	M NP R 2B 6E	
6 664	R 3C 5A	
6 667	R 1E 2B 6F	
6 670	R 3C	
6 673	M AFI CEP R 2A 6G 10F 12D 13D 14B	
6 676	V VSEA	
6 679	V VPAC	
6 682	R 6G	

* See page AP27-75.

27/226 Band **8 815-8 965 kHz** **9 MHz**

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
8 816	R 4A 6G 12C 13J 14A	
8 819	R 2B 2C 9B 10 13C	CC 2B 2C
8 822	R 2A 3B 5A 5C 11B 13G 14	CC 5A 5C C005/2A
8 825	M NAT R 6G 13H 14F	
8 828	R 1D 13N V VPAC	
8 831	M NAT R 6G 13F 14F	
8 834	R 2B 2C 6C 7C 10 13C	CC 2B 2C
8 837	R 3A 3C 4A 9B 10B 13M	CC 3A 3C
8 840	R 1C 6	
8 843	M CEP R 5D 6G 10E 13C 13J 13K 14D	CC 13C 13J 13K
8 846	M CAR R 2 3 7F 9	CC 2 3
8 849	R 13K V VSEA	
8 852	R 3B 3C 9 12E V VAFI	CC 3B 3C
8 855	M SAM R 2 10A 14	
8 858	R 4A 6G 10D 13E 13F 14D	CC 13E 13F
8 861	M SAT R 3A 3B 6E 9B	CC 3A 3B C011/6E
8 864	M NAT R 2B 6B 6F 7E 13F	CC 6B 6F
8 867	M SP R 6G 10C 13D 13M	CC 13D 13M
8 870	R 5 6G 14 V VNAT	C004/6G
8 873	R 4 6G 9C 9D 12E 12F 13I	CC 9C 9D CC 12E 12F
8 876	R 2A 10A 12D 14G	

* See page AP27-75.

(See cont.)

Band **8 815-8 965 kHz** **9 MHz**

(Cont.)

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
8 879	M INO NAT R 3B	
8 882	R 2C 6D	
8 885	R 5 6B 11B 13G 14C	
8 888	R 2 6G 7	C009/6G
8 891	M NAT R 6A 14E	
8 894	M AFI R 3C 12F 14A	
8 897	M EA	
8 900	R 3A 10D 13G 14B	
8 903	M AFI CWP R 10B 13M	
8 906	M NAT R 6A 6E 7B 9B 13H	CC 6A 6E
8 909	R 2A 6E	
8 912	R 5B 6G 11B 13D 14C	C004/6G
8 915	R 3C 5A	
8 918	M CAR MID R 6C	
8 921	W WORLDWIDE	C100/I III
8 924	W WORLDWIDE	C100/I IV
8 927	W WORLDWIDE	C100/II V
8 930	W WORLDWIDE	C100/I III
8 933	W WORLDWIDE	C100/II V
8 936	W WORLDWIDE	C100/I II
8 939	R 2A 2C 6F 10B 13C	CC 2A 2C
8 942	M SEA R 3A	
8 945	R 10F 13K 14E V VMID	
8 948	R 6A 12C	
8 951	M MID	
8 954	R 3 10E 12J 14B	
8 957	R 3B 6D 12C 13D 14G V VEUR	
8 960	R 6G 7F	

* See page AP27-75.

27/227 Band **10 005-10 100 kHz** **10 MHz**

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
10 006	R 6A 10 13G	
10 009	R 2B 2C 7B 9B 13K	CC 2B 2C
10 012	R 5 10 13J	
10 015	R 2 6C 12D	
10 018	M MID R 6G 9 13J 13K	CC 13J 13K C003/6G
10 021	R 1 6B 12C 13G	
10 024	M SAM R 2B 2C 3B 9B	CC 2B 2C 3B
10 027	W WORLDWIDE	C100/I II
10 030	W WORLDWIDE	C100/I IV
10 033	W WORLDWIDE	C100/II V
10 036	R 1E 6E 13G 13H	CC 13G 13H
10 039	R 3B 3C 4A 9B 12C	CC 3B 3C
10 042	M EA R 9C 10F 13C 13J 13K	CC 13C 13J 13K
10 045	R 2 3A 11B 13H 14	CC 2 3A
10 048	M NP R 2A 5D 13A 13B	CC 13A 13B
10 051	R 6A 6E 13I V VNAT	CC 6A 6E
10 054	R 2A 2C 6G 12	CC 2A 2C C004/6G
10 057	M CEP R 3A V VAFI	
10 060	R 1D 6F 13K	
10 063	R 4B 6G 12E	C004/6G
10 066	M SEA R 1B 10A 13M	
10 069	W WORLDWIDE	C100/I IV
10 072	W WORLDWIDE	C100/I III
10 075	W WORLDWIDE	C100/II V
10 078	W WORLDWIDE	C100/I III
10 081	M CWP R 4A 6A 7C 13F	C006/6A
10 084	M EUR SP R 6E 13D	

* See page AP27-75. (See cont.)

Band **10 005-10 100 kHz** **10 MHz**

(Cont.)

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
10 087	R 3 14 V VSAM	
10 090	R 12E 12F V VNCA	CC 12E 12F
10 093	R 5B 6B 11B 13N	
10 096	M NCA SAM R 7D	

27/228 Band **11 275-11 400 kHz** **11.3 MHz**

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
11 276	R 2A 2C 6G 10E 13J	CC 2A 2C C002/6G
11 279	M NAT R 2B 6F 9C	
11 282	M CEP R 4A 6G 13H	C003/6G
11 285	R 2A 3B 7	CC 2A 3B
11 288	R 5A 6G 11B	
11 291	M SAT R 3B 3C	CC 3B 3C
11 294	R 2A 6G 7C	C002/6G
11 297	R 2 12F	
11 300	M AFI R 6G 13H	C002/6G
11 303	R 3C 13E	
11 306	R 6G 7E 11B	
11 309	M NAT R 3A 6D	
11 312	R 5 9C 9D	CC 9C 9D
11 315	R 6G V VCAR	
11 318	R 3 4A 13D	

* See page AP27-75. (See cont.)

Band **11 275-11 400 kHz** **11.3 MHz**

(Cont.)

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
11 321	R 6A 13F	
11 324	R 3A 3C 4B 12C	CC 3A 3C
11 327	M SP R 3B 5 13C	
11 330	M AFI NP R 3A 13F	
11 333	R 2B 2C 10	CC 2B 2C
11 336	M NAT R 3	
11 339	R 2B 6B 9 13K	
11 342	W WORLDWIDE	C100/II III
11 345	W WORLDWIDE	C100/I IV
11 348	W WORLDWIDE	C100/II V
11 351	W WORLDWIDE	C100/I III
11 354	W WORLDWIDE	C100/II V
11 357	R 6A 6E 10A	CC 6A 6E
11 360	M SAM R 2 3 14	CC 2 3
11 363	R 1 6E 10A	
11 366	R 1C 6B 6F 13K	CC 6B 6F
11 369	R 6G 13G	
11 372	R 2C 3B 6D	
11 375	M MID R 10A 13C	
11 378	R 3C 13M V VEUR	
11 381	R 6 12E 12J	CC 12E 12J
11 384	M CWP R 1D 12J	
11 387	M CAR V VSEA	
11 390	R 2 10	
11 393	R 9B 12E V VMID	
11 396	M CAR EA SEA	CC EA SEA

* See page AP27-75.

27/229 Band **13 260-13 360 kHz** **13.3 MHz**

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
13 261	V VAFI	
13 264	R 14 V VEUR	
13 267	R 3 13H	
13 270	R 6G V VNAT	
13 273	M AFI	
13 276	R 6G V VNAT	
13 279	V VNCA VSAM	
13 282	V VPAC	
13 285	R 10 V VSEA	
13 288	M AFI EUR MID	CC AFI EUR MID
13 291	M NAT R 6	
13 294	M AFI	
13 297	M CAR EA SAM	CC CAR SAM
13 300	M CEP CWP NP SP R 4	CC CEP CWP NP SP
13 303	M EA NCA	CC EA NCA
13 306	M INO NAT	
13 309	M EA SEA R 13C 13K	CC EA SEA CC 13C 13K
13 312	M MID R 11B	
13 315	M NCA SAT	
13 318	M SEA R 13	
13 321	R 2 3	CC 2 3
13 324	W WORLDWIDE	C100/I III
13 327	W WORLDWIDE	C100/I IV
13 330	W WORLDWIDE	C100/II V
13 333	W WORLDWIDE	C100/I III
13 336	W WORLDWIDE	C100/I IV
13 339	W WORLDWIDE	C100/II V
13 342	W WORLDWIDE	C100/I III

* See page AP27-75. (See cont.)

Band **13 260-13 360 kHz** **13.3 MHz**

(Cont.)

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
13 345	W WORLDWIDE	C100/I IV
13 348	W WORLDWIDE	C100/II V
13 351	W WORLDWIDE	C100/I III
13 354	R 5 7	CC 5 7
13 357	M SAT R 2	

27/230 Band **17 900-17 970 kHz** **18 MHz**

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
17 901	R 12	
17 904	M CEP CWP NP SP R 4	CC CEP CWP NP SP
17 907	M CAR EA SAM SEA	CC CAR SAM CC EA SEA
17 910	R 10	
17 913	R 6G 13	
17 916	W WORLDWIDE	C100/I III
17 919	W WORLDWIDE	C100/II IV
17 922	W WORLDWIDE	C100/I III
17 925	W WORLDWIDE	C100/II V
17 928	W WORLDWIDE	C100/III IV
17 931	W WORLDWIDE	C100/I V
17 934	W WORLDWIDE	C100/II III
17 937	W WORLDWIDE	C100/IV V
17 940	W WORLDWIDE	C100/II III
17 943	R 6	
17 946	M NAT R 14	
17 949	R 5	

* See page AP27-75.

(See cont.)

Band **17 900-17 970 kHz** **18 MHz**

(Cont.)

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
17 952	R 3	
17 955	M SAT R 6B	
17 958	M NCA	
17 961	M AFI EUR INO MID	CC AFI EUR INO MID
17 964	R 2 11B	
17 967	R 5 13A 13B 13E 13F	CC 13A 13B 13E 13F

27/231 Band **21 924-22 000 kHz** **22 MHz**

Frequency (kHz)	Authorized area of use*	Remarks*
1	2	3
21 940	W WORLDWIDE	C100/I
21 943	W WORLDWIDE	C100/V
21 946	W WORLDWIDE	C100/I
21 949	W WORLDWIDE	C100/III
21 952	W WORLDWIDE	C100/I
21 955	W WORLDWIDE	C100/IV
21 958	W WORLDWIDE	C100/I
21 961	W WORLDWIDE	C100/V
21 964	W WORLDWIDE	C100/II
21 967	W WORLDWIDE	C100/I
21 970	W WORLDWIDE	C100/III
21 973	W WORLDWIDE	C100/I
21 976	W WORLDWIDE	C100/IV
21 979	W WORLDWIDE	C100/I
21 982	W WORLDWIDE	C100/V
21 985	W WORLDWIDE	C100/II
21 988	W WORLDWIDE	C100/I
21 991	W WORLDWIDE	C100/IV
21 994	W WORLDWIDE	C100/V
21 997	W WORLDWIDE	C100/I

* See page AP27-75.

Explanation of symbols and abbreviations

Column 2	M = MWARA R = RDARA V = VOLMET W = worldwide
Column 3	CC = common channel to
C001/...	Restricted to daytime only, in the area indicated after the slant stroke
C002/6G	In area 6G, operation is restricted to east of 95° E
C003/6G	In area 6G, operation is restricted to west of 95° E
C004/6G	Use limited to east of 110° E
C005/2A	Use limited to north of 60° N
C006/6A	Use limited to east of 75° E
C007	Not used
C008	Not used
C009/6G	In area 6G, use limited to east of 110° E and south of 25° N
C010/6G	In area 6G, use limited to east of 118° E and north of 40° N
C011/6E	In area 6E, use is limited to south of 20° N
C100/...	Worldwide Allotment Area is indicated after the symbol. For assignment procedure see No. 27/217.

ARTICLE 3

Frequencies for common use

27/232 1 The carrier (reference) frequencies 3 023 kHz and 5 680 kHz are intended for common use on a world-wide basis.

27/233 2 The use of these frequencies in any part of the world is authorized:

2.1 aboard aircraft for:

a) communications with approach and aerodrome control;

b) communication with an aeronautical station when other frequencies of the station are either unavailable or unknown;

2.2 at aeronautical stations for aerodrome and approach control under the following conditions:

a) with mean power limited to a value of not more than 20 W in the antenna circuit;

b) special attention must be given in each case to the type of antenna used in order to avoid harmful interference;

c) the power of aeronautical stations which use these frequencies in accordance with the above conditions may be increased to the extent necessary to meet certain operational requirements subject to coordination between the administrations directly concerned and those whose services may be adversely affected.

27/234 3 Notwithstanding these provisions, the frequency 5 680 kHz may also be used at aeronautical stations for communication with aircraft stations when other frequencies of the aeronautical stations are either unavailable or unknown. However, this use shall be restricted to such areas and conditions that harmful interference cannot be caused to other authorized operations of stations in the aeronautical mobile service.

27/235 4 Additional particulars regarding the use of these channels for the above purposes may be recommended by the meetings of ICAO.

27/236 5 Frequencies 3 023 kHz and 5 680 kHz may also be used by stations of other mobile services participating in coordinated air-surface search and rescue operations, including communications between these stations and participating land stations. Aeronautical stations are authorized to use these frequencies to establish communications with such stations.

27/237 6 These channels may be used for AlA, A1B or A3E emissions, in accordance with special arrangements. Such channels shall not be subdivided.

27/238 7 All stations participating directly in coordinated search and rescue operations and using frequencies 3 023 kHz and 5 680 kHz shall transmit solely on the upper sideband except in the cases provided for in No. **27**/57.

APPENDIX 30 (REV.WRC-23)*

Provisions for all services and associated Plans and List[1] for the broadcasting-satellite service in the frequency bands 11.7-12.2 GHz (in Region 3), 11.7-12.5 GHz (in Region 1) and 12.2-12.7 GHz (in Region 2) (WRC-03)

(See Articles **9** and **11**) (WRC-03)

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* The expression "frequency assignment to a space station", wherever it appears in this Appendix, shall be understood to refer to a frequency assignment associated with a given orbital position. See also Annex 7 for the orbital limitations. (WRC-2000)

1 The Regions 1 and 3 List of additional uses is annexed to the Master International Frequency Register. (WRC-23)

Note by the Secretariat: Reference to an Article with the number in roman is referring to an Article in this Appendix.

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ARTICLE 1 (REV.WRC-03)

General definitions

1 For the purposes of this Appendix, the following terms shall have the meanings defined below:

1.1 *1977 Conference*: World Administrative Radio Conference for the Planning of the Broadcasting-Satellite Service in the Frequency Bands 11.7-12.2 GHz (in Regions 2 and 3) and 11.7-12.5 GHz (in Region 1), called in short World Broadcasting-Satellite Administrative Radio Conference (Geneva, 1977) (WARC-77).

1.2 *1983 Conference*: Regional Administrative Radio Conference for the Planning in Region 2 of the Broadcasting-Satellite Service in the Frequency Band 12.2-12.7 GHz and Associated Feeder Links in the Frequency Band 17.3-17.8 GHz, called in short Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2 (Geneva, 1983) (RARC Sat-R2).

1.3 *1985 Conference*: First Session of the World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It (Geneva, 1985), called in short WARC Orb-85.

1.3A *1997 Conference*: World Radiocommunication Conference (Geneva, 1997), called in short WRC-97.

1.3B *2000 Conference*: World Radiocommunication Conference (Istanbul, 2000), called in short WRC-2000.

1.4 *Regions 1 and 3 Plan*: The Plan for the broadcasting-satellite service in the frequency bands 11.7-12.2 GHz in Region 3 and 11.7-12.5 GHz in Region 1 contained in this Appendix.

1.5 *Region 2 Plan*: The Plan for the broadcasting-satellite service in the frequency band 12.2-12.7 GHz in Region 2 contained in this Appendix, together with any modifications resulting from the successful application of the procedures of Article 4.

1.6 *Frequency assignment in conformity with the Plan*:

– any frequency assignment which appears in the Regions 1 and 3 Plan; *or*

– any frequency assignment which appears in the Region 2 Plan or for which the procedure of Article 4 has been successfully applied.

1.7 *Additional use in Regions 1 and 3*: For the application of the provisions of this Appendix, additional uses in Regions 1 and 3 are:

– use of assignments with characteristics different from those appearing in the Regions 1 and 3 Plan and which are capable of causing more interference than the corresponding entries in the Plan;

– use of assignments in addition to those appearing in the Plan.

1.8 *Regions 1 and 3 List of additional uses (hereafter called in short the "List")*: The List of assignments for additional uses in Regions 1 and 3 as established by WRC-2000, as updated following the successful application of the procedure of § 4.1 of Article 4. (WRC-23)

1.9 *Frequency assignment in conformity with the List*: Any frequency assignment which appears in the List as updated following successful application of § 4.1 of Article 4. (WRC-03)

1.10 *The broadcasting-satellite service subject to one of the Plans*: The broadcasting-satellite service subject to one of the Plans referred to in this Appendix is the broadcasting-satellite service in the bands 11.7-12.5 GHz in Region 1, 12.2-12.7 GHz in Region 2 and 11.7-12.2 GHz in Region 3. (WRC-03)

ARTICLE 2 (WRC-03)

Frequency bands

2.1 The provisions of this Appendix apply to the broadcasting-satellite service in the frequency bands between 11.7 GHz and 12.2 GHz in Region 3, between 11.7 GHz and 12.5 GHz in Region 1 and between 12.2 GHz and 12.7 GHz in Region 2 and to the other services to which these bands are allocated in Regions 1, 2 and 3, insofar as their relationship to the broadcasting-satellite service in these bands is concerned.

2.2 (SUP - WRC-03)

ARTICLE 2A (REV.WRC-19)

Use of the guardbands[1*bis*]

2A.1 The use of the guardbands defined in § 3.9 of Annex 5 to provide space operation functions in accordance with No. **1.23** in support of the operation of geostationary-satellite networks in the broadcasting-satellite service (BSS) is not subject to the application of Section I of Article **9**.

2A.1.1 Coordination between assignments intended to provide the space operation functions and assignments of the BSS subject to a Plan shall be effected using the provisions of Article 7.

2A.1.2 Coordination among assignments intended to provide the space operation functions and services not subject to a Plan shall be effected using the provisions of Nos. **9.7**, **9.17**, **9.18** and the associated provisions of Section II of Article **9**, or § 4.1.1 *d)* or 4.2.3 *d)* of Article 4, as appropriate.

[1*bis*] The provisions of Resolution **49 (Rev.WRC-19)*** do not apply. (WRC-19)

* *Note by the Secretariat*: This Resolution was revised by WRC-23.

2A.1.3 Coordination of modifications to the Region 2 Plan or assignments to be included in the Regions 1 and 3 List with assignments intended to provide these functions shall be effected using § 4.1.1 *e)* or 4.2.3 *e)*, as appropriate, of Article 4.

2A.1.4 Requests for the coordination referred to in §2A.1.1, 2A.1.2 and 2A.1.3 shall be sent by the requesting administration to the Bureau, together with the appropriate information listed in Appendix **4**.

2A.2 Any assignment intended to provide these functions in support of a geostationary-satellite network in the BSS shall be notified under Article **11** and brought into use within the following time-limits[1*ter*]: (WRC-15)

2A.2.1 *a)* for the case where the associated BSS assignments are contained in one of the initial Plans (Region 2 Plans incorporated in the Radio Regulations at WARC Orb-85 and the Regions 1 and 3 Plan adopted at WRC-2000), within the regulatory time-limit referred to in § 4.1.3 or § 4.2.6 of Article 4 from the date of receipt by the Bureau of the complete Appendix **4** data for those assignments intended to provide the space operation functions;

2A.2.2 *b)* for the case where the associated BSS assignments have been submitted under § 4.1.3 or § 4.2.6 of Article 4 for entry in the Regions 1 and 3 List or a modification to the Region 2 Plan, within the regulatory time-limit referred to in § 4.1.3 or § 4.2.6 of Article 4 for those associated BSS assignments;

2A.2.3 *c)* for the case where the associated BSS assignments have already been brought into use in accordance with the Radio Regulations, within the regulatory time-limit referred to in § 4.1.3 and § 4.2.6 of Article 4 from the date of receipt by the Bureau of the complete Appendix **4** data for those assignments intended to provide the space operation functions.

2A.3 Section II of Article **23** does not apply to assignments in the guardbands intended to provide the above-mentioned functions.

ARTICLE 3 (WRC-2000)

Execution of the provisions and associated Plans

3.1 The Member States in Regions 1, 2 and 3 shall adopt, for their broadcasting-satellite space stations[2] operating in the frequency bands referred to in this Appendix, the characteristics specified in the appropriate Regional Plan and the associated provisions.

3.2 The Member States shall not change the characteristics specified in the Regions 1 and 3 Plan or in the Region 2 Plan, or bring into use assignments to broadcasting-satellite space stations or to stations in the other services to which these frequency bands are allocated, except as provided for in the Radio Regulations and the appropriate Articles and Annexes of this Appendix.

1*ter* The time-limit is established at the time when the request is received under § 2A.1.4. (WRC-15)

2 Such stations may also be used for transmissions in the fixed-satellite service (space-to-Earth) in accordance with No. **5.492**.

3.3 The Regions 1 and 3 Plan is based on national coverage from the geostationary-satellite orbit. The associated procedures contained in this Appendix are intended to promote long-term flexibility of the Plan and to avoid monopolization of the planned bands and orbit by a country or a group of countries.

ARTICLE 4 (REV.WRC-23)

Procedures for modifications to the Region 2 Plan or for additional uses in Regions 1 and 3[3]

4.1 Provisions applicable to Regions 1 and 3

4.1.1 An administration proposing to include a new or modified assignment in the List shall seek the agreement of those administrations whose services are considered to be affected, i.e. administrations:

a) of Regions 1 and 3 having a frequency assignment to a space station in the broadcasting-satellite service which is included in the Regions 1 and 3 Plan with a necessary bandwidth, any portion of which falls within the necessary bandwidth of the proposed assignment; *or*

b) of Regions 1 and 3 having a frequency assignment included in the List or for which complete Appendix **4** information has been received by the Radiocommunication Bureau in accordance with the provisions of § 4.1.3, and any portion of which falls within the necessary bandwidth of the proposed assignment; *or*

c) of Region 2 having a frequency assignment to a space station in the broadcasting-satellite service which is in conformity with the Region 2 Plan, or in respect of which proposed modifications to that Plan have been received by the Bureau in accordance with the provisions of § 4.2.6 with a necessary bandwidth, any portion of which falls within the necessary bandwidth of the proposed assignment; *or*

d) having no frequency assignment in the broadcasting-satellite service with a necessary bandwidth, any portion of which falls within the necessary bandwidth of the proposed assignment, but in whose territory the power flux-density value exceeds the prescribed limit as a result of the proposed assignment, or having an assignment whose associated service area does not cover the whole of the territory of the administration, and in whose territory outside that service area the power flux-density from the proposed assignment exceeds the prescribed limit as a result of the proposed assignment; *or*

e) having a frequency assignment in the band 11.7-12.2 GHz in Region 2 or 12.2-12.5 GHz in Region 3 to a space station in the fixed-satellite service which is recorded in the Master International Frequency Register (Master Register) or for which complete coordination information has been received by the Bureau for coordination under No. **9.7**, or under § 7.1 of Article 7.

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3 The provisions of Resolution **49 (Rev.WRC-15)*** apply. (WRC-15)

* *Note by the Secretariat*: This Resolution was revised by WRC-19 and WRC-23.

4.1.2 The services of an administration are considered to be affected when the limits shown in Annex 1 are exceeded.

4.1.3 An administration, or one[4] acting on behalf of a group of named administrations, intending to include a new or modified assignment in the List shall send to the Bureau, not earlier than eight years but preferably not later than two years before the date on which the assignment is to be brought into use, the relevant information listed in Appendix **4**. An assignment in the List shall lapse if it is not brought into use within eight years after the date of receipt by the Bureau of the relevant complete information. A proposed new or modified assignment not included in the List within eight years after the date of receipt by the Bureau of the relevant complete information shall also lapse. (WRC-23)

4.1.3*bis* The regulatory time-limit for bringing into use of an assignment in the List may be extended once by not more than three years due to launch failure in the following cases:

– the destruction of the satellite intended to bring the assignment into use;

– the destruction of the satellite launched to replace an already operating satellite which is intended to be relocated to bring another assignment into use; *or*

– the satellite is launched, but fails to reach its assigned orbital location.

For this extension to be granted, the launch failure must have occurred at least five years after the date of receipt of the complete Appendix **4** data. In no case shall the period of the extension of the regulatory time-limit exceed the difference in time between the three-year period and the period remaining from the date of the launch failure to the end of the regulatory time-limit[6]. In order to take advantage of this extension, the administration shall have, within one month of the launch failure or one month after 5 July 2003, whichever comes later, notified the Bureau in writing of such failure, and shall also provide the following information to the Bureau before the end of the regulatory time-limit of § 4.1.3:

– date of launch failure;

– due diligence information as required in Resolutions **49 (Rev.WRC-15)**[*] for the assignment with respect to the satellite that suffered the launch failure, if that information has not already been provided.

If, 11 months after the request for extension, the administration has not provided to the Bureau updated Resolution **49 (Rev.WRC-15)**[*] information, the Bureau shall promptly send a reminder to the notifying administration. If, within one year of the request for extension, the administration has not provided to the Bureau updated Resolution **49 (Rev.WRC-15)**[*] information for the new satellite under procurement, the related frequency assignments shall lapse. (WRC-15)

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4 Whenever, under this provision, an administration acts on behalf of a group of named administrations, all members of that group retain the right to respond in respect of their own networks or systems. (WRC-03)

5 (SUP – WRC-23)

6 For a launch failure which occurred before 5 July 2003, the maximum extension of three years shall apply as from 5 July 2003. (WRC-03)

* *Note by the Secretariat*: This Resolution was revised by WRC-19 and WRC-23.

4.1.4 If the information received by the Bureau under § 4.1.3 is found to be incomplete, the Bureau shall immediately seek from the administration concerned any clarification required and information not provided.

4.1.5 The Bureau shall determine, on the basis of Annex 1, the administrations whose frequency assignments are considered to be affected. The Bureau shall publish[7], in a Special Section of its International Frequency Information Circular (BR IFIC), the complete information received under § 4.1.3, together with the names of the affected administrations, the corresponding fixed-satellite service networks, the corresponding broadcasting-satellite service assignments and terrestrial stations, as appropriate. The Bureau shall immediately send a telegram/fax to the administration proposing the assignment, drawing its attention to the information contained in the relevant BR IFIC. (WRC-07)

4.1.6 The Bureau shall send a telegram/fax to the administrations listed in the Special Section of the BR IFIC, drawing their attention to the information it contains. (WRC-07)

4.1.7 An administration which considers that it should have been identified in the publication referred to under § 4.1.5 above shall, within four months of the date of publication of its relevant BR IFIC, and giving the technical reasons for so doing, request the Bureau to include its name in the publication. The Bureau shall study this information on the basis of Annex 1 and shall inform both administrations of its conclusions. Should the Bureau agree to the administration's request, it shall publish an addendum to the publication under § 4.1.5.

4.1.7*bis* Except as provided under § 4.1.18 to 4.1.20, any inclusion of a new or modified frequency assignment in the Regions 1 and 3 List which would have the effect of exceeding the limits specified in Annex 1 shall be subject to the agreement of all administrations whose services are considered to be affected. (WRC-03)

4.1.8 The administration seeking agreement or the administration with which agreement is sought may request any additional technical information it considers necessary. The administrations shall inform the Bureau of such requests.

4.1.9 Comments from administrations identified in the publication referred to under § 4.1.5 above shall be sent to the Bureau and to the administration proposing the modification. (WRC-15)

4.1.10 An administration that has not notified its agreement either to the administration seeking agreement or to the Bureau within a period of four months following the date of the BR IFIC referred to in § 4.1.5 shall be deemed to have not agreed to the proposed assignment unless the provisions of § 4.1.10a to 4.1.10d and § 4.1.21 are applied. This time-limit may be extended:

– for an administration that has requested additional information under § 4.1.8, by up to three months; *or*

– for an administration that has requested the assistance of the Bureau under § 4.1.21, by up to three months following the date at which the Bureau communicated the result of its action. (WRC-15)

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[7] If the payments are not received in accordance with the provisions of Council Decision 482, as amended, on the implementation of cost recovery for satellite network filings, the Bureau shall cancel the publication, after informing the administration concerned. The Bureau shall inform all administrations of such action and that the network specified in the publication in question no longer has to be taken into consideration by the Bureau and other administrations. The Bureau shall send a reminder to the notifying administration not later than two months prior to the deadline for the payment in accordance with the above-mentioned Council Decision 482 unless the payment has already been received. (WRC-07)

4.1.10*bis* Thirty days prior to the expiry of the same four-month period, the Bureau shall dispatch a reminder telegram or fax to an administration which has not made its comments under § 4.1.10, bringing the matter to its attention. (WRC-03)

4.1.10*ter* (SUP - WRC-15)

4.1.10a After the same time period as specified in § 4.1.10, the notifying administration may, pursuant to § 4.1.21, request the Bureau to assist in respect of an administration which has not replied within this time period. (WRC-15)

4.1.10b The Bureau, acting under § 4.1.10a, shall send a reminder to the administration which has not replied, together with the results of its previously published compatibility analysis, containing the change in the values referred to in paragraph 1b of Annex 1 to Appendix **30**, requesting a decision. (WRC-15)

4.1.10c Fifteen days before the expiry of the 30-day period referred to in § 4.1.10d, the Bureau shall send a reminder to the above-mentioned administration drawing its attention to the consequence of no reply. (WRC-15)

4.1.10d If no decision is communicated to the Bureau within 30 days after the date of dispatch of the reminder under § 4.1.10b and the identification is for:

– an assignment in the Regions 1 and 3 Plan, it shall be deemed that the administration which has not given a decision has no objection to the proposed assignment and an agreement under § 4.1.13*bis* is considered as concluded between the administration for the affected assignment in the Regions 1 and 3 Plan and the notifying administration for the proposed assignment; or

– an assignment not in the Regions 1 and 3 Plan, it shall be deemed that the administration which has not given a decision has agreed to the proposed assignment. (WRC-23)

4.1.11 If, in seeking agreement, an administration modifies its initial proposal, it shall again apply the provisions of § 4.1 and the subsequent procedure in cases where:

– the assignments of any other administration received by the Bureau in accordance with § 4.1.3 or § 4.2.6, or § 2A.1.4 of Article 2A, or § 7.1 of Article 7, or No. **9.7** before this modified proposal is received under § 4.1.12;

– the assignments of any other administration contained in the Plans or the Lists; *or*

– the terrestrial services of any other administration,

are considered as being affected and receive more interference as a result of the modifications than that produced by the initial proposal. (WRC-15)

4.1.12[7*bis*] If agreement has been reached with the administrations identified in the publication referred to under § 4.1.5 above, the administration proposing the new or modified assignment may continue with the appropriate procedure in Article **5**, and shall so inform the Bureau, indicating the final characteristics of the frequency assignment together with the names of the administrations with which agreement has been reached. (WRC-19)

[7*bis*] For any remaining affected networks whose assignments were entered in the List before the notice received under § 4.1.12, the Bureau shall use the method in Annex 1 to further examine if the remaining corresponding assignments in the List are still considered as being affected. The examination in respect of those remaining affected networks is conducted independently using the Appendices **30** and **30A** master database corresponding to the Part B Special Section that was published under § 4.1.15. Resolution **548 (Rev.WRC-12)** applies. (WRC-19)

4.1.12*bis* In application of § 4.1.12, an administration may indicate the changes to the information communicated to the Bureau under § 4.1.3 and published under § 4.1.5. In submitting such information, noting the requirements of § 5.1.2, the administration may also request the Bureau to examine the submission in respect of notification under § 5.1.1. (WRC-19)

4.1.13 The agreement of the administrations affected may also be obtained in accordance with this Article, for a specified period. When this specific period of agreement expires for an assignment in the List, the assignment in question shall be maintained in the List until the end of the period referred to in § 4.1.3 above. After that date this assignment shall lapse unless the agreement of the administrations affected is renewed[7*ter*]. (WRC-19)

4.1.13*bis* When an agreement under this provision is concluded with the administration of an affected assignment in the Regions 1 and 3 Plan, the notifying administration for the proposed assignment shall provide a firm, objective, measurable and enforceable commitment to respect the power flux-density limit shown in section 1*a)* of Annex 1 to Appendix **30** at any point within the territory, situated inside the −3 dB contour of the associated beam area, of the administration whose assignment was the basis of the disagreement at the date on which the frequency assignment in the Regions 1 and 3 Plan is to be brought into use, as communicated under § 5.1.6*bis* or within 12 months of the date of dispatch of the telefax sent under § 5.1.6*bis*, whichever comes later. (WRC-23)

4.1.13*ter* Upon the conclusion of agreements under § 4.1.13*bis*, when entering the assignment in the List, the Bureau shall indicate those administrations whose assignments in the Regions 1 and 3 Plan were the basis of the agreement. (WRC-23)

4.1.14 Where the proposed assignment involves developing countries, administrations shall seek all practicable solutions conducive to the economical development of the broadcasting-satellite systems of these countries.

4.1.15 The Bureau shall publish[8] in a Special Section of its BR IFIC the information received under § 4.1.12, together with the names of any administrations with which the provisions of this Article have been successfully applied. The frequency assignment concerned shall be included in the List. (WRC-03)

4.1.16 In case of disagreement on the part of an administration whose agreement has been sought, the requesting administration shall first endeavour to solve the problem by exploring all possible means of meeting its requirement. If the problem still cannot be solved by such means, the administration whose agreement has been sought should endeavour to overcome the difficulties as far as possible, and shall state the technical reasons for any disagreement if the administration seeking the agreement requests it to do so. (WRC-19)

[7*ter*] Unless the Bureau has been informed by the notifying administration of the renewal of the agreement, it shall, no later than six months before the end of the specified period, send a reminder to the notifying administration. (WRC-19)

[8] If the payments are not received in accordance with the provisions of Council Decision 482, as amended, on the implementation of cost recovery for satellite network filings, the Bureau shall cancel the publication, after informing the administration concerned. The Bureau shall inform all administrations of such action and that the network specified in the publication in question no longer has to be taken into consideration by the Bureau and other administrations. The Bureau shall send a reminder to the notifying administration not later than two months prior to the deadline for the payment in accordance with the above-mentioned Council Decision 482 unless the payment has already been received. (WRC-07)

4.1.17 If no agreement is reached between the administrations concerned, the Bureau shall carry out any study that may be requested by either one of these administrations; the Bureau shall inform them of the result of the study and shall make such recommendations as it may be able to offer for the solution of the problem.

4.1.18 If, in spite of the application of § 4.1.16 and 4.1.17, there is still continuing disagreement and the assignment which was the basis of the disagreement is not an assignment in the Regions 1 and 3 Plan, or in the Region 2 Plan or for which the procedure of § 4.2 has been initiated, and if the notifying administration insists that the proposed assignment be included in the Regions 1 and 3 List, the Bureau shall provisionally enter the assignment in the Regions 1 and 3 List with an indication of those administrations whose assignments were the basis of the disagreement; however, the entry shall be changed from provisional to definitive recording in the List only if the Bureau is informed that the new assignment in the Regions 1 and 3 List has been in use, together with the assignment which was the basis for the disagreement, for at least four months without any complaint of harmful interference being made. (WRC-03)

4.1.18*bis* When requesting the application of § 4.1.18, the notifying administration shall undertake to meet the requirements of § 4.1.20 and provide to the administration in respect of which § 4.1.18 is applied, with a copy to the Bureau, a description of the steps by which it undertakes to meet these requirements. Once an assignment is entered in the List provisionally under the provisions of § 4.1.18, the calculation of the equivalent protection margin (EPM)[9] of an assignment in the Regions 1 and 3 List or for which the procedure of Article 4 has been initiated and which was the basis for the disagreement shall not take into account the interference produced by the assignment for which the provisions of § 4.1.18 have been applied. When the recording of an assignment entered into the List is changed from provisional to definitive in accordance with § 4.1.18, but there is still continuing disagreement between the administrations, the Bureau shall consult with the administration responsible for the assignments which were the basis for the disagreement in determining the appropriate course of action as regards any update to the EPM for the assignments which were the basis for the disagreement. (WRC-19)

4.1.19 Should the assignments that were the basis of the disagreement not be brought into use within the period specified in No. **11.44** (for non-planned services), or in § 4.1 (for assignments in the List or having initiated the procedure under § 4.1), as appropriate, then the status of the assignment in the List shall be reviewed accordingly.

4.1.20 Should harmful interference be caused by an assignment included in the List under § 4.1.18 to any recorded assignment in the Master Register which was the basis of the disagreement, the administration using the frequency assignment included in the List under § 4.1.18 shall, upon receipt of advice thereof, immediately eliminate this harmful interference.

4.1.21 An administration may, at any stage in the procedure described, or before applying it, request the assistance of the Bureau.

4.1.22 The relevant provisions of Article 5 shall be applied when frequency assignments are notified to the Bureau.

4.1.23 When a frequency assignment included in the List is no longer required, the administration concerned shall immediately so inform the Bureau. The Bureau shall publish this information in a Special Section of its BR IFIC and delete the assignment from the List.

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[9] For the definition of EPM, see § 3.4 of Annex 5. (WRC-03)

4.1.24 No assignment in the List shall have a period of operation exceeding 15 years, counted from the date of bringing into use, or 2 June 2000, whichever is later. Upon request by the responsible administration received by the Bureau at the latest three years before the expiry of this period, this period may be extended by up to 15 years, on condition that all the characteristics of the assignment remain unchanged[9*bis*]. (WRC-19)

4.1.25 Where an administration already having included in the List two assignments (not including those systems notified on behalf of a group of named administrations and included in the List by WRC-2000), in the same channel and covering the same service area, proposes to include in the List a new assignment in the same channel over this same service area, it shall apply the following in respect of another administration which has no assignment in the List in the same channel and which proposes to include in the List a new assignment:

a) if the agreement of the former administration is required following the application of § 4.1 by the latter administration, in order to protect the new assignment proposed by the former administration from interference caused by the assignment proposed by the latter administration, both administrations shall make every possible effort to resolve the difficulties by means of mutually acceptable adjustments to their networks;

b) in case of continuing disagreement, and if the former administration has not communicated to the Bureau the information specified in Annex 2 to Resolution **49 (Rev.WRC-15)***, this administration shall be deemed to have given its agreement to inclusion in the List of the assignment of the latter administration. (WRC-15)

4.1.26 The procedure of this Article may be applied by the administration of a new ITU Member State in order to include new assignments in the List. Upon completion of the procedure, the next World Radiocommunication Conference may be requested to consider, among the assignments included in the List after the successful completion of this procedure, the inclusion in the Plan of up to 10 channels (for Region 1) and up to 12 channels (for Region 3), over the national territory of the new Member State. (WRC-03)

4.1.27 When an administration has successfully applied this procedure and received all the agreements[10] required to include in the List assignments over its national territory, at an orbital location and/or in channels different from those appearing in the Plan for its country, it may request the next world radiocommunication conference to consider the inclusion in the Plan of up to 10 (for Region 1) and up to 12 (for Region 3) of these assignments, in replacement of its assignments appearing in the Plan.

4.1.27*bis* Should the assignments mentioned in § 4.1.26 and 4.1.27 over the national territory of the administration not be brought into use within the regulatory time-limit mentioned in § 4.1.3, they would be retained in the List until the end of the world radiocommunication conference immediately following the successful completion of the procedure referred to in § 4.1.26 and 4.1.27 respectively, and thereafter they shall be removed from the List. (WRC-03)

9*bis* Unless the request has been received by the Bureau, it shall, no later than 90 days before the deadline of such a request, send a reminder to the notifying administration. (WRC-19)

* *Note by the Secretariat*: This Resolution was revised by WRC-19 and WRC-23.

10 In such a case, § 4.1.18 does not apply.

4.1.28 The List, as updated, shall be published periodically by the Bureau.

4.1.29 New or modified assignments in the List shall be limited to digital modulation.

4.1.30 When an assignment is entered in the List referred to in § 4.1.13*ter*, that assignment shall not be taken into account in updating the reference situation of those assignments in the Regions 1 and 3 Plan with which an agreement under § 4.1.13*bis* was concluded. (WRC-23)

4.1.31 If the Bureau is informed that a commitment under § 4.1.13*bis* is not being respected by an assignment in the List, the Bureau shall immediately consult the administration responsible for the assignment, requesting immediate respect for the conditions specified in § 4.1.13*bis*. (WRC-23)

4.1.32 If, in spite of the application of § 4.1.31, the conditions specified in § 4.1.13*bis* are still not respected by an assignment in the List, the Bureau shall submit the case, together with additional supporting materials from administrations, to the subsequent meeting of the Radio Regulations Board for review and the necessary actions. (WRC-23)

4.2 Provisions applicable to Region 2

4.2.1 When an administration intends to make a modification[11] to the Region 2 Plan, i.e.:

a) to modify the characteristics of any of its frequency assignments to a space station in the broadcasting-satellite service which are shown in the Region 2 Plan, or for which the procedure in this Article has been successfully applied, whether or not the station has been brought into use; *or*

b) to include in the Region 2 Plan a new frequency assignment to a space station in the broadcasting-satellite service; *or*

c) to cancel a frequency assignment to a space station in the broadcasting-satellite service,

the following procedure shall be applied before any notification of the frequency assignment is made to the Bureau (see Article 5).

4.2.2 The term "frequency assignment in conformity with the Plan" used in this and the following Articles is defined in Article 1.

4.2.3 An administration proposing a modification to the characteristics of a frequency assignment in conformity with the Region 2 Plan, or the inclusion of a new frequency assignment in that Plan, shall seek the agreement of those administrations:

a) of Regions 1 and 3 having a frequency assignment to a space station in the broadcasting-satellite service which is in conformity with the Regions 1 and 3 Plan with a necessary bandwidth, any portion of which falls within the necessary bandwidth of the proposed assignment; *or*

[11] For assignments using analogue modulation, the intention not to employ energy dispersal in accordance with § 3.18 of Annex 5 shall be treated as a modification and thus subject to the appropriate provisions of this Article.

b) of Regions 1 and 3 having a frequency assignment included in the List or for which complete Appendix 4 information has been received by the Bureau in accordance with the provisions of § 4.1.3, and any portion of which falls within the necessary bandwidth of the proposed assignment; *or*

c) of Region 2 having a frequency assignment in the Region 2 Plan to a space station in the broadcasting-satellite service in the same or adjacent channel which is in conformity with that Plan, or in respect of which proposed modifications to that Plan have been received by the Bureau in accordance with the provisions of § 4.2.6; *or*

d) having no frequency assignment in the broadcasting-satellite service in the channel concerned, but in whose territory the power flux-density value exceeds the prescribed limit as a result of the proposed modification, or having an assignment whose associated service area does not cover the whole of the territory of the administration, and in whose territory outside that service area the power flux-density from the broadcasting-satellite space station subject to this modification exceeds the prescribed limit as a result of the proposed modification; *or*

e) having a frequency assignment in the band 12.5-12.7 GHz in Region 1 or 12.2-12.7 GHz in Region 3 to a space station in the fixed-satellite service which is recorded in the Master Register, or for which complete coordination information has been received by the Bureau for coordination under No. **9.7** or under § 7.1 of Article 7; *or*

f) having a frequency assignment to a space station in the broadcasting-satellite service in the frequency band 12.5-12.7 GHz in Region 3 with a necessary bandwidth, any portion of which falls within the necessary bandwidth of the proposed assignment, and:

– which is recorded in the Master Register; *or*

– for which complete coordination information has been received by the Bureau for coordination under No. **9.7** or under § 7.1 of Article **7**;

g) whose services are considered to be affected.

4.2.4 Not used.

4.2.5 The services of an administration are considered to be affected when the limits shown in Annex 1 are exceeded.

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12 (SUP – WRC-19)

4.2.6 An administration, or one[13] acting on behalf of a group of named administrations, intending to make a modification to the Region 2 Plan shall send to the Bureau, not earlier than eight years but preferably not later than two years before the date on which the assignment is to be brought into use, the relevant information listed in Appendix **4**. Modifications to that Plan shall lapse if the assignment is not brought into use within eight years after the date of receipt by the Bureau of the relevant complete information. A request for a modification that has not been included in that Plan within eight years after the date of receipt by the Bureau of the relevant complete information shall also lapse. (WRC-23)

4.2.6*bis* The regulatory time-limit for bringing into use of an assignment in the Region 2 Plan obtained through application of § 4.2 may be extended once by not more than three years due to launch failure in the following cases:

– the destruction of the satellite intended to bring the assignment into use;

– the destruction of the satellite launched to replace an already operating satellite which is intended to be relocated to bring another assignment into use; *or*

– the satellite is launched, but fails to reach its assigned orbital location.

For this extension to be granted, the launch failure must have occurred at least five years after the date of receipt of the complete Appendix **4** data. In no case shall the period of the extension of the regulatory time-limit exceed the difference in time between the three-year period and the period remaining from the date of the launch failure to the end of the regulatory time-limit[15]. In order to take advantage of this extension, the administration shall have, within one month of the launch failure or one month after 5 July 2003, whichever comes later, notified the Bureau in writing of such failure, and shall also provide the following information to the Bureau before the end of the regulatory time-limit of § 4.2.6:

– date of launch failure;

– due diligence information as required in Resolution **49 (Rev.WRC-15)***[*] for the assignment with respect to the satellite that suffered the launch failure, if that information has not already been provided.

If, 11 months after the request for extension, the administration has not provided to the Bureau updated Resolution **49 (Rev.WRC-15)***[*] information, the Bureau shall promptly send a reminder to the notifying administration. If, within one year of the request for extension, the administration has not provided to the Bureau updated Resolution **49 (Rev.WRC-15)***[*] information for the new satellite under procurement, the related frequency assignments shall lapse. (WRC-15)

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[13] Whenever, under this provision, an administration acts on behalf of a group of named administrations, all members of that group retain the right to respond in respect of their own networks or systems. (WRC-03)

[14] (SUP – WRC-23)

[15] For a launch failure which occurred before 5 July 2003, the maximum extension of three years shall apply as from 5 July 2003. (WRC-03)

[*] *Note by the Secretariat*: This Resolution was revised by WRC-19 and WRC-23.

4.2.7 If the information received by the Bureau under § 4.2.6 is found to be incomplete, the Bureau shall immediately seek from the administration concerned any clarification required and information not provided.

4.2.8 The Bureau shall determine, on the basis of Annex 1, the administrations whose frequency assignments are considered to be affected within the meaning of § 4.2.3. The Bureau shall publish[16], in a Special Section of its BR IFIC, the complete information received under § 4.2.6, together with the names of the affected administrations, the corresponding fixed-satellite service networks, the corresponding broadcasting-satellite service assignments and terrestrial stations, as appropriate. The Bureau shall immediately send a telegram/fax to the administration proposing the modification to the Region 2 Plan, drawing its attention to the information contained in the relevant BR IFIC. (WRC-07)

4.2.9 The Bureau shall send a telegram/fax to the administrations listed in the Special Section of its BR IFIC, drawing their attention to the information it contains. (WRC-07)

4.2.10 An administration which considers that it should have been included in the publication referred to under § 4.2.8 above shall, within four months of the date of publication in the relevant BR IFIC, and giving the technical reasons for so doing, request the Bureau to include its name in the publication. The Bureau shall study this information on the basis of Annex 1 and shall inform both administrations of its conclusions. Should the Bureau agree to the administration's request, it shall publish an addendum to the publication under § 4.2.8. (WRC-07)

4.2.11 Except as provided under § 4.2.21A to 4.2.21D, any modification to a frequency assignment which is in conformity with the Region 2 Plan or any inclusion in that Plan of a new frequency assignment which would have the effect of exceeding the limits specified in Annex 1 shall be subject to the agreement of all administrations whose services are considered to be affected. (WRC-03)

4.2.12 The administration seeking agreement or the administration with which agreement is sought may request any additional technical information it considers necessary. The administrations shall inform the Bureau of such requests.

4.2.13 Comments from administrations on the information published pursuant to § 4.2.8 should be sent either directly to the administration proposing the modification or through the Bureau. In any event, the Bureau shall be informed that comments have been made.

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[16] If the payments are not received in accordance with the provisions of Council Decision 482, as amended, on the implementation of cost recovery for satellite network filings, the Bureau shall cancel the publication, after informing the administration concerned. The Bureau shall inform all administrations of such action and that the network specified in the publication in question no longer has to be taken into consideration by the Bureau and other administrations. The Bureau shall send a reminder to the notifying administration not later than two months prior to the deadline for the payment in accordance with the above-mentioned Council Decision 482 unless the payment has already been received. (WRC-07)

4.2.14 An administration that has not notified its comments either to the administration seeking agreement or to the Bureau within a period of four months following the date of the BR IFIC referred to in § 4.2.8 shall be deemed to have agreed to the proposed assignment. This time-limit may be extended by up to three months for an administration that has requested additional information under § 4.2.12 or for an administration that has requested the assistance of the Bureau under § 4.2.22. In the latter case, the Bureau shall inform the administrations concerned of this request.

4.2.14*bis* Thirty days prior to the expiry of the same four-month period the Bureau shall dispatch a reminder telegram or fax to an administration which has not made its comments under § 4.2.14, bringing the matter to its attention. (WRC-03)

4.2.14*ter* After expiry of the deadline for comments in respect of the proposed assignment, the Bureau shall, according to its records, publish a Special Section, indicating the list of administrations whose agreements are required for completion of the Article 4 procedure. (WRC-03)

4.2.15 If, in seeking agreement, an administration modifies its initial proposal, it shall again apply the provisions of § 4.2 and the consequent procedure with respect to any other administration whose services might be affected as a result of modifications to the initial proposal.

4.2.16[16*bis*] If no comments have been received on the expiry of the periods specified in § 4.2.14, or if agreement has been reached with the administrations which have made comments and with which agreement is necessary, the administration proposing the modification may continue with the appropriate procedure in Article 5, and shall so inform the Bureau, indicating the final characteristics of the frequency assignment together with the names of the administrations with which agreement has been reached. (WRC-19)

4.2.16*bis* In application of § 4.2.16, an administration may indicate the changes to the information communicated to the Bureau under § 4.2.6 and published under § 4.2.8. In submitting such information, noting the requirements of § 5.1.2, the administration may also request the Bureau to examine the submission in respect of notification under § 5.1.1. (WRC-19)

4.2.17 The agreement of the administrations affected may also be obtained in accordance with this Article, for a specified period. When this specific period of agreement expires for an assignment in the Plan, the assignment in question shall be maintained in the Plan until the end of the period referred to in § 4.2.6 above. After that date this assignment in the Plan shall lapse unless the agreement of the administrations affected is renewed[16*ter*]. (WRC-19)

[16*bis*] For any remaining affected networks whose assignments were entered in the Plan before the notice received under § 4.2.16, the Bureau shall use the method in Annex 1 to further examine if the remaining corresponding assignments in the Plan are still considered as being affected. The examination in respect of those remaining affected networks is conducted independently using the Appendices **30** and **30A** master database corresponding to the Part B Special Section that was published under § 4.2.19. (WRC-19)

[16*ter*] Unless the Bureau has been informed by the notifying administration of the renewal of the agreement, it shall, no later than six months before the end of the specified period, send a reminder to the notifying administration. (WRC-19)

4.2.18 When the proposed modification to the Region 2 Plan involves developing countries, administrations shall seek all practicable solutions conducive to the economical development of the broadcasting-satellite systems of these countries.

4.2.19 The Bureau shall publish[17] in a Special Section of its BR IFIC the information received under § 4.2.16 together with the names of any administrations with which the provisions of this Article have been successfully applied. The frequency assignment concerned shall enjoy the same status as those appearing in the Region 2 Plan and will be considered as a frequency assignment in conformity with the Plan. (WRC-03)

4.2.20 When an administration proposing to modify the characteristics of a frequency assignment or to make a new frequency assignment receives notice of disagreement on the part of an administration whose agreement it has sought, it shall first endeavour to solve the problem by exploring all possible means of meeting its requirement. If the problem still cannot be solved by such means, the administration whose agreement has been sought should endeavour to overcome the difficulties as far as possible, and shall state the technical reasons for any disagreement if the administration seeking the agreement requests it to do so. (WRC-19)

4.2.21 If no agreement is reached between the administrations concerned, the Bureau shall carry out any study that may be requested by these administrations; the Bureau shall inform them of the result of the study and shall make such recommendations as it may be able to offer for the solution of the problem.

4.2.21A If, in spite of the application of § 4.2.20 and 4.2.21, there is still continuing disagreement and the assignment which was the basis of the disagreement is not an assignment in the Region 2 Plan, or in the Regions 1 and 3 Plan or List, or for which the procedure of § 4.1 or 4.2 has been initiated, and if the notifying administration insists that the proposed assignment be included in the Region 2 Plan, the Bureau shall provisionally enter the assignment in the Region 2 Plan with an indication of those administrations whose assignments were the basis of the disagreement; however, the entry shall be changed from provisional to definitive recording in the Region 2 Plan only if the Bureau is informed that the new assignment in the Region 2 Plan has been in use, together with the assignment which was the basis for the disagreement, for at least four months without any complaint of harmful interference being made. (WRC-03)

4.2.21B When requesting the application of § 4.2.21A, the notifying administration shall undertake to meet the requirements of § 4.2.21D and provide to the administration in respect of which § 4.2.21A has been applied, with a copy to the Bureau, a description of the steps by which it undertakes to meet these requirements. (WRC-03)

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[17] If the payments are not received in accordance with the provisions of Council Decision 482, as amended, on the implementation of cost recovery for satellite network filings, the Bureau shall cancel the publication, after informing the administration concerned. The Bureau shall inform all administrations of such action and that the network specified in the publication in question no longer has to be taken into consideration by the Bureau and other administrations. The Bureau shall send a reminder to the notifying administration not later than two months prior to the deadline for the payment in accordance with the above-mentioned Council Decision 482 unless the payment has already been received. (WRC-07)

4.2.21C Should the assignments that were the basis of the disagreement not be brought into use within the period specified in No. **11.44**, the status of the assignment in the Region 2 Plan shall be reviewed accordingly. (WRC-03)

4.2.21D Should harmful interference be caused by an assignment included in the Region 2 Plan under § 4.2.21A to any recorded assignment in the Master Register which was the basis of the disagreement, the administration using the frequency assignment included in the Region 2 Plan under § 4.2.21A shall, upon receipt of advice thereof, immediately eliminate this harmful interference. (WRC-03)

4.2.22 An administration may at any stage in the procedure described, or before applying it, request the assistance of the Bureau.

4.2.23 The relevant provisions of Article 5 shall be applied when frequency assignments are notified to the Bureau.

4.2.24 Cancellation of frequency assignments

When a frequency assignment in conformity with the Region 2 Plan is no longer required, whether or not as a result of a modification, the administration concerned shall immediately so inform the Bureau. The Bureau shall publish this information in a Special Section of its BR IFIC and delete the assignment from the Region 2 Plan.

4.2.25 Master copy of the Region 2 Plan

4.2.25.1 The Bureau shall maintain an up-to-date master copy of the Region 2 Plan, including the overall equivalent protection margins of each assignment, taking account of the application of the procedure set out in this Article. This master copy shall contain the overall equivalent protection margins derived from the Plan as established by the 1983 Conference and those derived from all modifications to the Plan as a result of the successful completion of the modification procedure set out in this Article.

4.2.25.2 An up-to-date version of the Region 2 Plan shall be published by the Secretary-General when justified by the circumstances.

ARTICLE 5 (REV.WRC-23)

Notification, examination and recording in the Master International Frequency Register of frequency assignments to space stations in the broadcasting-satellite service [18] (WRC-07)

5.1 Notification

5.1.1 Whenever an administration[19] intends to bring into use a frequency assignment to a space station in the broadcasting-satellite service, it shall notify this frequency assignment to the Bureau. For this purpose, the notifying administration shall apply the following provisions. (WRC-03)

5.1.2 For any notification under § 5.1.1, an individual notice for each frequency assignment shall be drawn up as prescribed in Appendix **4**, the various Sections of which specify the basic characteristics to be provided as appropriate. It is recommended that the notifying administration should also supply any other data it may consider useful. (WRC-2000)

5.1.2*bis* In application of § 5.1.2, an administration may identify the characteristics of assignments in the Plans or the List as notification and send to the Bureau the changes thereto. (WRC-03)

5.1.3 Each notice must reach the Bureau not earlier than three years before the date on which the frequency assignment is to be brought into use. In any case, the notice must reach the Bureau not later than three months before that date[20]. (WRC-19)

5.1.4 Any frequency assignment the notice of which reaches the Bureau after the applicable period specified in § 5.1.3 shall, where it is to be recorded, bear a remark in the Master Register to indicate that it is not in conformity with § 5.1.3.

5.1.5 Any notice made under § 5.1.1 which does not contain the characteristics specified in Appendix **4** shall be returned by the Bureau immediately by airmail to the notifying administration with the relevant reasons. (WRC-2000)

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[18] If the payments are not received in accordance with the provisions of Council Decision 482, as amended, on the implementation of cost recovery for satellite network filings, the Bureau shall cancel the publication specified in § 5.1.6 and the corresponding entries in the Master Register under § 5.2.2, 5.2.2.1, 5.2.2.2 or 5.2.6, as appropriate, and the corresponding entries included in the Plan on and after 3 June 2000 or in the List, as appropriate, after informing the administration concerned. The Bureau shall inform all administrations of such action. The Bureau shall send a reminder to the notifying administration not later than two months prior to the deadline for the payment in accordance with the above-mentioned Council Decision 482 unless the payment has already been received. (WRC-23)

[19] A frequency assignment may be notified by one administration acting on behalf of a group of named administrations. Any further notice (modification or deletion) relating to that assignment shall, in the absence of information to the contrary, be regarded as having been submitted on behalf of the entire group. (WRC-03)

[20] Where appropriate, the notifying administration shall initiate the procedure for modifying the Plan concerned or for including assignments in the Regions 1 and 3 List in sufficient time to ensure that this limit is observed. For Region 2, see also Resolution **42 (Rev.WRC-19)** and § B of Annex 7. (WRC-19)

5.1.6 Upon receipt of a complete notice, the Bureau shall include its particulars, with the date of receipt, in its BR IFIC, which shall contain the particulars of all such notices received since the publication of the previous Circular. (WRC-2000)

5.1.6*bis* Upon receipt of a complete notice, the Bureau shall immediately send a telefax to administrations which have applied § 4.1.13*bis* with regard to this notice, if any. This telefax shall inform the administrations concerned of the notification under § 5.1.1 of this notice and the date on which the frequency assignment which is the subject of the agreement under § 4.1.13*bis* is planned to be brought into use. (WRC-23)

5.1.7 The Circular shall constitute the acknowledgement to the notifying administration of the receipt of a complete notice.

5.1.8 Complete notices shall be considered by the Bureau in order of receipt. The Bureau shall not postpone its finding unless it lacks sufficient data to reach a decision; moreover, the Bureau shall not act upon any notice which has a technical bearing on an earlier notice still under consideration by the Bureau until it has reached a finding with respect to such earlier notice.

5.2 Examination and recording

5.2.1 The Bureau shall examine each notice:

a) with respect to its conformity with the Constitution, the Convention and the relevant provisions of the Radio Regulations (with the exception of those relating to § *b)*, *c)*, *d)* and *e)* below);

b) with respect to its conformity with the appropriate Regional Plan or the Regions 1 and 3 List, as appropriate; *or*

c) with respect to the coordination requirements specified in the Remarks column of Article **10** or Article **11**; *or*

d) with respect to its conformity with the appropriate Regional Plan or the Regions 1 and 3 List, however, having characteristics differing from those in the appropriate Regional Plan or in the Regions 1 and 3 List, in one or more of the following aspects:

– use of a reduced e.i.r.p.,

– use of a reduced coverage area entirely situated within the coverage area appearing in the appropriate Regional Plan or in the Regions 1 and 3 List,

– use of other modulating signals in accordance with the provisions of § 3.1.3 of Annex 5,

– use of the assignment for transmission in the fixed-satellite service in accordance with No. **5.492**,

– in the case of Region 2, use of an orbital position under the conditions specified in § B of Annex 7,

– in the case of the notification of Plan assignments, use of an e.i.r.p. which produces a pfd that exceeds the limit of −103.6 dB(W/(m^2 · 27 MHz)) given in Section 1 of Annex 1 to Appendix **30** on the territory of the notifying administration under the condition that the calculated pfd at test points of any Plan assignment, List assignment or proposed assignment submitted under Article 4 are equal to or below that of the original Plan assignments in the same channel of the administration applying this section; *or*

e) with respect to its conformity with the provisions of Resolution **42 (Rev.WRC-19)**. (WRC-19)

5.2.2 Where the Bureau reaches a favourable finding with respect to § 5.2.1 *a)*, 5.2.1 *b)* and 5.2.1 *c)*, the frequency assignment of an administration shall be recorded in the Master Register. The date of receipt of the notice by the Bureau shall be entered in the Master Register. In relations between administrations, all frequency assignments brought into use in conformity with the appropriate Regional Plan and recorded in the Master Register shall be considered to have the same status irrespective of the dates of receipt entered in the Master Register for such frequency assignments. (WRC-07)

5.2.2.1 Where the Bureau reaches a favourable finding with respect to § 5.2.1 *a)*, 5.2.1 *c)* and 5.2.1 *d)*, the frequency assignment shall be recorded in the Master Register. The date of receipt of the notice by the Bureau shall be entered in the Master Register. In relations between administrations, all frequency assignments brought into use in conformity with the appropriate Regional Plan and recorded in the Master Register shall be considered to have the same status irrespective of the dates of receipt entered in the Master Register for such frequency assignments. When recording these assignments, the Bureau shall indicate by an appropriate symbol the characteristics having a value different from that appearing in the appropriate regional Plan. (WRC-07)

5.2.2.2 In the case of Region 2, where the Bureau reaches a favourable finding with respect to § 5.2.1 *a)* and 5.2.1 *c)*, but an unfavourable finding with respect to § 5.2.1 *b)* and 5.2.1 *d)*, it shall examine the notice with respect to the successful application of the provisions of Resolution **42 (Rev.WRC-19)**. A frequency assignment for which the provisions of Resolution **42 (Rev.WRC-19)** have been successfully applied shall be recorded in the Master Register with an appropriate symbol to indicate its interim status. The date of receipt of the notice by the Bureau shall be entered in the Master Register. In relations between administrations all frequency assignments brought into use following the successful application of the provisions of Resolution **42 (Rev.WRC-19)** and recorded in the Master Register shall be considered to have the same status irrespective of the dates of receipt entered in the Master Register for such frequency assignments. (WRC-19)

5.2.2.3 In the case of Regions 1 and 3, when the Bureau reaches a favourable finding with respect to § 5.2.1 *a)* and 5.2.1 *c)* but an unfavourable finding with respect to § 5.2.1 *b)* and 5.2.1 *d)*, the notice shall be returned immediately by airmail to the notifying administration with the Bureau's reasons for this finding and with such suggestions as the Bureau may be able to offer with a view to a satisfactory solution of the problem. (WRC-2000)

5.2.3 Whenever a frequency assignment is recorded in the Master Register, the finding reached by the Bureau shall be indicated. (WRC-07)

5.2.4 Where the Bureau reaches an unfavourable finding with respect to:

– § 5.2.1 *a)*, or

– § 5.2.1 *c)*, or

– § 5.2.1 *b)* and 5.2.1 *d)* and, where applicable, § 5.2.1 *e)*,

the notice shall be returned immediately by airmail to the notifying administration with the reasons of the Bureau for this finding and with such suggestions as the Bureau may be able to offer with a view to a satisfactory solution of the problem. (WRC-2000)

5.2.5 Where the notifying administration resubmits the notice and the finding of the Bureau becomes favourable with respect to the appropriate parts of § 5.2.1, the notice shall be treated as in § 5.2.2, 5.2.2.1 or 5.2.2.2, as appropriate.

5.2.6 If the notifying administration resubmits the notice without modification and insists on its reconsideration, and if the Bureau's finding with respect to § 5.2.1 remains unfavourable, the notice is returned to the notifying administration in accordance with § 5.2.4. In this case, the notifying administration undertakes not to bring into use the frequency assignment until the condition specified in § 5.2.5 is fulfilled. For Regions 1, 2 and 3, in the event that the Bureau has been informed of agreement to modification of the Plan for a specified period of time in accordance with Article 4, the frequency assignment shall be recorded in the Master Register with a note indicating that the frequency assignment is valid only for the period specified. The notifying administration using the frequency assignment over a specified period shall not subsequently invoke this fact to justify the continued use of the frequency beyond the period specified unless it obtains the agreement of the administration(s) concerned.

5.2.7 If a frequency assignment notified in advance of bringing into use in conformity with § 5.1.3 has received a favourable finding by the Bureau with respect to the provisions of § 5.2.1, it shall be entered provisionally in the Master Register with a special symbol in the Remarks Column indicating the provisional nature of that entry.

5.2.8 When the Bureau has received confirmation that the frequency assignment has been brought into use, the Bureau shall remove the symbol in the Master Register.

5.2.9 The date of bringing into use notified by the administration concerned shall be recorded in the Master Register. (WRC-07)

5.2.10 Wherever the use of a frequency assignment to a space station recorded in the Master Register and emanating from the Regions 1 and 3 List is suspended for a period exceeding six months, the notifying administration shall inform the Bureau of the date on which such use was suspended. When the recorded assignment is brought back into use, the notifying administration shall so inform the Bureau, as soon as possible. On receipt of the information sent under this provision, the Bureau shall make that information available on the ITU website as soon as possible and shall publish it in the BR IFIC. The date on which the recorded assignment is brought back into use[20*bis*, 20*ter*] shall be no later than three years from the date on which the use of the frequency assignment was suspended, provided that the notifying administration informs the Bureau of the suspension within six months from the date on which the use was suspended. If the notifying administration informs the Bureau of the suspension more than six months after the date on which the use of the frequency assignment was suspended, this three-year time period shall be reduced. In this case, the amount by which the three-year period shall be reduced shall be equal to the amount of time that has elapsed between the end of the six-month period and the date that the Bureau is informed of the suspension. If the notifying administration informs the Bureau of the suspension more than 21 months after the date on which the use of the frequency assignment was suspended, the frequency assignment shall be cancelled. (WRC-23)

5.2.11 If a recorded frequency assignment stemming from the Regions 1 and 3 List is not brought back into use within the suspension period resulting from the application of § 5.2.10 above, the Bureau shall cancel the assignment from the Master Register and the assignment in the List, unless the assignment is one to which § 4.1.26 or § 4.1.27 is being applied. (WRC-15)

5.3 Cancellation of entries in the Master Register

5.3.1 Any notified frequency assignment to which the Article 4 procedures have been applied and which has been provisionally recorded under § 5.2.7 shall be brought into use no later than the end of the period provided under § 4.1.3, 4.1.3*bis*, 4.2.6 or 4.2.6*bis* of Article 4. Any other frequency assignment provisionally recorded under § 5.2.7 shall be brought into use by the date specified in the notice. Unless the Bureau has been informed by the notifying administration of the bringing into use of the assignment under § 5.2.8, it shall, no later than 15 days before the notified date of bringing into use or the end of the regulatory period established under § 4.1.3, 4.1.3*bis*, 4.2.6 or 4.2.6*bis* of Article 4, as appropriate, send a reminder requesting confirmation that the assignment has been brought into use within the regulatory period. If the Bureau does not receive that confirmation within 30 days following the notified date of bringing into use or the period provided under § 4.1.3, 4.1.3*bis*, 4.2.6 or 4.2.6*bis* of Article 4, as the case may be, it shall cancel the entry in the Master Register. (WRC-15)

20*bis* The date of bringing-back-into-use of a frequency assignment to a space station in the geostationary-satellite orbit shall be the commencement of the 90-day period defined below. A frequency assignment to a space station in the geostationary-satellite orbit shall be considered as having been brought back into use when a space station in the geostationary-satellite orbit with the capability of transmitting or receiving that frequency assignment has been deployed and maintained at the notified orbital position for a continuous period of 90 days. The notifying administration shall inform the Bureau within 30 days from the end of the 90-day period. Resolution **40 (Rev.WRC-19)** shall apply. (WRC-19)

20*ter* If the notifying administration has informed the Bureau of the date of commencement of the 90-day bringing-back-into-use period, but, as of 15 days after the end of the 90-day bringing-back-into-use period, has not yet informed the Bureau of the completion of the bringing-back-into-use period in accordance with footnote 20*bis*, the Bureau shall promptly send the notifying administration a reminder of its obligation to inform the Bureau of the completion of the bringing-back-into-use period under footnote 20*bis*. (WRC-23)

5.3.2 If the use of any recorded frequency assignment is permanently discontinued, the notifying administration shall so inform the Bureau within three months, whereupon the entry shall be removed from the Master Register.

ARTICLE 6 (WRC-2000)

Coordination, notification and recording in the Master International Frequency Register of frequency assignments to terrestrial stations or to earth stations in the fixed-satellite service (Earth-to-space) affecting frequency assignments to broadcasting-satellite stations in the bands 11.7-12.2 GHz (in Region 3), 11.7-12.5 GHz (in Region 1) and 12.2-12.7 GHz (in Region 2)[21]

6.1 The provisions of No. **9.19** and the associated provisions under Articles **9** and **11** are applicable in respect of frequency assignments to broadcasting-satellite stations in the bands 11.7-12.5 GHz in Region 1, 12.2-12.7 GHz in Region 2 and 11.7-12.2 GHz in Region 3:

a) to transmitting terrestrial stations in the band 11.7-12.7 GHz in all Regions;

b) to transmitting earth stations in the fixed-satellite service in the band 12.5-12.7 GHz (in Region 1).

6.2 In applying the procedures referred to in § 6.1, the provisions of Appendix **5** are replaced by the following:

6.2.1 These procedures are to be applied in respect of administrations whose territory is included within the service area associated with:

a) assignments in conformity with the appropriate Regional Plan in Appendix **30**;

b) assignments included in the Regions 1 and 3 List;

c) assignments for which the procedure of Article 4 has been initiated, as from the date of receipt of the complete Appendix **4** information under § 4.1 or 4.2.

6.2.2 The criteria to be applied are those given in Annex 3.

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[21] These procedures do not replace the procedures prescribed for terrestrial stations in Articles **9** and **11**.

ARTICLE 7 (REV.WRC-19)

Coordination, notification and recording in the Master International Frequency Register of frequency assignments to stations in the fixed-satellite service (space-to-Earth) in the bands 11.7-12.2 GHz (in Region 2), 12.2-12.7 GHz (in Region 3) and 12.5-12.7 GHz (in Region 1), and to stations in the broadcasting-satellite service in the band 12.5-12.7 GHz (in Region 3) when frequency assignments to broadcasting-satellite stations in the bands 11.7-12.5 GHz in Region 1, 12.2-12.7 GHz in Region 2 and 11.7-12.2 GHz in Region 3 are involved[22]

7.1 The provisions of No. **9.7**[23] and the associated provisions under Articles **9** and **11** are applicable in respect of frequency assignments to broadcasting-satellite stations in the frequency bands 11.7-12.5 GHz in Region 1, 12.2-12.7 GHz in Region 2 and 11.7-12.2 GHz in Region 3:

a) to transmitting space stations in the fixed-satellite service in the frequency bands 11.7-12.2 GHz (in Region 2), 12.2-12.7 GHz (in Region 3) and 12.5-12.7 GHz (in Region 1); and

b) to transmitting space stations in the broadcasting-satellite service in the frequency band 12.5-12.7 GHz (in Region 3). (WRC-19)

7.2 In applying the procedures referred to in § 7.1, the provisions of Appendix **5** are replaced by the following:

7.2.1 The frequency assignments to be taken into account are:

a) the assignments in conformity with the appropriate Regional Plan in Appendix **30**;

b) the assignments included in the Regions 1 and 3 List;

c) the assignments for which the procedure of Article 4 has been initiated, as from the date of receipt of the complete Appendix **4** information under § 4.1.3 or 4.2.6. (WRC-03)

7.2.2 The criteria to be applied are those given in Annex 4.

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22 These provisions do not replace the procedures prescribed in Articles **9** and **11** when stations other than those in the broadcasting-satellite service subject to a Plan are involved. (WRC-03)

23 (SUP – WRC-19)

ARTICLE 8

Miscellaneous provisions relating to the procedures*

8.1 If so requested by any administration, the Board, using such means at its disposal as are appropriate in the circumstances, shall conduct a study of cases of alleged contravention or non-observance of these provisions or of harmful interference.

8.2 The Board shall thereupon prepare and forward to the administration or administrations concerned a report containing its findings and recommendations for the solution of the problem.

8.3 On receiving the Board's recommendations for the solution of the problem, an administration shall promptly acknowledge their receipt by telegram and shall indicate the action it intends to take. Where the Board's suggestions or recommendations are unacceptable to the administrations concerned, further efforts should be made by the Board to find an acceptable solution to the problem.

8.4 Where, as a result of a study, the Board submits to one or more administrations suggestions or recommendations for the solution of a problem, and where no reply has been received from one or more of these administrations within a period of three months, the Board shall consider that the suggestions or recommendations concerned are unacceptable to the administrations which did not answer. If it was the requesting administration which failed to answer within this period, the Board shall discontinue the study.

8.5 If so requested by any administration, particularly by an administration of a country in need of special assistance, the Board, using such means at its disposal as are appropriate in the circumstances, shall render the following assistance:

a) computation necessary in the application of Annexes 1, 3 and 4;

b) any other assistance of a technical nature for completion of the procedures in this Appendix.

8.6 In making a request to the Board under § 8.5, the administration shall provide the Board with the necessary information.

ARTICLE 9 (SUP - WRC-03)

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* *Note by the Secretariat:* WRC-97 did not review this Article. The subject matter is also dealt with in Articles **13** and **14**, which were reviewed by WRC-97.

ARTICLE 10 (REV.WRC-19)

The Plan for the broadcasting-satellite service in the frequency band 12.2-12.7 GHz in Region 2

10.1 COLUMN HEADINGS OF THE PLAN

Col. 1 *Beam identification* (Column 1 contains the symbol designating the country or the geographical area taken from Table B1 of the Preface to the International Frequency Information Circular (BR IFIC) followed by the symbol designating the service area).

Col. 2 *Nominal orbital position*, in degrees and hundredths of a degree.

Col. 3 *Channel number* (see Table 4 showing channel numbers and corresponding assigned frequencies).

Col. 4 *Boresight* geographical coordinates, in degrees and hundredths of a degree.

Col. 5 *Antenna beamwidth*. This column contains two figures corresponding to the major axis and the minor axis respectively of the elliptical cross-section half-power beam, in degrees and hundredths of a degree.

Col. 6 *Orientation of the ellipse* determined as follows: in a plane normal to the beam axis, the direction of a major axis of the ellipse is specified as the angle measured anti-clockwise from a line parallel to the equatorial plane to the major axis of the ellipse to the nearest degree.

Col. 7 *Polarization* (1 = direct, 2 = indirect)[24].

Col. 8 *e.i.r.p.* in the direction of maximum radiation, in dBW.

Col. 9 *Remarks*.

10.2 TEXT FOR NOTES IN REMARKS COLUMN OF THE PLAN

1 Fast roll-off space station transmitting antenna as defined in Annex 5 (item 3.13.3).

2 Television standard with 625 lines using greater video bandwidth and necessary bandwidth of 27 MHz.

3 Not used

[24] See Annex 5 (§ 3.2) of this Appendix.

4 This assignment may be utilized in the geographical area of Anguilla (AIA) (which is in the beam area).

5 Feeder-link earth stations for this assignment may also be located in the territories of Puerto Rico and the United States Virgin Islands. Such operation shall not cause more interference nor require more protection than the assignment under the Plan.

6 Feeder-link earth stations for this assignment may also be located in the States of Alaska and Hawaii. Such operation shall not cause more interference nor require more protection than the assignment under the Plan.

7 The feeder-link earth station for this assignment may also be located at the point with geographical coordinates 3° 31′ West, 48° 46′ North. Such operation shall not cause more interference nor require more protection than the assignment under the Plan.

8 Feeder-link earth stations for this assignment may also be located at the points with the following geographical coordinates:

47° 55′ West	15° 47′ South	34° 53′ West	08° 04′ South
43° 13′ West	22° 55′ South	60° 02′ West	03° 06′ South
46° 38′ West	23° 33′ South	38° 31′ West	12° 56′ South
51° 13′ West	30° 02′ South	49° 15′ West	16° 40′ South

Such operation shall not cause more interference nor require more protection than the assignment under the Plan.

9/GR . . . This assignment is part of a group, the number of which follows the symbol. The group consists of the beams and has the number of channels assigned to it as indicated in Table 1 below.

a) The overall equivalent protection margin to be used for the application of Article 4 and Resolution **42 (Rev.WRC-19)** shall be calculated on the following basis:

– for the calculation of interference to assignments that are part of a group, only the interference contributions from assignments that are not part of the same group are to be included; and

– for the calculation of interference from assignments belonging to a group to assignments that are not part of that same group, only the worst interference contribution from that group shall be used on a test point to test point basis. (WRC-03)

b) If an administration notifies the same frequency in more than one beam of a group for use at the same time, the aggregated *C*/*I* produced by all emissions from that group shall not exceed the *C*/*I* calculated on the basis of *a)* above.

10 This assignment shall be brought into use only when the limits given in Table 2 are not exceeded or with the agreement of the affected administration identified in Table 3.

These administrations shall be informed by the notifying administration of changes in characteristics before these beams are brought into use.

TABLE 1

Group	Beams in the group	Number of channels assigned to the group
GR1	ALS00002 HWA00002 USAPSA02	32 channels
GR2	ALS00003 HWA00003 USAPSA03	32 channels
GR3	ARGINSU4 ARGSUR04	16 channels
GR4	ARGINSU5 ARGSUR05	12 channels
GR5	BOLAND01 CLMAND01 EQACAND1 EQAGAND1 PRUAND02 VENAND03	16 channels
GR6	B SU111 B SU211	32 channels
GR7	B CE311 B CE411 B CE511	32 channels
GR8	B NO611 B NO711 B NO811	32 channels
GR9	B SU112 B SU212 B CE312 B CE412	32 channels
GR10	CAN01101 CAN01201	32 channels
GR11	*Not used*	
GR12	CAN01203 CAN01303 CAN01403	32 channels
GR13	CAN01304 CAN01404 CAN01504	32 channels
GR14	CAN01405 CAN01505 CAN01605	32 channels
GR15	*Not used*	
GR16	CHLCONT4 CHLCONT6	16 channels
GR17	CHLCONT5 PAQPAC01 CHLPAC02	16 channels
GR18	CRBBER01 CRBBLZ01 CRBJMC01 CRBBAH01 CRBECO01	16 channels
GR19	EQACOO01 EQAGOO01	16 channels
GR20	PTRVIR01 USAEHO02	32 channels
GR21	PTRVIR02 USAEHO03	32 channels
GR22	VEN02VEN VEN11VEN	4 channels

TABLE 2

Applicable criteria

Symbol	pfd limit criteria
a	§ 3, Annex 1
b	§ 5 *b)*, Annex 1
c	§ 5 *c)*, Annex 1
d	§ 5 *d)*, Annex 1

Note – Section 5 of Annex 1 was merged with Section 4 by WRC-2000. See also the Note to Table 3. (WRC-2000)

11 This assignment shall be brought into use only when the e.i.r.p. in the direction of all points situated within the service area and within the −3 dB contour of the "Metropole" beam (space-to-Earth) in the VIDEOSAT-3 network as described in ex-IFRB Special Section AR11/C/766 to BR IFIC No. 1678 of 2 July 1985 does not exceed the limit 26.8 dBW.

12 This assignment shall be brought into use only when the e.i.r.p. in the direction of all points situated within the service area and within the −3 dB contour of the "Metropole" beam (space-to-Earth) in the VIDEOSAT-3 network as described in ex-IFRB Special Section AR11/C/766 to Weekly Circular No. 1678 of 2 July 1985 does not exceed the limit 26.8 dBW, and when the e.i.r.p. in the direction of all points situated within the service area and also between the −3 dB and −6 dB contours of the same beam does not exceed the limit 29.5 dBW.

TABLE 3

Beam name	Channels	Limit criteria ref. Table 2	Countries or geographical areas affected*
ALS00002	1, 4, 5, 6, 9, 10, 11, 14, 15, 16 All channels For channels 20 to 32	a c d	URS MNG/URS URS
ALS00003	1, 4, 5, 6, 9, 10, 11, 14, 15, 16 All channels For channels 20 to 32	a c d	URS URS URS
ARGINSU5	3, 7, 11, 15, 17, 19	b	NOR
ARGNORT4	2, 4, 6, 8, 10, 12, 14, 16, 18, 20	b	AOE/ASC/AZR/CPV/E/GMB/GNB/GUI/MRC/MTN/POR/SEN
ARGNORT5	2, 4, 6, 8, 10, 12, 14, 16, 18, 20	b	AFS/AGL/BOT/NMB/NOR/OCE/PTC/TKL/COD/ZMB/ZWE
ARGSUR04	1, 3, 5, 7, 9, 11, 13, 15, 17, 19	b	ASC
ARGSUR05	3, 7, 11, 15, 17, 19	b	NOR
B CE311	For channels 1 to 20	b	AGL/ALG/CAF/CME/COG/GAB/GNE/NGR/NIG/NMB/STP/TCD/COD
B CE312	For channels 1 to 20 For channels 1 to 20 All channels	b c c	AFS/BDI/BOT/LSO/RRW/TZA/UGA/ZMB/ZWE MOZ/MWI/TZA ETH/KEN/SDN
B CE411	For channels 1 to 20	b	AGL/ALG/CAF/CME/COG/CVA/E/GAB/GNE/I/LBY/MLT/NGR/NIG/SMR/STP/TCD/TUN/COD
B CE412	For channels 1 to 20 All channels	c c	CYP/TUR ARS/EGY/ISR/SDN/URS
B CE511	For channels 1 to 20	b	CAF/CME/COG/GAB/GNE/NIG/NMB/NOR/STP/COD
B NO611	For channels 1 to 20	b	BEN/GHA/TGO
B NO711	For channels 1 to 20	b	BEN
B SE911	2, 4, 6, 8, 10, 12, 14, 16, 18, 20	b	CPV

* *Note by the Secretariat*: This Table was not modified by WRC-97. As such, the references to ETH, TCH, URS and YUG in this column refer to the countries or geographical areas described by these symbols when the Plan was established.

TABLE 3 (*continued*)

Beam name	Channels	Limit criteria ref. Table 2	Countries or geographical areas affected*
B SU111	For channels 1 to 20	b	BFA/CTI/GHA/GUI/LBR/MTN/SHN/TRC
B SU211	For channels 1 to 20	b	ALG/BFA/CTI/GHA/GUI/LBR/MLI/MRC/MTN/SHN/TRC
BERBER02	1, 5, 17 5, 9, 13	a a	CNR/E ISL
BOL00001	3, 7, 11, 15, 19	b	ALG/AOE/ASC/E/GMB/GNB/GUI/LBR/MLI/MRC/MTN/POR/SEN/SRL/TRC
CAN01101	All channels For channels 20 to 32	c d	URS URS
CAN01201	All channels	c	URS
CAN01203	All channels	c	URS
CAN01303	All channels	c	URS
CAN01403	All channels	c	URS
CAN01404	For channels 1 to 20	b	ISL/POR
CAN01405	For channels 1 to 20	b	F/G/IRL/ISL
CAN01504	For channels 1 to 20	b	AOE/AZR/E/ISL/MRC/MTN/POR
CAN01505	For channels 1 to 20	b	ALG/E/F/G/IRL/ISL/MRC/POR
CAN01605	For channels 1 to 20	b	E/F/G/IRL/ISL/MRC/POR
CAN01606	For channels 1 to 20	b	BEL/F/G/HOL/IRL/ISL/LUX/NOR
CLMAND01	21, 23, 25, 27, 29, 31	c	URS
CLM00001	1, 3, 5, 7, 9, 11, 13, 15, 17, 19 21, 23, 25, 27, 29, 31	b c	AZR/CPV URS
CRBEC001	2, 4, 6, 8, 10, 12, 14, 16, 18, 20	b	ASC/AZR/GMB/GNB/GUI/ISL/MTN/SEN/SRL
FLKANT01	1, 5, 9, 13	b	NOR
GRLDNK01	3, 7, 11, 15, 19	b	D/DNK/G/HOL/ISL/NOR/POL/S/TCH
GUFMGG02	4, 8, 12, 16, 20	b	NOR
HWA00002	For channels 1 to 20 All channels	b c	CHN/KRE MNG/URS
HWA00003	For channels 1 to 20 All channels	b c	CHN MNG/URS
MEX02NTE	All channels	c	URS
MEX01SUR	1, 3, 5, 7, 9, 11, 13, 15, 17, 19	b	KIR

TABLE 3 (*end*)

Beam name	Channels	Limit criteria ref. Table 2	Countries or geographical areas affected*
MEX02SUR	All channels	c	URS
PRU00004	2, 4, 6, 8, 10, 12, 14, 16, 18, 20	b	ALG/AOE/ASC/BFA/CTI/E/G/GMB/ GUI/ISL/LBR/MLI/MRC/MTN/POR/ SEN/SHN/SRL/TRC
SPMFRAN3	1, 5, 9, 13, 17	b	D/DNK/ISL/NOR/S
USAEH001	For channels 1 to 20	b	ALG/AUT/BEL/CVA/D/DNK/E/F/G/ HOL/I/ISL/LBY/LIE/LUX/MCO/MLT/ NGR/NIG/NOR/OCE/SMR/SUI/TCH/ TUN/YUG
USAEH002	For channels 1 to 20 All channels	b c	AZR/CPV/HWL URS
USAEH003	For channels 1 to 20 All channels	b c	MHL URS
USAEH004	For channels 1 to 20 All channels For channels 20 to 32	b c d	WAK URS URS
USAWH101	All channels	c	URS
USAWH102	All channels	c	URS
VENAND03	21, 23, 25, 27, 29, 31	c	URS
VEN11VEN	2, 4, 6, 8, 10, 12, 14, 16, 18, 20 20, 22, 24, 26, 28, 30, 32	b c	AZR/CPV URS

Note – The administrations listed in Table 3 were identified on the basis of the criteria adopted at the Regional Administrative Conference for the Planning of the Broadcasting-satellite Service in Region 2 (Geneva, 1983) (RARC Sat-R2), as shown in Table 2. WRC-2000 and WRC-03 revised the criteria applicable to determine affected administrations. Therefore, the Bureau, when receiving a notification for an assignment in the Region 2 Plan, shall determine which countries are affected on the basis of the revised criteria adopted by WRC-03, which may lead to a different set of affected administration(s) from that currently contained in Table 3. (WRC-07)

Country symbols

1 For the explanation of symbols designating countries or geographical areas in Region 2, see the Preface to the BR IFIC.

2 One additional symbol, CRB, has been created for the purposes of the 1983 Conference only, to designate to geographical area in the Caribbean Area. The five Caribbean beams are identified as follows:

CRBBAH01, CRBBER01, CRBBLZ01, CRBEC001 and CRBJMC01

and are intended collectively to provide coverage for the following countries or geographical areas: AIA, ATG, BAH, BER, BLZ, BRB, CYM, DMA, GRD, GUY, JMC, LCA, MSR, KNA, SUR, TCA, TRD, VCT and VRG to be so used if approved by them.

TABLE 4

Table showing correspondence between channel numbers and assigned frequencies

Channel No.	Assigned frequency (MHz)	Channel No.	Assigned frequency (MHz)
1	12 224.00	17	12 457.28
2	12 238.58	18	12 471.86
3	12 253.16	19	12 486.44
4	12 267.74	20	12 501.02
5	12 282.32	21	12 515.60
6	12 296.90	22	12 530.18
7	12 311.48	23	12 544.76
8	12 326.06	24	12 559.34
9	12 340.64	25	12 573.92
10	12 355.22	26	12 588.50
11	12 369.80	27	12 603.08
12	12 384.38	28	12 617.66
13	12 398.96	29	12 632.24
14	12 413.54	30	12 646.82
15	12 428.12	31	12 661.40
16	12 442.70	32	12 675.98

12 224.00 MHz (1)

1	2	3	4		5		6	7	8	9	
ALS00002	−166.20	1	−149.66	58.37	3.76	1.24	170	1	59.7	9/GR1	10
ALS00003	−175.20	1	−150.98	58.53	3.77	1.11	167	1	60.0	9/GR2	10
ARGINSU4	−94.20	1	−52.98	−59.81	3.40	0.80	19	1	59.9	9/GR3	
ARGSUR04	−94.20	1	−65.04	−43.33	3.32	1.50	40	1	60.7	9/GR3	10
B CE311	−64.20	1	−40.60	−6.07	3.04	2.06	174	1	61.6	8 9/GR7	10
B CE312	−45.20	1	−40.27	−6.06	3.44	2.09	174	1	61.0	8 9/GR9	10
B CE411	−64.20	1	−50.97	−15.27	3.86	1.38	49	1	62.6	8 9/GR7	10
B CE412	−45.20	1	−50.71	−15.30	3.57	1.56	52	1	62.7	8 9/GR9	10
B CE511	−64.20	1	−53.10	−2.90	2.44	2.13	104	1	63.0	8 9/GR7	10
B NO611	−74.20	1	−59.60	−11.62	2.85	1.69	165	2	62.8	8 9/GR8	10
B NO711	−74.20	1	−60.70	−1.78	3.54	1.78	126	2	62.8	8 9/GR8	10
B NO811	−74.20	1	−68.76	−4.71	2.37	1.65	73	2	62.8	8 9/GR8	
B SU111	−81.20	1	−51.12	−25.63	2.76	1.05	50	1	62.8	8 9/GR6	10
B SU112	−45.20	1	−50.75	−25.62	2.47	1.48	56	1	62.2	8 9/GR9	
B SU211	−81.20	1	−44.51	−16.95	3.22	1.36	60	1	62.5	8 9/GR6	10
B SU212	−45.20	1	−44.00	−16.87	3.20	1.96	58	1	61.3	8 9/GR9	
BAHIFRB1	−87.20	1	−76.06	24.16	1.81	0.80	142	1	61.6		
BERBERMU	−96.20	1	−64.77	32.32	0.80	0.80	90	2	56.8		
BERBER02	−31.00	1	−64.77	32.32	0.80	0.80	90	1	56.9	2	10
BOLAND01	−115.20	1	−65.04	−16.76	2.49	1.27	76	1	67.9	9/GR5	
CAN01101	−138.20	1	−125.63	57.24	3.45	1.27	157	1	59.5	9/GR10	10
CAN01201	−138.20	1	−112.04	55.95	3.35	0.97	151	1	59.6	9/GR10	10
CAN01202	−72.70	1	−107.70	55.63	2.74	1.12	32	1	59.6		
CAN01203	−129.20	1	−111.48	55.61	3.08	1.15	151	1	59.5	9/GR12	10
CAN01303	−129.20	1	−102.42	57.12	3.54	0.91	154	1	60.0	9/GR12	10
CAN01304	−91.20	1	−99.12	57.36	1.98	1.72	2	1	59.8	9/GR13	
CAN01403	−129.20	1	−89.75	52.02	4.68	0.80	148	1	61.8	9/GR12	10
CAN01404	−91.20	1	−84.82	52.42	3.10	2.05	152	1	60.4	9/GR13	10
CAN01405	−82.20	1	−84.00	52.39	2.84	2.29	172	1	60.3	9/GR14	10
CAN01504	−91.20	1	−72.66	53.77	3.57	1.67	156	1	60.2	9/GR13	10
CAN01505	−82.20	1	−71.77	53.79	3.30	1.89	162	1	60.1	9/GR14	10
CAN01605	−82.20	1	−61.50	49.55	2.65	1.40	143	1	60.3	9/GR14	10
CAN01606	−70.70	1	−61.30	49.55	2.40	1.65	148	1	60.2	10	
CHLCONT5	−106.20	1	−72.23	−35.57	2.60	0.80	55	1	59.4	9/GR17	
CHLPAC02	−106.20	1	−80.06	−30.06	1.36	0.80	69	1	59.2	9/GR17	
CLMAND01	−115.20	1	−74.72	5.93	3.85	1.63	114	1	64.9	9/GR5	
CLM00001	−103.20	1	−74.50	5.87	3.98	1.96	118	1	63.5	10	
EQACAND1	−115.20	1	−78.40	−1.61	1.37	0.95	75	1	64.0	9/GR5	
EQAGAND1	−115.20	1	−90.34	−0.62	0.90	0.81	89	1	61.3	9/GR5	
FLKANT01	−57.20	1	−44.54	−60.13	3.54	0.80	12	1	59.3	2	10
FLKFALKS	−31.00	1	−59.90	−51.64	0.80	0.80	90	1	58.1	2	
GRD00002	−42.20	1	−61.58	12.29	0.80	0.80	90	1	58.8		
HWA00002	−166.20	1	−165.79	23.42	4.20	0.80	160	1	58.8	9/GR1	10
HWA00003	−175.20	1	−166.10	23.42	4.25	0.80	159	1	58.8	9/GR2	10
MEX01NTE	−78.20	1	−105.81	26.01	2.89	2.08	155	1	60.5	1	
MEX01SUR	−69.20	1	−94.84	19.82	3.05	2.09	4	1	62.2	1	10
MEX02NTE	−136.20	1	−107.21	26.31	3.84	1.55	148	1	61.2	1	10
MEX02SUR	−127.20	1	−96.39	19.88	3.18	1.87	157	1	62.5	1	10
PAQPAC01	−106.20	1	−109.18	−27.53	0.80	0.80	90	1	56.2	9/GR17	
PRG00002	−99.20	1	−58.66	−23.32	1.45	1.04	76	1	60.2		
PRUAND02	−115.20	1	−74.69	−8.39	3.41	1.79	95	1	63.9	9/GR5	
PTRVIR01	−101.20	1	−65.85	18.12	0.80	0.80	90	1	60.5	1 6 9/GR20	
PTRVIR02	−110.20	1	−65.86	18.12	0.80	0.80	90	1	61.0	1 6 9/GR21	
SPMFRAN3	−53.20	1	−67.24	47.51	3.16	0.80	7	1	60.4	2 7	10
TRD00001	−84.70	1	−61.23	10.70	0.80	0.80	90	1	59.4		
URG00001	−71.70	1	−56.22	−32.52	1.02	0.89	11	1	60.0		
USAEH001	−61.70	1	−85.19	36.21	5.63	3.33	22	1	61.8	1 5 6	10
USAEH002	−101.20	1	−89.24	36.16	5.67	3.76	170	1	61.7	1 6 9/GR20	10
USAEH003	−110.20	1	−90.14	36.11	5.55	3.55	161	1	62.0	1 6 9/GR21	10
USAEH004	−119.20	1	−91.16	36.05	5.38	3.24	152	1	62.6	1 5 6	10
USAPSA02	−166.20	1	−117.80	40.58	4.03	0.82	135	1	63.2	9/GR1	
USAPSA03	−175.20	1	−118.27	40.12	3.62	0.80	136	1	65.0	9/GR2	
USAWH101	−148.20	1	−109.65	38.13	5.53	1.95	142	1	62.1	10	
USAWH102	−157.20	1	−111.41	38.57	5.51	1.54	138	1	63.2	10	
VENAND03	−115.20	1	−67.04	6.91	2.37	1.43	111	1	67.2	9/GR5	
VRG00001	−79.70	1	−64.37	18.48	0.80	0.80	90	1	58.3	4	

12 238.58 MHz (2)

1	2	3	4		5		6	7	8	9	
ALS00002	−165.80	2	−149.63	58.52	3.81	1.23	171	2	59.7	9/GR1	10
ALS00003	−174.80	2	−150.95	58.54	3.77	1.11	167	2	60.0	9/GR2	10
ARGNORT4	−93.80	2	−63.96	−30.01	3.86	1.99	48	2	65.6	10	
ARGNORT5	−54.80	2	−62.85	−29.80	3.24	2.89	47	2	63.5	10	
ATNBEAM1	−52.80	2	−66.44	14.87	1.83	0.80	39	2	61.0		
B CE311	−63.80	2	−40.60	−6.07	3.04	2.06	174	2	61.6	8 9/GR7	10
B CE312	−44.80	2	−40.26	−6.06	3.44	2.09	174	2	61.0	8 9/GR9	10
B CE411	−63.80	2	−50.97	−15.26	3.86	1.38	49	2	62.6	8 9/GR7	10
B CE412	−44.80	2	−50.71	−15.30	3.57	1.56	52	2	62.7	8 9/GR9	10
B CE511	−63.80	2	−53.11	−2.98	2.42	2.15	107	2	63.1	8 9/GR7	10
B NO611	−73.80	2	−59.60	−11.62	2.86	1.69	165	1	62.8	8 9/GR8	10
B NO711	−73.80	2	−60.70	−1.78	3.54	1.78	126	1	62.8	8 9/GR8	10
B NO811	−73.80	2	−68.75	−4.71	2.37	1.65	73	1	62.8	8 9/GR8	
B SE911	−101.80	2	−45.99	−19.09	2.22	0.80	62	2	65.3	8	10
B SU111	−80.80	2	−51.10	−25.64	2.76	1.06	50	2	62.8	8 9/GR6	10
B SU112	−44.80	2	−50.76	−25.62	2.47	1.48	56	2	62.3	8 9/GR9	
B SU211	−80.80	2	−44.51	−16.94	3.22	1.37	60	2	62.5	8 9/GR6	10
B SU212	−44.80	2	−43.99	−16.97	3.27	1.92	59	2	61.3	8 9/GR9	
CAN01101	−137.80	2	−125.60	57.24	3.45	1.27	157	2	59.5	9/GR10	10
CAN01201	−137.80	2	−111.92	55.89	3.33	0.98	151	2	59.6	9/GR10	10
CAN01202	−72.30	2	−107.64	55.62	2.75	1.11	32	2	59.6		
CAN01203	−128.80	2	−111.43	55.56	3.07	1.15	151	2	59.5	9/GR12	10
CAN01303	−128.80	2	−102.39	57.12	3.54	0.92	154	2	60.0	9/GR12	10
CAN01304	−90.80	2	−99.00	57.33	1.96	1.73	1	2	59.8	9/GR13	
CAN01403	−128.80	2	−89.70	52.02	4.67	0.80	148	2	61.8	9/GR12	10
CAN01404	−90.80	2	−84.78	52.41	3.09	2.06	153	2	60.4	9/GR13	10
CAN01405	−81.80	2	−84.02	52.34	2.82	2.30	172	2	60.3	9/GR14	10
CAN01504	−90.80	2	−72.68	53.78	3.57	1.67	157	2	60.2	9/GR13	10
CAN01505	−81.80	2	−71.76	53.76	3.30	1.89	162	2	60.1	9/GR14	10
CAN01605	−81.80	2	−61.54	49.50	2.66	1.39	144	2	60.3	9/GR14	10
CAN01606	−70.30	2	−61.32	49.51	2.41	1.65	148	2	60.2	10	
CHLCONT4	−105.80	2	−69.59	−23.20	2.21	0.80	68	2	59.1	9/GR16	
CHLCONT6	−105.80	2	−73.52	−55.52	3.65	1.31	39	2	59.6	9/GR16	
CRBBAH01	−92.30	2	−76.09	24.13	1.83	0.80	141	1	61.7	9/GR18	
CRBBER01	−92.30	2	−64.76	32.13	0.80	0.80	90	1	56.7	9/GR18	
CRBBLZ01	−92.30	2	−88.61	17.26	0.80	0.80	90	1	58.6	9/GR18	
CRBEC001	−92.30	2	−60.07	8.26	4.20	0.86	115	1	64.2	9/GR18	10
CRBJMC01	−92.30	2	−79.45	17.97	0.99	0.80	151	1	61.1	9/GR18	
CTR00201	−130.80	2	−84.33	9.67	0.82	0.80	119	2	65.6		
EQAC0001	−94.80	2	−78.31	−1.52	1.48	1.15	65	1	63.0	9/GR19	
EQAG0001	−94.80	2	−90.36	−0.57	0.94	0.89	99	1	61.0	9/GR19	
GUY00302	−33.80	2	−59.07	4.77	1.43	0.85	91	2	63.5		
HNDIFRB2	−107.30	2	−86.23	15.16	1.14	0.85	8	1	63.4		
HTI00002	−83.30	2	−73.28	18.96	0.82	0.80	11	2	60.9		
HWA00002	−165.80	2	−165.79	23.32	4.20	0.80	160	2	58.8	9/GR1	10
HWA00003	−174.80	2	−166.10	23.42	4.25	0.80	159	2	58.8	9/GR2	10
MEX01NTE	−77.80	2	−105.80	25.99	2.88	2.07	155	2	60.5	1	
MEX02NTE	−135.80	2	−107.36	26.32	3.80	1.57	149	2	61.2	1	10
MEX02SUR	−126.80	2	−96.39	19.88	3.19	1.87	158	2	62.5	1	10
PRU00004	−85.80	2	−74.19	−8.39	3.74	2.45	112	2	62.8	10	
PTRVIR01	−100.80	2	−65.85	18.12	0.80	0.80	90	2	60.6	1 6 9/GR20	
PTRVIR02	−109.80	2	−65.85	18.12	0.80	0.80	90	2	61.1	1 6 9/GR21	
TCA00001	−115.80	2	−71.79	21.53	0.80	0.80	90	2	60.4		
USAEH001	−61.30	2	−85.16	36.21	5.63	3.32	22	2	61.8	1 5 6	10
USAEH002	−100.80	2	−89.28	36.16	5.65	3.78	170	2	61.7	1 6 9/GR20	10
USAEH003	−109.80	2	−90.12	36.11	5.55	3.56	161	2	62.1	1 6 9/GR21	10
USAEH004	−118.80	2	−91.16	36.05	5.38	3.24	153	2	62.6	1 5 6	10
USAPSA02	−165.80	2	−117.79	40.58	4.04	0.82	135	2	63.2	9/GR1	
USAPSA03	−174.80	2	−118.20	40.15	3.63	0.80	136	2	64.9	9/GR2	
USAWH101	−147.80	2	−109.70	38.13	5.52	1.96	142	2	62.1	10	
USAWH102	−156.80	2	−111.40	38.57	5.51	1.55	138	2	63.2	10	
VCT00001	−79.30	2	−61.18	13.23	0.80	0.80	90	2	58.4		
VEN11VEN	−103.80	2	−66.79	6.90	2.50	1.77	122	2	65.1	10	

12 253.16 MHz (3)

1	2	3	4		5		6	7	8	9	
ALS00002	−166.20	3	−149.66	58.37	3.76	1.24	170	1	59.8	9/GR1	10
ALS00003	−175.20	3	−150.98	58.53	3.77	1.11	167	1	60.0	9/GR2	10
ARGINSU4	−94.20	3	−52.98	−59.81	3.40	0.80	19	1	59.9	9/GR3	
ARGINSU5	−55.20	3	−44.17	−59.91	3.77	0.80	13	1	59.3	9/GR4	10
ARGSUR04	−94.20	3	−65.04	−43.33	3.32	1.50	40	1	60.7	9/GR3	10
ARGSUR05	−55.20	3	−63.68	−43.01	2.54	2.38	152	1	60.1	9/GR4	10
ATGSJN01	−79.70	3	−61.79	17.07	0.80	0.80	90	1	58.4		
B CE311	−64.20	3	−40.60	−6.07	3.04	2.06	174	1	61.6	8 9/GR7	10
B CE312	−45.20	3	−40.27	−6.06	3.44	2.09	174	1	61.0	8 9/GR9	10
B CE411	−64.20	3	−50.97	−15.27	3.86	1.38	49	1	62.6	8 9/GR7	10
B CE412	−45.20	3	−50.71	−15.30	3.57	1.56	52	1	62.7	8 9/GR9	10
B CE511	−64.20	3	−53.10	−2.90	2.44	2.13	104	1	63.1	8 9/GR7	10
B NO611	−74.20	3	−59.60	−11.62	2.85	1.69	165	2	62.9	8 9/GR8	10
B NO711	−74.20	3	−60.70	−1.78	3.54	1.78	126	2	62.8	8 9/GR8	10
B NO811	−74.20	3	−68.76	−4.71	2.37	1.65	73	2	62.8	8 9/GR8	
B SU111	−81.20	3	−51.12	−25.63	2.76	1.05	50	1	62.9	8 9/GR6	10
B SU112	−45.20	3	−50.75	−25.62	2.47	1.48	56	1	62.3	8 9/GR9	
B SU211	−81.20	3	−44.51	−16.95	3.22	1.36	60	1	62.5	8 9/GR6	10
B SU212	−45.20	3	−44.00	−16.87	3.20	1.96	58	1	61.3	8 9/GR9	
BERBERMU	−96.20	3	−64.77	32.32	0.80	0.80	90	2	56.8		
BOLAND01	−115.20	3	−65.04	−16.76	2.49	1.27	76	1	67.9	9/GR5	
BOL00001	−87.20	3	−64.61	−16.71	2.52	2.19	85	1	63.8	10	
BRB00001	−92.70	3	−59.85	12.93	0.80	0.80	90	2	59.1		
CAN01101	−138.20	3	−125.63	57.24	3.45	1.27	157	1	59.5	9/GR10	10
CAN01201	−138.20	3	−112.04	55.95	3.35	0.97	151	1	59.6	9/GR10	10
CAN01202	−72.70	3	−107.70	55.63	2.74	1.12	32	1	59.6		
CAN01203	−129.20	3	−111.48	55.61	3.08	1.15	151	1	59.5	9/GR12	10
CAN01303	−129.20	3	−102.42	57.12	3.54	0.91	154	1	60.1	9/GR12	10
CAN01304	−91.20	3	−99.12	57.36	1.98	1.72	2	1	59.8	9/GR13	
CAN01403	−129.20	3	−89.75	52.02	4.68	0.80	148	1	61.8	9/GR12	10
CAN01404	−91.20	3	−84.82	52.42	3.10	2.05	152	1	60.4	9/GR13	10
CAN01405	−82.20	3	−84.00	52.39	2.84	2.29	172	1	60.3	9/GR14	10
CAN01504	−91.20	3	−72.66	53.77	3.57	1.67	156	1	60.2	9/GR13	10
CAN01505	−82.20	3	−71.77	53.79	3.30	1.89	162	1	60.1	9/GR14	10
CAN01605	−82.20	3	−61.50	49.55	2.65	1.40	143	1	60.3	9/GR14	10
CAN01606	−70.70	3	−61.30	49.55	2.40	1.65	148	1	60.2	10	
CHLCONT5	−106.20	3	−72.23	−35.57	2.60	0.80	55	1	59.4	9/GR17	
CHLPAC02	−106.20	3	−80.06	−30.06	1.36	0.80	69	1	59.2	9/GR17	
CLMAND01	−115.20	3	−74.72	5.93	3.85	1.63	114	1	65.0	9/GR5	
CLM00001	−103.20	3	−74.50	5.87	3.98	1.96	118	1	63.6	10	
CUB00001	−89.20	3	−79.81	21.62	2.24	0.80	168	1	61.1		
EQACAND1	−115.20	3	−78.40	−1.61	1.37	0.95	75	1	64.1	9/GR5	
EQAGAND1	−115.20	3	−90.34	−0.62	0.90	0.81	89	1	61.3	9/GR5	
GRD00002	−42.20	3	−61.58	12.29	0.80	0.80	90	1	58.8		
GRD00059	−57.20	3	−61.58	12.29	0.80	0.80	90	1	58.5		
GRLDNK01	−53.20	3	−44.89	66.56	2.70	0.82	173	1	60.0	2	10
HWA00002	−166.20	3	−165.79	23.42	4.20	0.80	160	1	58.8	9/GR1	10
HWA00003	−175.20	3	−166.10	23.42	4.25	0.80	159	1	58.8	9/GR2	10
MEX01NTE	−78.20	3	−105.81	26.01	2.89	2.08	155	1	60.5	1	
MEX01SUR	−69.20	3	−94.84	19.82	3.05	2.09	4	1	62.3	1	10
MEX02NTE	−136.20	3	−107.21	26.31	3.84	1.55	148	1	61.2	1	10
MEX02SUR	−127.20	3	−96.39	19.88	3.18	1.87	157	1	62.6	1	10
PAQPAC01	−106.20	3	−109.18	−27.53	0.80	0.80	90	1	56.2	9/GR17	
PRG00002	−99.20	3	−58.66	−23.32	1.45	1.04	76	1	60.2		
PRUAND02	−115.20	3	−74.69	−8.39	3.41	1.79	95	1	64.0	9/GR5	
PTRVIR01	−101.20	3	−65.85	18.12	0.80	0.80	90	1	60.6	1 6 9/GR20	
PTRVIR02	−110.20	3	−65.86	18.12	0.80	0.80	90	1	61.0	1 6 9/GR21	
SURINAM2	−84.70	3	−55.69	4.35	1.00	0.80	86	1	63.2		
URG00001	−71.70	3	−56.22	−32.52	1.02	0.89	11	1	60.0		
USAEH001	−61.70	3	−85.19	36.21	5.63	3.33	22	1	61.8	1 5 6	10
USAEH002	−101.20	3	−89.24	36.16	5.67	3.76	170	1	61.7	1 6 9/GR20	10
USAEH003	−110.20	3	−90.14	36.11	5.55	3.55	161	1	62.1	1 6 9/GR21	10
USAEH004	−119.20	3	−91.16	36.05	5.38	3.24	152	1	62.6	1 5 6	10
USAPSA02	−166.20	3	−117.80	40.58	4.03	0.82	135	1	63.3	9/GR1	
USAPSA03	−175.20	3	−118.27	40.12	3.62	0.80	136	1	65.0	9/GR2	
USAWH101	−148.20	3	−109.65	38.13	5.53	1.95	142	1	62.1	10	
USAWH102	−157.20	3	−111.41	38.57	5.51	1.54	138	1	63.2	10	
VENAND03	−115.20	3	−67.04	6.91	2.37	1.43	111	1	67.3	9/GR5	

12 267.74 MHz (4)

1	2	3	4		5		6	7	8	9	
ALS00002	−165.80	4	−149.63	58.52	3.81	1.23	171	2	59.8	9/GR1	10
ALS00003	−174.80	4	−150.95	58.54	3.77	1.11	167	2	60.0	9/GR2	10
ARGNORT4	−93.80	4	−63.96	−30.01	3.86	1.99	48	2	65.7	10	
ARGNORT5	−54.80	4	−62.85	−29.80	3.24	2.89	47	2	63.5	10	
B CE311	−63.80	4	−40.60	−6.07	3.04	2.06	174	2	61.6	8 9/GR7	10
B CE312	−44.80	4	−40.26	−6.06	3.44	2.09	174	2	61.0	8 9/GR9	10
B CE411	−63.80	4	−50.97	−15.26	3.86	1.38	49	2	62.6	8 9/GR7	10
B CE412	−44.80	4	−50.71	−15.30	3.57	1.56	52	2	62.8	8 9/GR9	10
B CE511	−63.80	4	−53.11	−2.98	2.42	2.15	107	2	63.1	8 9/GR7	10
B NO611	−73.80	4	−59.60	−11.62	2.86	1.69	165	1	62.9	8 9/GR8	10
B NO711	−73.80	4	−60.70	−1.78	3.54	1.78	126	1	62.8	8 9/GR8	10
B NO811	−73.80	4	−68.75	−4.71	2.37	1.65	73	1	62.8	8 9/GR8	
B SE911	−101.80	4	−45.99	−19.09	2.22	0.80	62	2	65.3	8	10
B SU111	−80.80	4	−51.10	−25.64	2.76	1.06	50	2	62.9	8 9/GR6	10
B SU112	−44.80	4	−50.76	−25.62	2.47	1.48	56	2	62.3	8 9/GR9	
B SU211	−80.80	4	−44.51	−16.94	3.22	1.37	60	2	62.5	8 9/GR6	10
B SU212	−44.80	4	−43.99	−16.97	3.27	1.92	59	2	61.3	8 9/GR9	
CAN01101	−137.80	4	−125.60	57.24	3.45	1.27	157	2	59.5	9/GR10	10
CAN01201	−137.80	4	−111.92	55.89	3.33	0.98	151	2	59.6	9/GR10	10
CAN01202	−72.30	4	−107.64	55.62	2.75	1.11	32	2	59.6		
CAN01203	−128.80	4	−111.43	55.56	3.07	1.15	151	2	59.5	9/GR12	10
CAN01303	−128.80	4	−102.39	57.12	3.54	0.92	154	2	60.1	9/GR12	10
CAN01304	−90.80	4	−99.00	57.33	1.96	1.73	1	2	59.8	9/GR13	
CAN01403	−128.80	4	−89.70	52.02	4.67	0.80	148	2	61.8	9/GR12	10
CAN01404	−90.80	4	−84.78	52.41	3.09	2.06	153	2	60.4	9/GR13	10
CAN01405	−81.80	4	−84.02	52.34	2.82	2.30	172	2	60.3	9/GR14	10
CAN01504	−90.80	4	−72.68	53.78	3.57	1.67	157	2	60.2	9/GR13	10
CAN01505	−81.80	4	−71.76	53.76	3.30	1.89	162	2	60.2	9/GR14	10
CAN01605	−81.80	4	−61.54	49.50	2.66	1.39	144	2	60.3	9/GR14	10
CAN01606	−70.30	4	−61.32	49.51	2.41	1.65	148	2	60.2	10	
CHLCONT4	−105.80	4	−69.59	−23.20	2.21	0.80	68	2	59.1	9/GR16	
CHLCONT6	−105.80	4	−73.52	−55.52	3.65	1.31	39	2	59.6	9/GR16	
CRBBAH01	−92.30	4	−76.09	24.13	1.83	0.80	141	1	61.7	9/GR18	
CRBBER01	−92.30	4	−64.76	32.13	0.80	0.80	90	1	56.8	9/GR18	
CRBBLZ01	−92.30	4	−88.61	17.26	0.80	0.80	90	1	58.7	9/GR18	
CRBEC001	−92.30	4	−60.07	8.26	4.20	0.86	115	1	64.3	9/GR18	10
CRBJMC01	−92.30	4	−79.45	17.97	0.99	0.80	151	1	61.1	9/GR18	
CYM00001	−115.80	4	−80.58	19.57	0.80	0.80	90	2	59.6		
DOMIFRB2	−83.30	4	−70.51	18.79	0.98	0.80	167	2	61.1		
EQAC0001	−94.80	4	−78.31	−1.52	1.48	1.15	65	1	63.0	9/GR19	
EQAG0001	−94.80	4	−90.36	−0.57	0.94	0.89	99	1	61.0	9/GR19	
GUFMGG02	−52.80	4	−56.42	8.47	4.16	0.81	123	2	62.7	2 7	10
HWA00002	−165.80	4	−165.79	23.32	4.20	0.80	160	2	58.8	9/GR1	10
HWA00003	−174.80	4	−166.10	23.42	4.25	0.80	159	2	58.8	9/GR2	10
JMC00005	−33.80	4	−77.27	18.12	0.80	0.80	90	2	60.6		
LCAIFRB1	−79.30	4	−61.15	13.90	0.80	0.80	90	2	58.4		
MEX01NTE	−77.80	4	−105.80	25.99	2.88	2.07	155	2	60.5	1	
MEX02NTE	−135.80	4	−107.36	26.32	3.80	1.57	149	2	61.2	1	10
MEX02SUR	−126.80	4	−96.39	19.88	3.19	1.87	158	2	62.5	1	10
PRU00004	−85.80	4	−74.19	−8.39	3.74	2.45	112	2	62.9	10	
PTRVIR01	−100.80	4	−65.85	18.12	0.80	0.80	90	2	60.6	1 6 9/GR20	
PTRVIR02	−109.80	4	−65.85	18.12	0.80	0.80	90	2	61.1	1 6 9/GR21	
SLVIFRB2	−107.30	4	−88.91	13.59	0.80	0.80	90	1	61.7		
USAEH001	−61.30	4	−85.16	36.21	5.63	3.32	22	2	61.9	1 5 6	10
USAEH002	−100.80	4	−89.28	36.16	5.65	3.78	170	2	61.7	1 6 9/GR20	10
USAEH003	−109.80	4	−90.12	36.11	5.55	3.56	161	2	62.1	1 6 9/GR21	10
USAEH004	−118.80	4	−91.16	36.05	5.38	3.24	153	2	62.6	1 5 6	10
USAPSA02	−165.80	4	−117.79	40.58	4.04	0.82	135	2	63.3	9/GR1	
USAPSA03	−174.80	4	−118.20	40.15	3.63	0.80	136	2	65.0	9/GR2	
USAWH101	−147.80	4	−109.70	38.13	5.52	1.96	142	2	62.1	10	
USAWH102	−156.80	4	−111.40	38.57	5.51	1.55	138	2	63.2	10	
VEN11VEN	−103.80	4	−66.79	6.90	2.50	1.77	122	2	65.2	10	

12 282.32 MHz (5)

1	2	3	4		5		6	7	8	9	
ALS00002	−166.20	5	−149.66	58.37	3.76	1.24	170	1	59.7	9/GR1	10
ALS00003	−175.20	5	−150.98	58.53	3.77	1.11	167	1	60.0	9/GR2	10
ARGINSU4	−94.20	5	−52.98	−59.81	3.40	0.80	19	1	59.9	9/GR3	
ARGSUR04	−94.20	5	−65.04	−43.33	3.32	1.50	40	1	60.7	9/GR3	10
B CE311	−64.20	5	−40.60	−6.07	3.04	2.06	174	1	61.6	89/GR7	10
B CE312	−45.20	5	−40.27	−6.06	3.44	2.09	174	1	61.0	89/GR9	10
B CE411	−64.20	5	−50.97	−15.27	3.86	1.38	49	1	62.6	89/GR7	10
B CE412	−45.20	5	−50.71	−15.30	3.57	1.56	52	1	62.7	89/GR9	10
B CE511	−64.20	5	−53.10	−2.90	2.44	2.13	104	1	63.0	89/GR7	10
B NO611	−74.20	5	−59.60	−11.62	2.85	1.69	165	2	62.8	89/GR8	10
B NO711	−74.20	5	−60.70	−1.78	3.54	1.78	126	2	62.8	89/GR8	10
B NO811	−74.20	5	−68.76	−4.71	2.37	1.65	73	2	62.8	89/GR8	
B SU111	−81.20	5	−51.12	−25.63	2.76	1.05	50	1	62.8	89/GR6	10
B SU112	−45.20	5	−50.75	−25.62	2.47	1.48	56	1	62.2	89/GR9	
B SU211	−81.20	5	−44.51	−16.95	3.22	1.36	60	1	62.5	89/GR6	10
B SU212	−45.20	5	−44.00	−16.87	3.20	1.96	58	1	61.3	89/GR9	
BAHIFRB1	−87.20	5	−76.06	24.16	1.81	0.80	142	1	61.6		
BERBERMU	−96.20	5	−64.77	32.32	0.80	0.80	90	2	56.8		
BERBER02	−31.00	5	−64.77	32.32	0.80	0.80	90	1	56.9	2	10
BOLAND01	−115.20	5	−65.04	−16.76	2.49	1.27	76	1	67.9	9/GR5	
CAN01101	−138.20	5	−125.63	57.24	3.45	1.27	157	1	59.5	9/GR10	10
CAN01201	−138.20	5	−112.04	55.95	3.35	0.97	151	1	59.6	9/GR10	10
CAN01202	−72.70	5	−107.70	55.63	2.74	1.12	32	1	59.6		
CAN01203	−129.20	5	−111.48	55.61	3.08	1.15	151	1	59.5	9/GR12	10
CAN01303	−129.20	5	−102.42	57.12	3.54	0.91	154	1	60.0	9/GR12	10
CAN01304	−91.20	5	−99.12	57.36	1.98	1.72	2	1	59.8	9/GR13	
CAN01403	−129.20	5	−89.75	52.02	4.68	0.80	148	1	61.8	9/GR12	10
CAN01404	−91.20	5	−84.82	52.42	3.10	2.05	152	1	60.4	9/GR13	10
CAN01405	−82.20	5	−84.00	52.39	2.84	2.29	172	1	60.3	9/GR14	10
CAN01504	−91.20	5	−72.66	53.77	3.57	1.67	156	1	60.2	9/GR13	10
CAN01505	−82.20	5	−71.77	53.79	3.30	1.89	162	1	60.1	9/GR14	10
CAN01605	−82.20	5	−61.50	49.55	2.65	1.40	143	1	60.3	9/GR14	10
CAN01606	−70.70	5	−61.30	49.55	2.40	1.65	148	1	60.2	10	
CHLCONT5	−106.20	5	−72.23	−35.57	2.60	0.80	55	1	59.4	9/GR17	
CHLPAC02	−106.20	5	−80.06	−30.06	1.36	0.80	69	1	59.2	9/GR17	
CLMAND01	−115.20	5	−74.72	5.93	3.85	1.63	114	1	64.9	9/GR5	
CLM00001	−103.20	5	−74.50	5.87	3.98	1.96	118	1	63.5	10	
EQACAND1	−115.20	5	−78.40	−1.61	1.37	0.95	75	1	64.0	9/GR5	
EQAGAND1	−115.20	5	−90.34	−0.62	0.90	0.81	89	1	61.3	9/GR5	
FLKANT01	−57.20	5	−44.54	−60.13	3.54	0.80	12	1	59.3	2	10
FLKFALKS	−31.00	5	−59.90	−51.64	0.80	0.80	90	1	58.1	2	
GRD00002	−42.20	5	−61.58	12.29	0.80	0.80	90	1	58.8		
HWA00002	−166.20	5	−165.79	23.42	4.20	0.80	160	1	58.8	9/GR1	10
HWA00003	−175.20	5	−166.10	23.42	4.25	0.80	159	1	58.8	9/GR2	10
MEX01NTE	−78.20	5	−105.81	26.01	2.89	2.08	155	1	60.5	1	
MEX01SUR	−69.20	5	−94.84	19.82	3.05	2.09	4	1	62.2	1	10
MEX02NTE	−136.20	5	−107.21	26.31	3.84	1.55	148	1	61.2	1	10
MEX02SUR	−127.20	5	−96.39	19.88	3.18	1.87	157	1	62.5	1	10
PAQPAC01	−106.20	5	−109.18	−27.53	0.80	0.80	90	1	56.2	9/GR17	
PRG00002	−99.20	5	−58.66	−23.32	1.45	1.04	76	1	60.2		
PRUAND02	−115.20	5	−74.69	−8.39	3.41	1.79	95	1	63.9	9/GR5	
PTRVIR01	−101.20	5	−65.85	18.12	0.80	0.80	90	1	60.5	169/GR20	
PTRVIR02	−110.20	5	−65.86	18.12	0.80	0.80	90	1	61.0	169/GR21	
SPMFRAN3	−53.20	5	−67.24	47.51	3.16	0.80	7	1	60.4	27	10
TRD00001	−84.70	5	−61.23	10.70	0.80	0.80	90	1	59.4		
URG00001	−71.70	5	−56.22	−32.52	1.02	0.89	11	1	60.0		
USAEH001	−61.70	5	−85.19	36.21	5.63	3.33	22	1	61.8	156	10
USAEH002	−101.20	5	−89.24	36.16	5.67	3.76	170	1	61.7	169/GR20	10
USAEH003	−110.20	5	−90.14	36.11	5.55	3.55	161	1	62.0	169/GR21	10
USAEH004	−119.20	5	−91.16	36.05	5.38	3.24	152	1	62.6	156	10
USAPSA02	−166.20	5	−117.80	40.58	4.03	0.82	135	1	63.2	9/GR1	
USAPSA03	−175.20	5	−118.27	40.12	3.62	0.80	136	1	65.0	9/GR2	
USAWH101	−148.20	5	−109.65	38.13	5.53	1.95	142	1	62.1	10	
USAWH102	−157.20	5	−111.41	38.57	5.51	1.54	138	1	63.2	10	
VENAND03	−115.20	5	−67.04	6.91	2.37	1.43	111	1	67.2	9/GR5	
VRG00001	−79.70	5	−64.37	18.48	0.80	0.80	90	1	58.3	4	

12 296.90 MHz (6)

1	2	3	4		5		6	7	8	9	
ALS00002	−165.80	6	−149.63	58.52	3.81	1.23	171	2	59.7	9/GR1	10
ALS00003	−174.80	6	−150.95	58.54	3.77	1.11	167	2	60.0	9/GR2	10
ARGNORT4	−93.80	6	−63.96	−30.01	3.86	1.99	48	2	65.6	10	
ARGNORT5	−54.80	6	−62.85	−29.80	3.24	2.89	47	2	63.5	10	
ATNBEAM1	−52.80	6	−66.44	14.87	1.83	0.80	39	2	61.0		
B CE311	−63.80	6	−40.60	−6.07	3.04	2.06	174	2	61.6	8 9/GR7	10
B CE312	−44.80	6	−40.26	−6.06	3.44	2.09	174	2	61.0	8 9/GR9	10
B CE411	−63.80	6	−50.97	−15.26	3.86	1.38	49	2	62.6	8 9/GR7	10
B CE412	−44.80	6	−50.71	−15.30	3.57	1.56	52	2	62.7	8 9/GR9	10
B CE511	−63.80	6	−53.11	−2.98	2.42	2.15	107	2	63.1	8 9/GR7	10
B NO611	−73.80	6	−59.60	−11.62	2.86	1.69	165	1	62.8	8 9/GR8	10
B NO711	−73.80	6	−60.70	−1.78	3.54	1.78	126	1	62.8	8 9/GR8	10
B NO811	−73.80	6	−68.75	−4.71	2.37	1.65	73	1	62.8	8 9/GR8	
B SE911	−101.80	6	−45.99	−19.09	2.22	0.80	62	2	65.3	8	10
B SU111	−80.80	6	−51.10	−25.64	2.76	1.06	50	2	62.8	8 9/GR6	10
B SU112	−44.80	6	−50.76	−25.62	2.47	1.48	56	2	62.3	8 9/GR9	
B SU211	−80.80	6	−44.51	−16.94	3.22	1.37	60	2	62.5	8 9/GR6	10
B SU212	−44.80	6	−43.99	−16.97	3.27	1.92	59	2	61.3	8 9/GR9	
CAN01101	−137.80	6	−125.60	57.24	3.45	1.27	157	2	59.5	9/GR10	10
CAN01201	−137.80	6	−111.92	55.89	3.33	0.98	151	2	59.6	9/GR10	10
CAN01202	−72.30	6	−107.64	55.62	2.75	1.11	32	2	59.6		
CAN01203	−128.80	6	−111.43	55.56	3.07	1.15	151	2	59.5	9/GR12	10
CAN01303	−128.80	6	−102.39	57.12	3.54	0.92	154	2	60.0	9/GR12	10
CAN01304	−90.80	6	−99.00	57.33	1.96	1.73	1	2	59.8	9/GR13	
CAN01403	−128.80	6	−89.70	52.02	4.67	0.80	148	2	61.8	9/GR12	10
CAN01404	−90.80	6	−84.78	52.41	3.09	2.06	153	2	60.4	9/GR13	10
CAN01405	−81.80	6	−84.02	52.34	2.82	2.30	172	2	60.3	9/GR14	10
CAN01504	−90.80	6	−72.68	53.78	3.57	1.67	157	2	60.2	9/GR13	10
CAN01505	−81.80	6	−71.76	53.76	3.30	1.89	162	2	60.1	9/GR14	10
CAN01605	−81.80	6	−61.54	49.50	2.66	1.39	144	2	60.3	9/GR14	10
CAN01606	−70.30	6	−61.32	49.51	2.41	1.65	148	2	60.2	10	
CHLCONT4	−105.80	6	−69.59	−23.20	2.21	0.80	68	2	59.1	9/GR16	
CHLCONT6	−105.80	6	−73.52	−55.52	3.65	1.31	39	2	59.6	9/GR16	
CRBBAH01	−92.30	6	−76.09	24.13	1.83	0.80	141	1	61.7	9/GR18	
CRBBER01	−92.30	6	−64.76	32.13	0.80	0.80	90	1	56.7	9/GR18	
CRBBLZ01	−92.30	6	−88.61	17.26	0.80	0.80	90	1	58.6	9/GR18	
CRBEC001	−92.30	6	−60.07	8.26	4.20	0.86	115	1	64.2	9/GR18	10
CRBJMC01	−92.30	6	−79.45	17.97	0.99	0.80	151	1	61.1	9/GR18	
CTR00201	−130.80	6	−84.33	9.67	0.82	0.80	119	2	65.6		
EQAC0001	−94.80	6	−78.31	−1.52	1.48	1.15	65	1	63.0	9/GR19	
EQAG0001	−94.80	6	−90.36	−0.57	0.94	0.89	99	1	61.0	9/GR19	
GUY00302	−33.80	6	−59.07	4.77	1.43	0.85	91	2	63.5		
HNDIFRB2	−107.30	6	−86.23	15.16	1.14	0.85	8	1	63.4		
HTI00002	−83.30	6	−73.28	18.96	0.82	0.80	11	2	60.9		
HWA00002	−165.80	6	−165.79	23.32	4.20	0.80	160	2	58.8	9/GR1	10
HWA00003	−174.80	6	−166.10	23.42	4.25	0.80	159	2	58.8	9/GR2	10
MEX01NTE	−77.80	6	−105.80	25.99	2.88	2.07	155	2	60.5	1	
MEX02NTE	−135.80	6	−107.36	26.32	3.80	1.57	149	2	61.2	1	10
MEX02SUR	−126.80	6	−96.39	19.88	3.19	1.87	158	2	62.5	1	10
PRU00004	−85.80	6	−74.19	−8.39	3.74	2.45	112	2	62.8	10	
PTRVIR01	−100.80	6	−65.85	18.12	0.80	0.80	90	2	60.6	1 6 9/GR20	
PTRVIR02	−109.80	6	−65.85	18.12	0.80	0.80	90	2	61.1	1 6 9/GR21	
TCA00001	−115.80	6	−71.79	21.53	0.80	0.80	90	2	60.4		
USAEH001	−61.30	6	−85.16	36.21	5.63	3.32	22	2	61.8	1 5 6	10
USAEH002	−100.80	6	−89.28	36.16	5.65	3.78	170	2	61.7	1 6 9/GR20	10
USAEH003	−109.80	6	−90.12	36.11	5.55	3.56	161	2	62.1	1 6 9/GR21	10
USAEH004	−118.80	6	−91.16	36.05	5.38	3.24	153	2	62.6	1 5 6	10
USAPSA02	−165.80	6	−117.79	40.58	4.04	0.82	135	2	63.2	9/GR1	
USAPSA03	−174.80	6	−118.20	40.15	3.63	0.80	136	2	64.9	9/GR2	
USAWH101	−147.80	6	−109.70	38.13	5.52	1.96	142	2	62.1	10	
USAWH102	−156.80	6	−111.40	38.57	5.51	1.55	138	2	63.2	10	
VCT00001	−79.30	6	−61.18	13.23	0.80	0.80	90	2	58.4		
VEN11VEN	−103.80	6	−66.79	6.90	2.50	1.77	122	2	65.1	10	

12 311.48 MHz (7)

1	2	3	4		5		6	7	8	9	
ALS00002	−166.20	7	−149.66	58.37	3.76	1.24	170	1	59.8	9/GR1	10
ALS00003	−175.20	7	−150.98	58.53	3.77	1.11	167	1	60.0	9/GR2	10
ARGINSU4	−94.20	7	−52.98	−59.81	3.40	0.80	19	1	59.9	9/GR3	
ARGINSU5	−55.20	7	−44.17	−59.91	3.77	0.80	13	1	59.3	9/GR4	10
ARGSUR04	−94.20	7	−65.04	−43.33	3.32	1.50	40	1	60.7	9/GR3	10
ARGSUR05	−55.20	7	−63.68	−43.01	2.54	2.38	152	1	60.1	9/GR4	10
ATGSJN01	−79.70	7	−61.79	17.07	0.80	0.80	90	1	58.4		
B CE311	−64.20	7	−40.60	−6.07	3.04	2.06	174	1	61.6	8 9/GR7	10
B CE312	−45.20	7	−40.27	−6.06	3.44	2.09	174	1	61.0	8 9/GR9	10
B CE411	−64.20	7	−50.97	−15.27	3.86	1.38	49	1	62.6	8 9/GR7	10
B CE412	−45.20	7	−50.71	−15.30	3.57	1.56	52	1	62.7	8 9/GR9	10
B CE511	−64.20	7	−53.10	−2.90	2.44	2.13	104	1	63.1	8 9/GR7	10
B NO611	−74.20	7	−59.60	−11.62	2.85	1.69	165	2	62.9	8 9/GR8	10
B NO711	−74.20	7	−60.70	−1.78	3.54	1.78	126	2	62.8	8 9/GR8	10
B NO811	−74.20	7	−68.76	−4.71	2.37	1.65	73	2	62.8	8 9/GR8	
B SU111	−81.20	7	−51.12	−25.63	2.76	1.05	50	1	62.9	8 9/GR6	10
B SU112	−45.20	7	−50.75	−25.62	2.47	1.48	56	1	62.3	8 9/GR9	
B SU211	−81.20	7	−44.51	−16.95	3.22	1.36	60	1	62.5	8 9/GR6	10
B SU212	−45.20	7	−44.00	−16.87	3.20	1.96	58	1	61.3	8 9/GR9	
BERBERMU	−96.20	7	−64.77	32.32	0.80	0.80	90	2	56.8		
BOLAND01	−115.20	7	−65.04	−16.76	2.49	1.27	76	1	67.9	9/GR5	
BOL00001	−87.20	7	−64.61	−16.71	2.52	2.19	85	1	63.8	10	
BRB00001	−92.70	7	−59.85	12.93	0.80	0.80	90	2	59.1		
CAN01101	−138.20	7	−125.63	57.24	3.45	1.27	157	1	59.5	9/GR10	10
CAN01201	−138.20	7	−112.04	55.95	3.35	0.97	151	1	59.6	9/GR10	10
CAN01202	−72.70	7	−107.70	55.63	2.74	1.12	32	1	59.6		
CAN01203	−129.20	7	−111.48	55.61	3.08	1.15	151	1	59.5	9/GR12	10
CAN01303	−129.20	7	−102.42	57.12	3.54	0.91	154	1	60.1	9/GR12	10
CAN01304	−91.20	7	−99.12	57.36	1.98	1.72	2	1	59.8	9/GR13	
CAN01403	−129.20	7	−89.75	52.02	4.68	0.80	148	1	61.8	9/GR12	10
CAN01404	−91.20	7	−84.82	52.42	3.10	2.05	152	1	60.4	9/GR13	10
CAN01405	−82.20	7	−84.00	52.39	2.84	2.29	172	1	60.3	9/GR14	10
CAN01504	−91.20	7	−72.66	53.77	3.57	1.67	156	1	60.2	9/GR13	10
CAN01505	−82.20	7	−71.77	53.79	3.30	1.89	162	1	60.1	9/GR14	10
CAN01605	−82.20	7	−61.50	49.55	2.65	1.40	143	1	60.3	9/GR14	10
CAN01606	−70.70	7	−61.30	49.55	2.40	1.65	148	1	60.2	10	
CHLCONT5	−106.20	7	−72.23	−35.57	2.60	0.80	55	1	59.4	9/GR17	
CHLPAC02	−106.20	7	−80.06	−30.06	1.36	0.80	69	1	59.2	9/GR17	
CLMAND01	−115.20	7	−74.72	5.93	3.85	1.63	114	1	65.0	9/GR5	
CLM00001	−103.20	7	−74.50	5.87	3.98	1.96	118	1	63.6	10	
CUB00001	−89.20	7	−79.81	21.62	2.24	0.80	168	1	61.1		
EQACAND1	−115.20	7	−78.40	−1.61	1.37	0.95	75	1	64.1	9/GR5	
EQAGAND1	−115.20	7	−90.34	−0.62	0.90	0.81	89	1	61.3	9/GR5	
GRD00002	−42.20	7	−61.58	12.29	0.80	0.80	90	1	58.8		
GRD00059	−57.20	7	−61.58	12.29	0.80	0.80	90	1	58.5		
GRLDNK01	−53.20	7	−44.89	66.56	2.70	0.82	173	1	60.0	2	10
HWA00002	−166.20	7	−165.79	23.42	4.20	0.80	160	1	58.8	9/GR1	10
HWA00003	−175.20	7	−166.10	23.42	4.25	0.80	159	1	58.8	9/GR2	10
MEX01NTE	−78.20	7	−105.81	26.01	2.89	2.08	155	1	60.5	1	
MEX01SUR	−69.20	7	−94.84	19.82	3.05	2.09	4	1	62.3	1	10
MEX02NTE	−136.20	7	−107.21	26.31	3.84	1.55	148	1	61.2	1	10
MEX02SUR	−127.20	7	−96.39	19.88	3.18	1.87	157	1	62.6	1	10
PAQPAC01	−106.20	7	−109.18	−27.53	0.80	0.80	90	1	56.2	9/GR17	
PRG00002	−99.20	7	−58.66	−23.32	1.45	1.04	76	1	60.2		
PRUAND02	−115.20	7	−74.69	−8.39	3.41	1.79	95	1	64.0	9/GR5	
PTRVIR01	−101.20	7	−65.85	18.12	0.80	0.80	90	1	60.6	1 6 9/GR20	
PTRVIR02	−110.20	7	−65.86	18.12	0.80	0.80	90	1	61.0	1 6 9/GR21	
SURINAM2	−84.70	7	−55.69	4.35	1.00	0.80	86	1	63.2		
URG00001	−71.70	7	−56.22	−32.52	1.02	0.89	11	1	60.0		
USAEH001	−61.70	7	−85.19	36.21	5.63	3.33	22	1	61.8	1 5 6	10
USAEH002	−101.20	7	−89.24	36.16	5.67	3.76	170	1	61.7	1 6 9/GR20	10
USAEH003	−110.20	7	−90.14	36.11	5.55	3.55	161	1	62.1	1 6 9/GR21	10
USAEH004	−119.20	7	−91.16	36.05	5.38	3.24	152	1	62.6	1 5 6	10
USAPSA02	−166.20	7	−117.80	40.58	4.03	0.82	135	1	63.3	9/GR1	
USAPSA03	−175.20	7	−118.27	40.12	3.62	0.80	136	1	65.0	9/GR2	
USAWH101	−148.20	7	−109.65	38.13	5.53	1.95	142	1	62.1	10	
USAWH102	−157.20	7	−111.41	38.57	5.51	1.54	138	1	63.2	10	
VENAND03	−115.20	7	−67.04	6.91	2.37	1.43	111	1	67.3	9/GR5	

12 326.06 MHz (8)

1	2	3	4		5		6	7	8	9	
ALS00002	−165.80	8	−149.63	58.52	3.81	1.23	171	2	59.8	9/GR1	10
ALS00003	−174.80	8	−150.95	58.54	3.77	1.11	167	2	60.0	9/GR2	10
ARGNORT4	−93.80	8	−63.96	−30.01	3.86	1.99	48	2	65.7	10	
ARGNORT5	−54.80	8	−62.85	−29.80	3.24	2.89	47	2	63.5	10	
B CE311	−63.80	8	−40.60	−6.07	3.04	2.06	174	2	61.6	8 9/GR7	10
B CE312	−44.80	8	−40.26	−6.06	3.44	2.09	174	2	61.0	8 9/GR9	10
B CE411	−63.80	8	−50.97	−15.26	3.86	1.38	49	2	62.6	8 9/GR7	10
B CE412	−44.80	8	−50.71	−15.30	3.57	1.56	52	2	62.8	8 9/GR9	10
B CE511	−63.80	8	−53.11	−2.98	2.42	2.15	107	2	63.1	8 9/GR7	10
B NO611	−73.80	8	−59.60	−11.62	2.86	1.69	165	1	62.9	8 9/GR8	10
B NO711	−73.80	8	−60.70	−1.78	3.54	1.78	126	1	62.8	8 9/GR8	10
B NO811	−73.80	8	−68.75	−4.71	2.37	1.65	73	1	62.8	8 9/GR8	
B SE911	−101.80	8	−45.99	−19.09	2.22	0.80	62	2	65.3	8	10
B SU111	−80.80	8	−51.10	−25.64	2.76	1.06	50	2	62.9	8 9/GR6	10
B SU112	−44.80	8	−50.76	−25.62	2.47	1.48	56	2	62.3	8 9/GR9	
B SU211	−80.80	8	−44.51	−16.94	3.22	1.37	60	2	62.5	8 9/GR6	10
B SU212	−44.80	8	−43.99	−16.97	3.27	1.92	59	2	61.3	8 9/GR9	
CAN01101	−137.80	8	−125.60	57.24	3.45	1.27	157	2	59.5	9/GR10	10
CAN01201	−137.80	8	−111.92	55.89	3.33	0.98	151	2	59.6	9/GR10	10
CAN01202	−72.30	8	−107.64	55.62	2.75	1.11	32	2	59.6		
CAN01203	−128.80	8	−111.43	55.56	3.07	1.15	151	2	59.5	9/GR12	10
CAN01303	−128.80	8	−102.39	57.12	3.54	0.92	154	2	60.1	9/GR12	10
CAN01304	−90.80	8	−99.00	57.33	1.96	1.73	1	2	59.8	9/GR13	
CAN01403	−128.80	8	−89.70	52.02	4.67	0.80	148	2	61.8	9/GR12	10
CAN01404	−90.80	8	−84.78	52.41	3.09	2.06	153	2	60.4	9/GR13	10
CAN01405	−81.80	8	−84.02	52.34	2.82	2.30	172	2	60.3	9/GR14	10
CAN01504	−90.80	8	−72.68	53.78	3.57	1.67	157	2	60.2	9/GR13	10
CAN01505	−81.80	8	−71.76	53.76	3.30	1.89	162	2	60.2	9/GR14	10
CAN01605	−81.80	8	−61.54	49.50	2.66	1.39	144	2	60.3	9/GR14	10
CAN01606	−70.30	8	−61.32	49.51	2.41	1.65	148	2	60.2	10	
CHLCONT4	−105.80	8	−69.59	−23.20	2.21	0.80	68	2	59.1	9/GR16	
CHLCONT6	−105.80	8	−73.52	−55.52	3.65	1.31	39	2	59.6	9/GR16	
CRBBAH01	−92.30	8	−76.09	24.13	1.83	0.80	141	1	61.7	9/GR18	
CRBBER01	−92.30	8	−64.76	32.13	0.80	0.80	90	1	56.8	9/GR18	
CRBBLZ01	−92.30	8	−88.61	17.26	0.80	0.80	90	1	58.7	9/GR18	
CRBEC001	−92.30	8	−60.07	8.26	4.20	0.86	115	1	64.3	9/GR18	10
CRBJMC01	−92.30	8	−79.45	17.97	0.99	0.80	151	1	61.1	9/GR18	
CYM00001	−115.80	8	−80.58	19.57	0.80	0.80	90	2	59.6		
DOMIFRB2	−83.30	8	−70.51	18.79	0.98	0.80	167	2	61.1		
EQAC0001	−94.80	8	−78.31	−1.52	1.48	1.15	65	1	63.0	9/GR19	
EQAG0001	−94.80	8	−90.36	−0.57	0.94	0.89	99	1	61.0	9/GR19	
GUFMGG02	−52.80	8	−56.42	8.47	4.16	0.81	123	2	62.7	2 7	10
HWA00002	−165.80	8	−165.79	23.32	4.20	0.80	160	2	58.8	9/GR1	10
HWA00003	−174.80	8	−166.10	23.42	4.25	0.80	159	2	58.8	9/GR2	10
JMC00005	−33.80	8	−77.27	18.12	0.80	0.80	90	2	60.6		
LCAIFRB1	−79.30	8	−61.15	13.90	0.80	0.80	90	2	58.4		
MEX01NTE	−77.80	8	−105.80	25.99	2.88	2.07	155	2	60.5	1	
MEX02NTE	−135.80	8	−107.36	26.32	3.80	1.57	149	2	61.2	1	10
MEX02SUR	−126.80	8	−96.39	19.88	3.19	1.87	158	2	62.5	1	10
PRU00004	−85.80	8	−74.19	−8.39	3.74	2.45	112	2	62.9	10	
PTRVIR01	−100.80	8	−65.85	18.12	0.80	0.80	90	2	60.6	1 6 9/GR20	
PTRVIR02	−109.80	8	−65.85	18.12	0.80	0.80	90	2	61.1	1 6 9/GR21	
SLVIFRB2	−107.30	8	−88.91	13.59	0.80	0.80	90	1	61.7		
USAEH001	−61.30	8	−85.16	36.21	5.63	3.32	22	2	61.9	1 5 6	10
USAEH002	−100.80	8	−89.28	36.16	5.65	3.78	170	2	61.7	1 6 9/GR20	10
USAEH003	−109.80	8	−90.12	36.11	5.55	3.56	161	2	62.1	1 6 9/GR21	10
USAEH004	−118.80	8	−91.16	36.05	5.38	3.24	153	2	62.6	1 5 6	10
USAPSA02	−165.80	8	−117.79	40.58	4.04	0.82	135	2	63.3	9/GR1	
USAPSA03	−174.80	8	−118.20	40.15	3.63	0.80	136	2	65.0	9/GR2	
USAWH101	−147.80	8	−109.70	38.13	5.52	1.96	142	2	62.1	10	
USAWH102	−156.80	8	−111.40	38.57	5.51	1.55	138	2	63.2	10	
VEN11VEN	−103.80	8	−66.79	6.90	2.50	1.77	122	2	65.2	10	

12 340.64 MHz (9)

1	2	3	4		5		6	7	8	9	
ALS00002	−166.20	9	−149.66	58.37	3.76	1.24	170	1	59.7	9/GR1	10
ALS00003	−175.20	9	−150.98	58.53	3.77	1.11	167	1	60.0	9/GR2	10
ARGINSU4	−94.20	9	−52.98	−59.81	3.40	0.80	19	1	59.9	9/GR3	
ARGSUR04	−94.20	9	−65.04	−43.33	3.32	1.50	40	1	60.7	9/GR3	10
B CE311	−64.20	9	−40.60	−6.07	3.04	2.06	174	1	61.6	8 9/GR7	10
B CE312	−45.20	9	−40.27	−6.06	3.44	2.09	174	1	61.0	8 9/GR9	10
B CE411	−64.20	9	−50.97	−15.27	3.86	1.38	49	1	62.6	8 9/GR7	10
B CE412	−45.20	9	−50.71	−15.30	3.57	1.56	52	1	62.7	8 9/GR9	10
B CE511	−64.20	9	−53.10	−2.90	2.44	2.13	104	1	63.0	8 9/GR7	10
B NO611	−74.20	9	−59.60	−11.62	2.85	1.69	165	2	62.8	8 9/GR8	10
B NO711	−74.20	9	−60.70	−1.78	3.54	1.78	126	2	62.8	8 9/GR8	10
B NO811	−74.20	9	−68.76	−4.71	2.37	1.65	73	2	62.8	8 9/GR8	
B SU111	−81.20	9	−51.12	−25.63	2.76	1.05	50	1	62.8	8 9/GR6	10
B SU112	−45.20	9	−50.75	−25.62	2.47	1.48	56	1	62.2	8 9/GR9	
B SU211	−81.20	9	−44.51	−16.95	3.22	1.36	60	1	62.5	8 9/GR6	10
B SU212	−45.20	9	−44.00	−16.87	3.20	1.96	58	1	61.3	8 9/GR9	
BAHIFRB1	−87.20	9	−76.06	24.16	1.81	0.80	142	1	61.6		
BERBERMU	−96.20	9	−64.77	32.32	0.80	0.80	90	2	56.8		
BERBER02	−31.00	9	−64.77	32.32	0.80	0.80	90	1	56.9	2	10
BOLAND01	−115.20	9	−65.04	−16.76	2.49	1.27	76	1	67.9	9/GR5	
CAN01101	−138.20	9	−125.63	57.24	3.45	1.27	157	1	59.5	9/GR10	10
CAN01201	−138.20	9	−112.04	55.95	3.35	0.97	151	1	59.6	9/GR10	10
CAN01202	−72.70	9	−107.70	55.63	2.74	1.12	32	1	59.6		
CAN01203	−129.20	9	−111.48	55.61	3.08	1.15	151	1	59.5	9/GR12	10
CAN01303	−129.20	9	−102.42	57.12	3.54	0.91	154	1	60.0	9/GR12	10
CAN01304	−91.20	9	−99.12	57.36	1.98	1.72	2	1	59.8	9/GR13	
CAN01403	−129.20	9	−89.75	52.02	4.68	0.80	148	1	61.8	9/GR12	10
CAN01404	−91.20	9	−84.82	52.42	3.10	2.05	152	1	60.4	9/GR13	10
CAN01405	−82.20	9	−84.00	52.39	2.84	2.29	172	1	60.3	9/GR14	10
CAN01504	−91.20	9	−72.66	53.77	3.57	1.67	156	1	60.2	9/GR13	10
CAN01505	−82.20	9	−71.77	53.79	3.30	1.89	162	1	60.1	9/GR14	10
CAN01605	−82.20	9	−61.50	49.55	2.65	1.40	143	1	60.3	9/GR14	10
CAN01606	−70.70	9	−61.30	49.55	2.40	1.65	148	1	60.2	10	
CHLCONT5	−106.20	9	−72.23	−35.57	2.60	0.80	55	1	59.4	9/GR17	
CHLPAC02	−106.20	9	−80.06	−30.06	1.36	0.80	69	1	59.2	9/GR17	
CLMAND01	−115.20	9	−74.72	5.93	3.85	1.63	114	1	64.9	9/GR5	
CLM00001	−103.20	9	−74.50	5.87	3.98	1.96	118	1	63.5	10	
EQACAND1	−115.20	9	−78.40	−1.61	1.37	0.95	75	1	64.0	9/GR5	
EQAGAND1	−115.20	9	−90.34	−0.62	0.90	0.81	89	1	61.3	9/GR5	
FLKANT01	−57.20	9	−44.54	−60.13	3.54	0.80	12	1	59.3	2	10
FLKFALKS	−31.00	9	−59.90	−51.64	0.80	0.80	90	1	58.1	2	
GRD00002	−42.20	9	−61.58	12.29	0.80	0.80	90	1	58.8		
HWA00002	−166.20	9	−165.79	23.42	4.20	0.80	160	1	58.8	9/GR1	10
HWA00003	−175.20	9	−166.10	23.42	4.25	0.80	159	1	58.8	9/GR2	10
MEX01NTE	−78.20	9	−105.81	26.01	2.89	2.08	155	1	60.5	1	
MEX01SUR	−69.20	9	−94.84	19.82	3.05	2.09	4	1	62.2	1	10
MEX02NTE	−136.20	9	−107.21	26.31	3.84	1.55	148	1	61.2	1	10
MEX02SUR	−127.20	9	−96.39	19.88	3.18	1.87	157	1	62.5	1	10
PAQPAC01	−106.20	9	−109.18	−27.53	0.80	0.80	90	1	56.2	9/GR17	
PRG00002	−99.20	9	−58.66	−23.32	1.45	1.04	76	1	60.2		
PRUAND02	−115.20	9	−74.69	−8.39	3.41	1.79	95	1	63.9	9/GR5	
PTRVIR01	−101.20	9	−65.85	18.12	0.80	0.80	90	1	60.5	1 6 9/GR20	
PTRVIR02	−110.20	9	−65.86	18.12	0.80	0.80	90	1	61.0	1 6 9/GR21	
SPMFRAN3	−53.20	9	−67.24	47.51	3.16	0.80	7	1	60.4	2 7	10
TRD00001	−84.70	9	−61.23	10.70	0.80	0.80	90	1	59.4		
URG00001	−71.70	9	−56.22	−32.52	1.02	0.89	11	1	60.0		
USAEH001	−61.70	9	−85.19	36.21	5.63	3.33	22	1	61.8	1 5 6	10
USAEH002	−101.20	9	−89.24	36.16	5.67	3.76	170	1	61.7	1 6 9/GR20	10
USAEH003	−110.20	9	−90.14	36.11	5.55	3.55	161	1	62.0	1 6 9/GR21	10
USAEH004	−119.20	9	−91.16	36.05	5.38	3.24	152	1	62.6	1 5 6	10
USAPSA02	−166.20	9	−117.80	40.58	4.03	0.82	135	1	63.2	9/GR1	
USAPSA03	−175.20	9	−118.27	40.12	3.62	0.80	136	1	65.0	9/GR2	
USAWH101	−148.20	9	−109.65	38.13	5.53	1.95	142	1	62.1	10	
USAWH102	−157.20	9	−111.41	38.57	5.51	1.54	138	1	63.2	10	
VENAND03	−115.20	9	−67.04	6.91	2.37	1.43	111	1	67.2	9/GR5	
VRG00001	−79.70	9	−64.37	18.48	0.80	0.80	90	1	58.3	4	

12 355.22 MHz (10)

1	2	3	4		5		6	7	8	9	
ALS00002	−165.80	10	−149.63	58.52	3.81	1.23	171	2	59.7	9/GR1	10
ALS00003	−174.80	10	−150.95	58.54	3.77	1.11	167	2	60.0	9/GR2	10
ARGNORT4	−93.80	10	−63.96	−30.01	3.86	1.99	48	2	65.6	10	
ARGNORT5	−54.80	10	−62.85	−29.80	3.24	2.89	47	2	63.5	10	
ATNBEAM1	−52.80	10	−66.44	14.87	1.83	0.80	39	2	61.0		
B CE311	−63.80	10	−40.60	−6.07	3.04	2.06	174	2	61.6	8 9/GR7	10
B CE312	−44.80	10	−40.26	−6.06	3.44	2.09	174	2	61.0	8 9/GR9	10
B CE411	−63.80	10	−50.97	−15.26	3.86	1.38	49	2	62.6	8 9/GR7	10
B CE412	−44.80	10	−50.71	−15.30	3.57	1.56	52	2	62.7	8 9/GR9	10
B CE511	−63.80	10	−53.11	−2.98	2.42	2.15	107	2	63.1	8 9/GR7	10
B NO611	−73.80	10	−59.60	−11.62	2.86	1.69	165	1	62.8	8 9/GR8	10
B NO711	−73.80	10	−60.70	−1.78	3.54	1.78	126	1	62.8	8 9/GR8	10
B NO811	−73.80	10	−68.75	−4.71	2.37	1.65	73	1	62.8	8 9/GR8	
B SE911	−101.80	10	−45.99	−19.09	2.22	0.80	62	2	65.3	8	10
B SU111	−80.80	10	−51.10	−25.64	2.76	1.06	50	2	62.8	8 9/GR6	10
B SU112	−44.80	10	−50.76	−25.62	2.47	1.48	56	2	62.3	8 9/GR9	
B SU211	−80.80	10	−44.51	−16.94	3.22	1.37	60	2	62.5	8 9/GR6	10
B SU212	−44.80	10	−43.99	−16.97	3.27	1.92	59	2	61.3	8 9/GR9	
CAN01101	−137.80	10	−125.60	57.24	3.45	1.27	157	2	59.5	9/GR10	10
CAN01201	−137.80	10	−111.92	55.89	3.33	0.98	151	2	59.6	9/GR10	10
CAN01202	−72.30	10	−107.64	55.62	2.75	1.11	32	2	59.6		
CAN01203	−128.80	10	−111.43	55.56	3.07	1.15	151	2	59.5	9/GR12	10
CAN01303	−128.80	10	−102.39	57.12	3.54	0.92	154	2	60.0	9/GR12	10
CAN01304	−90.80	10	−99.00	57.33	1.96	1.73	1	2	59.8	9/GR13	
CAN01403	−128.80	10	−89.70	52.02	4.67	0.80	148	2	61.8	9/GR12	10
CAN01404	−90.80	10	−84.78	52.41	3.09	2.06	153	2	60.4	9/GR13	10
CAN01405	−81.80	10	−84.02	52.34	2.82	2.30	172	2	60.3	9/GR14	10
CAN01504	−90.80	10	−72.68	53.78	3.57	1.67	157	2	60.2	9/GR13	10
CAN01505	−81.80	10	−71.76	53.76	3.30	1.89	162	2	60.1	9/GR14	10
CAN01605	−81.80	10	−61.54	49.50	2.66	1.39	144	2	60.3	9/GR14	10
CAN01606	−70.30	10	−61.32	49.51	2.41	1.65	148	2	60.2	10	
CHLCONT4	−105.80	10	−69.59	−23.20	2.21	0.80	68	2	59.1	9/GR16	
CHLCONT6	−105.80	10	−73.52	−55.52	3.65	1.31	39	2	59.6	9/GR16	
CRBBAH01	−92.30	10	−76.09	24.13	1.83	0.80	141	1	61.7	9/GR18	
CRBBER01	−92.30	10	−64.76	32.13	0.80	0.80	90	1	56.7	9/GR18	
CRBBLZ01	−92.30	10	−88.61	17.26	0.80	0.80	90	1	58.6	9/GR18	
CRBEC001	−92.30	10	−60.07	8.26	4.20	0.86	115	1	64.2	9/GR18	10
CRBJMC01	−92.30	10	−79.45	17.97	0.99	0.80	151	1	61.1	9/GR18	
CTR00201	−130.80	10	−84.33	9.67	0.82	0.80	119	2	65.6		
EQAC0001	−94.80	10	−78.31	−1.52	1.48	1.15	65	1	63.0	9/GR19	
EQAG0001	−94.80	10	−90.36	−0.57	0.94	0.89	99	1	61.0	9/GR19	
GUY00302	−33.80	10	−59.07	4.77	1.43	0.85	91	2	63.5		
HNDIFRB2	−107.30	10	−86.23	15.16	1.14	0.85	8	1	63.4		
HTI00002	−83.30	10	−73.28	18.96	0.82	0.80	11	2	60.9		
HWA00002	−165.80	10	−165.79	23.32	4.20	0.80	160	2	58.8	9/GR1	10
HWA00003	−174.80	10	−166.10	23.42	4.25	0.80	159	2	58.8	9/GR2	10
MEX01NTE	−77.80	10	−105.80	25.99	2.88	2.07	155	2	60.5	1	
MEX02NTE	−135.80	10	−107.36	26.32	3.80	1.57	149	2	61.2	1	10
MEX02SUR	−126.80	10	−96.39	19.88	3.19	1.87	158	2	62.5	1	10
PRU00004	−85.80	10	−74.19	−8.39	3.74	2.45	112	2	62.8	10	
PTRVIR01	−100.80	10	−65.85	18.12	0.80	0.80	90	2	60.6	1 6 9/GR20	
PTRVIR02	−109.80	10	−65.85	18.12	0.80	0.80	90	2	61.1	1 6 9/GR21	
TCA00001	−115.80	10	−71.79	21.53	0.80	0.80	90	2	60.4		
USAEH001	−61.30	10	−85.16	36.21	5.63	3.32	22	2	61.8	1 5 6	10
USAEH002	−100.80	10	−89.28	36.16	5.65	3.78	170	2	61.7	1 6 9/GR20	10
USAEH003	−109.80	10	−90.12	36.11	5.55	3.56	161	2	62.1	1 6 9/GR21	10
USAEH004	−118.80	10	−91.16	36.05	5.38	3.24	153	2	62.6	1 5 6	10
USAPSA02	−165.80	10	−117.79	40.58	4.04	0.82	135	2	63.2	9/GR1	
USAPSA03	−174.80	10	−118.20	40.15	3.63	0.80	136	2	64.9	9/GR2	
USAWH101	−147.80	10	−109.70	38.13	5.52	1.96	142	2	62.1	10	
USAWH102	−156.80	10	−111.40	38.57	5.51	1.55	138	2	63.2	10	
VCT00001	−79.30	10	−61.18	13.23	0.80	0.80	90	2	58.4		
VEN11VEN	−103.80	10	−66.79	6.90	2.50	1.77	122	2	65.1	10	

12 369.80 MHz (11)

1	2	3	4		5		6	7	8	9	
ALS00002	−166.20	11	−149.66	58.37	3.76	1.24	170	1	59.8	9/GR1	10
ALS00003	−175.20	11	−150.98	58.53	3.77	1.11	167	1	60.0	9/GR2	10
ARGINSU4	−94.20	11	−52.98	−59.81	3.40	0.80	19	1	59.9	9/GR3	
ARGINSU5	−55.20	11	−44.17	−59.91	3.77	0.80	13	1	59.3	9/GR4	10
ARGSUR04	−94.20	11	−65.04	−43.33	3.32	1.50	40	1	60.7	9/GR3	10
ARGSUR05	−55.20	11	−63.68	−43.01	2.54	2.38	152	1	60.1	9/GR4	10
ATGSJN01	−79.70	11	−61.79	17.07	0.80	0.80	90	1	58.4		
B CE311	−64.20	11	−40.60	−6.07	3.04	2.06	174	1	61.6	8 9/GR7	10
B CE312	−45.20	11	−40.27	−6.06	3.44	2.09	174	1	61.0	8 9/GR9	10
B CE411	−64.20	11	−50.97	−15.27	3.86	1.38	49	1	62.6	8 9/GR7	10
B CE412	−45.20	11	−50.71	−15.30	3.57	1.56	52	1	62.7	8 9/GR9	10
B CE511	−64.20	11	−53.10	−2.90	2.44	2.13	104	1	63.1	8 9/GR7	10
B NO611	−74.20	11	−59.60	−11.62	2.85	1.69	165	2	62.9	8 9/GR8	10
B NO711	−74.20	11	−60.70	−1.78	3.54	1.78	126	2	62.8	8 9/GR8	10
B NO811	−74.20	11	−68.76	−4.71	2.37	1.65	73	2	62.8	8 9/GR8	
B SU111	−81.20	11	−51.12	−25.63	2.76	1.05	50	1	62.9	8 9/GR6	10
B SU112	−45.20	11	−50.75	−25.62	2.47	1.48	56	1	62.3	8 9/GR9	
B SU211	−81.20	11	−44.51	−16.95	3.22	1.36	60	1	62.5	8 9/GR6	10
B SU212	−45.20	11	−44.00	−16.87	3.20	1.96	58	1	61.3	8 9/GR9	
BERBERMU	−96.20	11	−64.77	32.32	0.80	0.80	90	2	56.8		
BOLAND01	−115.20	11	−65.04	−16.76	2.49	1.27	76	1	67.9	9/GR5	
BOL00001	−87.20	11	−64.61	−16.71	2.52	2.19	85	1	63.8	10	
BRB00001	−92.70	11	−59.85	12.93	0.80	0.80	90	2	59.1		
CAN01101	−138.20	11	−125.63	57.24	3.45	1.27	157	1	59.5	9/GR10	10
CAN01201	−138.20	11	−112.04	55.95	3.35	0.97	151	1	59.6	9/GR10	10
CAN01202	−72.70	11	−107.70	55.63	2.74	1.12	32	1	59.6		
CAN01203	−129.20	11	−111.48	55.61	3.08	1.15	151	1	59.5	9/GR12	10
CAN01303	−129.20	11	−102.42	57.12	3.54	0.91	154	1	60.1	9/GR12	10
CAN01304	−91.20	11	−99.12	57.36	1.98	1.72	2	1	59.8	9/GR13	
CAN01403	−129.20	11	−89.75	52.02	4.68	0.80	148	1	61.8	9/GR12	10
CAN01404	−91.20	11	−84.82	52.42	3.10	2.05	152	1	60.4	9/GR13	10
CAN01405	−82.20	11	−84.00	52.39	2.84	2.29	172	1	60.3	9/GR14	10
CAN01504	−91.20	11	−72.66	53.77	3.57	1.67	156	1	60.2	9/GR13	10
CAN01505	−82.20	11	−71.77	53.79	3.30	1.89	162	1	60.1	9/GR14	10
CAN01605	−82.20	11	−61.50	49.55	2.65	1.40	143	1	60.3	9/GR14	10
CAN01606	−70.70	11	−61.30	49.55	2.40	1.65	148	1	60.2	10	
CHLCONT5	−106.20	11	−72.23	−35.57	2.60	0.80	55	1	59.4	9/GR17	
CHLPAC02	−106.20	11	−80.06	−30.06	1.36	0.80	69	1	59.2	9/GR17	
CLMAND01	−115.20	11	−74.72	5.93	3.85	1.63	114	1	65.0	9/GR5	
CLM00001	−103.20	11	−74.50	5.87	3.98	1.96	118	1	63.6	10	
CUB00001	−89.20	11	−79.81	21.62	2.24	0.80	168	1	61.1		
EQACAND1	−115.20	11	−78.40	−1.61	1.37	0.95	75	1	64.1	9/GR5	
EQAGAND1	−115.20	11	−90.34	−0.62	0.90	0.81	89	1	61.3	9/GR5	
GRD00002	−42.20	11	−61.58	12.29	0.80	0.80	90	1	58.8		
GRD00059	−57.20	11	−61.58	12.29	0.80	0.80	90	1	58.5		
GRLDNK01	−53.20	11	−44.89	66.56	2.70	0.82	173	1	60.0	2	10
GUY00201	−84.70	11	−59.19	4.78	1.44	0.85	95	1	63.5		
HWA00002	−166.20	11	−165.79	23.42	4.20	0.80	160	1	58.8	9/GR1	10
HWA00003	−175.20	11	−166.10	23.42	4.25	0.80	159	1	58.8	9/GR2	10
MEX01NTE	−78.20	11	−105.81	26.01	2.89	2.08	155	1	60.5	1	
MEX01SUR	−69.20	11	−94.84	19.82	3.05	2.09	4	1	62.3	1	10
MEX02NTE	−136.20	11	−107.21	26.31	3.84	1.55	148	1	61.2	1	10
MEX02SUR	−127.20	11	−96.39	19.88	3.18	1.87	157	1	62.6	1	10
PAQPAC01	−106.20	11	−109.18	−27.53	0.80	0.80	90	1	56.2	9/GR17	
PRG00002	−99.20	11	−58.66	−23.32	1.45	1.04	76	1	60.2		
PRUAND02	−115.20	11	−74.69	−8.39	3.41	1.79	95	1	64.0	9/GR5	
PTRVIR01	−101.20	11	−65.85	18.12	0.80	0.80	90	1	60.6	1 6 9/GR20	
PTRVIR02	−110.20	11	−65.86	18.12	0.80	0.80	90	1	61.0	1 6 9/GR21	
URG00001	−71.70	11	−56.22	−32.52	1.02	0.89	11	1	60.0		
USAEH001	−61.70	11	−85.19	36.21	5.63	3.33	22	1	61.8	1 5 6	10
USAEH002	−101.20	11	−89.24	36.16	5.67	3.76	170	1	61.7	1 6 9/GR20	10
USAEH003	−110.20	11	−90.14	36.11	5.55	3.55	161	1	62.1	1 6 9/GR21	10
USAEH004	−119.20	11	−91.16	36.05	5.38	3.24	152	1	62.6	1 5 6	10
USAPSA02	−166.20	11	−117.80	40.58	4.03	0.82	135	1	63.3	9/GR1	
USAPSA03	−175.20	11	−118.27	40.12	3.62	0.80	136	1	65.0	9/GR2	
USAWH101	−148.20	11	−109.65	38.13	5.53	1.95	142	1	62.1	10	
USAWH102	−157.20	11	−111.41	38.57	5.51	1.54	138	1	63.2	10	
VENAND03	−115.20	11	−67.04	6.91	2.37	1.43	111	1	67.3	9/GR5	

12 384.38 MHz (12)

1	2	3	4		5		6	7	8	9	
ALS00002	−165.80	12	−149.63	58.52	3.81	1.23	171	2	59.8	9/GR1	10
ALS00003	−174.80	12	−150.95	58.54	3.77	1.11	167	2	60.0	9/GR2	10
ARGNORT4	−93.80	12	−63.96	−30.01	3.86	1.99	48	2	65.7	10	
ARGNORT5	−54.80	12	−62.85	−29.80	3.24	2.89	47	2	63.5	10	
B CE311	−63.80	12	−40.60	−6.07	3.04	2.06	174	2	61.6	8 9/GR7	10
B CE312	−44.80	12	−40.26	−6.06	3.44	2.09	174	2	61.0	8 9/GR9	10
B CE411	−63.80	12	−50.97	−15.26	3.86	1.38	49	2	62.6	8 9/GR7	10
B CE412	−44.80	12	−50.71	−15.30	3.57	1.56	52	2	62.8	8 9/GR9	10
B CE511	−63.80	12	−53.11	−2.98	2.42	2.15	107	2	63.1	8 9/GR7	10
B NO611	−73.80	12	−59.60	−11.62	2.86	1.69	165	1	62.9	8 9/GR8	10
B NO711	−73.80	12	−60.70	−1.78	3.54	1.78	126	1	62.8	8 9/GR8	10
B NO811	−73.80	12	−68.75	−4.71	2.37	1.65	73	1	62.8	8 9/GR8	
B SE911	−101.80	12	−45.99	−19.09	2.22	0.80	62	2	65.3	8	10
B SU111	−80.80	12	−51.10	−25.64	2.76	1.06	50	2	62.9	8 9/GR6	10
B SU112	−44.80	12	−50.76	−25.62	2.47	1.48	56	2	62.3	8 9/GR9	
B SU211	−80.80	12	−44.51	−16.94	3.22	1.37	60	2	62.5	8 9/GR6	10
B SU212	−44.80	12	−43.99	−16.97	3.27	1.92	59	2	61.3	8 9/GR9	
CAN01101	−137.80	12	−125.60	57.24	3.45	1.27	157	2	59.5	9/GR10	10
CAN01201	−137.80	12	−111.92	55.89	3.33	0.98	151	2	59.6	9/GR10	10
CAN01202	−72.30	12	−107.64	55.62	2.75	1.11	32	2	59.6		
CAN01203	−128.80	12	−111.43	55.56	3.07	1.15	151	2	59.5	9/GR12	10
CAN01303	−128.80	12	−102.39	57.12	3.54	0.92	154	2	60.1	9/GR12	10
CAN01304	−90.80	12	−99.00	57.33	1.96	1.73	1	2	59.8	9/GR13	
CAN01403	−128.80	12	−89.70	52.02	4.67	0.80	148	2	61.8	9/GR12	10
CAN01404	−90.80	12	−84.78	52.41	3.09	2.06	153	2	60.4	9/GR13	10
CAN01405	−81.80	12	−84.02	52.34	2.82	2.30	172	2	60.3	9/GR14	10
CAN01504	−90.80	12	−72.68	53.78	3.57	1.67	157	2	60.2	9/GR13	10
CAN01505	−81.80	12	−71.76	53.76	3.30	1.89	162	2	60.2	9/GR14	10
CAN01605	−81.80	12	−61.54	49.50	2.66	1.39	144	2	60.3	9/GR14	10
CAN01606	−70.30	12	−61.32	49.51	2.41	1.65	148	2	60.2	10	
CHLCONT4	−105.80	12	−69.59	−23.20	2.21	0.80	68	2	59.1	9/GR16	
CHLCONT6	−105.80	12	−73.52	−55.52	3.65	1.31	39	2	59.6	9/GR16	
CRBBAH01	−92.30	12	−76.09	24.13	1.83	0.80	141	1	61.7	9/GR18	
CRBBER01	−92.30	12	−64.76	32.13	0.80	0.80	90	1	56.8	9/GR18	
CRBBLZ01	−92.30	12	−88.61	17.26	0.80	0.80	90	1	58.7	9/GR18	
CRBEC001	−92.30	12	−60.07	8.26	4.20	0.86	115	1	64.3	9/GR18	10
CRBJMC01	−92.30	12	−79.45	17.97	0.99	0.80	151	1	61.1	9/GR18	
CYM00001	−115.80	12	−80.58	19.57	0.80	0.80	90	2	59.6		
DOMIFRB2	−83.30	12	−70.51	18.79	0.98	0.80	167	2	61.1		
EQAC0001	−94.80	12	−78.31	−1.52	1.48	1.15	65	1	63.0	9/GR19	
EQAG0001	−94.80	12	−90.36	−0.57	0.94	0.89	99	1	61.0	9/GR19	
GUFMGG02	−52.80	12	−56.42	8.47	4.16	0.81	123	2	62.7	2 7	10
HWA00002	−165.80	12	−165.79	23.32	4.20	0.80	160	2	58.8	9/GR1	10
HWA00003	−174.80	12	−166.10	23.42	4.25	0.80	159	2	58.8	9/GR2	10
JMC00005	−33.80	12	−77.27	18.12	0.80	0.80	90	2	60.6		
LCAIFRB1	−79.30	12	−61.15	13.90	0.80	0.80	90	2	58.4		
MEX01NTE	−77.80	12	−105.80	25.99	2.88	2.07	155	2	60.5	1	
MEX02NTE	−135.80	12	−107.36	26.32	3.80	1.57	149	2	61.2	1	10
MEX02SUR	−126.80	12	−96.39	19.88	3.19	1.87	158	2	62.5	1	10
PRU00004	−85.80	12	−74.19	−8.39	3.74	2.45	112	2	62.9	10	
PTRVIR01	−100.80	12	−65.85	18.12	0.80	0.80	90	2	60.6	1 6 9/GR20	
PTRVIR02	−109.80	12	−65.85	18.12	0.80	0.80	90	2	61.1	1 6 9/GR21	
SLVIFRB2	−107.30	12	−88.91	13.59	0.80	0.80	90	1	61.7		
USAEH001	−61.30	12	−85.16	36.21	5.63	3.32	22	2	61.9	1 5 6	10
USAEH002	−100.80	12	−89.28	36.16	5.65	3.78	170	2	61.7	1 6 9/GR20	10
USAEH003	−109.80	12	−90.12	36.11	5.55	3.56	161	2	62.1	1 6 9/GR21	10
USAEH004	−118.80	12	−91.16	36.05	5.38	3.24	153	2	62.6	1 5 6	10
USAPSA02	−165.80	12	−117.79	40.58	4.04	0.82	135	2	63.3	9/GR1	
USAPSA03	−174.80	12	−118.20	40.15	3.63	0.80	136	2	65.0	9/GR2	
USAWH101	−147.80	12	−109.70	38.13	5.52	1.96	142	2	62.1	10	
USAWH102	−156.80	12	−111.40	38.57	5.51	1.55	138	2	63.2	10	
VEN11VEN	−103.80	12	−66.79	6.90	2.50	1.77	122	2	65.2	10	

12 398.96 MHz (13)

1	2	3	4		5		6	7	8	9	
ALS00002	−166.20	13	−149.66	58.37	3.76	1.24	170	1	59.7	9/GR1	10
ALS00003	−175.20	13	−150.98	58.53	3.77	1.11	167	1	60.0	9/GR2	10
ARGINSU4	−94.20	13	−52.98	−59.81	3.40	0.80	19	1	59.9	9/GR3	
ARGSUR04	−94.20	13	−65.04	−43.33	3.32	1.50	40	1	60.7	9/GR3	10
B CE311	−64.20	13	−40.60	−6.07	3.04	2.06	174	1	61.6	8 9/GR7	10
B CE312	−45.20	13	−40.27	−6.06	3.44	2.09	174	1	61.0	8 9/GR9	10
B CE411	−64.20	13	−50.97	−15.27	3.86	1.38	49	1	62.6	8 9/GR7	10
B CE412	−45.20	13	−50.71	−15.30	3.57	1.56	52	1	62.7	8 9/GR9	10
B CE511	−64.20	13	−53.10	−2.90	2.44	2.13	104	1	63.0	8 9/GR7	10
B NO611	−74.20	13	−59.60	−11.62	2.85	1.69	165	2	62.8	8 9/GR8	10
B NO711	−74.20	13	−60.70	−1.78	3.54	1.78	126	2	62.8	8 9/GR8	10
B NO811	−74.20	13	−68.76	−4.71	2.37	1.65	73	2	62.8	8 9/GR8	
B SU111	−81.20	13	−51.12	−25.63	2.76	1.05	50	1	62.8	8 9/GR6	10
B SU112	−45.20	13	−50.75	−25.62	2.47	1.48	56	1	62.2	8 9/GR9	
B SU211	−81.20	13	−44.51	−16.95	3.22	1.36	60	1	62.5	8 9/GR6	10
B SU212	−45.20	13	−44.00	−16.87	3.20	1.96	58	1	61.3	8 9/GR9	
BAHIFRB1	−87.20	13	−76.06	24.16	1.81	0.80	142	1	61.6		
BERBERMU	−96.20	13	−64.77	32.32	0.80	0.80	90	2	56.8		
BERBER02	−31.00	13	−64.77	32.32	0.80	0.80	90	1	56.9	2	10
BOLAND01	−115.20	13	−65.04	−16.76	2.49	1.27	76	1	67.9	9/GR5	
CAN01101	−138.20	13	−125.63	57.24	3.45	1.27	157	1	59.5	9/GR10	10
CAN01201	−138.20	13	−112.04	55.95	3.35	0.97	151	1	59.6	9/GR10	10
CAN01202	−72.70	13	−107.70	55.63	2.74	1.12	32	1	59.6		
CAN01203	−129.20	13	−111.48	55.61	3.08	1.15	151	1	59.5	9/GR12	10
CAN01303	−129.20	13	−102.42	57.12	3.54	0.91	154	1	60.0	9/GR12	10
CAN01304	−91.20	13	−99.12	57.36	1.98	1.72	2	1	59.8	9/GR13	
CAN01403	−129.20	13	−89.75	52.02	4.68	0.80	148	1	61.8	9/GR12	10
CAN01404	−91.20	13	−84.82	52.42	3.10	2.05	152	1	60.4	9/GR13	10
CAN01405	−82.20	13	−84.00	52.39	2.84	2.29	172	1	60.3	9/GR14	10
CAN01504	−91.20	13	−72.66	53.77	3.57	1.67	156	1	60.2	9/GR13	10
CAN01505	−82.20	13	−71.77	53.79	3.30	1.89	162	1	60.1	9/GR14	10
CAN01605	−82.20	13	−61.50	49.55	2.65	1.40	143	1	60.3	9/GR14	10
CAN01606	−70.70	13	−61.30	49.55	2.40	1.65	148	1	60.2	10	
CHLCONT5	−106.20	13	−72.23	−35.57	2.60	0.80	55	1	59.4	9/GR17	
CHLPAC02	−106.20	13	−80.06	−30.06	1.36	0.80	69	1	59.2	9/GR17	
CLMAND01	−115.20	13	−74.72	5.93	3.85	1.63	114	1	64.9	9/GR5	
CLM00001	−103.20	13	−74.50	5.87	3.98	1.96	118	1	63.5	10	
EQACAND1	−115.20	13	−78.40	−1.61	1.37	0.95	75	1	64.0	9/GR5	
EQAGAND1	−115.20	13	−90.34	−0.62	0.90	0.81	89	1	61.3	9/GR5	
FLKANT01	−57.20	13	−44.54	−60.13	3.54	0.80	12	1	59.3	2	10
FLKFALKS	−31.00	13	−59.90	−51.64	0.80	0.80	90	1	58.1	2	
GRD00002	−42.20	13	−61.58	12.29	0.80	0.80	90	1	58.8		
HWA00002	−166.20	13	−165.79	23.42	4.20	0.80	160	1	58.8	9/GR1	10
HWA00003	−175.20	13	−166.10	23.42	4.25	0.80	159	1	58.8	9/GR2	10
MEX01NTE	−78.20	13	−105.81	26.01	2.89	2.08	155	1	60.5	1	
MEX01SUR	−69.20	13	−94.84	19.82	3.05	2.09	4	1	62.2	1	10
MEX02NTE	−136.20	13	−107.21	26.31	3.84	1.55	148	1	61.2	1	10
MEX02SUR	−127.20	13	−96.39	19.88	3.18	1.87	157	1	62.5	1	10
PAQPAC01	−106.20	13	−109.18	−27.53	0.80	0.80	90	1	56.2	9/GR17	
PRG00002	−99.20	13	−58.66	−23.32	1.45	1.04	76	1	60.2		
PRUAND02	−115.20	13	−74.69	−8.39	3.41	1.79	95	1	63.9	9/GR5	
PTRVIR01	−101.20	13	−65.85	18.12	0.80	0.80	90	1	60.5	1 6 9/GR20	
PTRVIR02	−110.20	13	−65.86	18.12	0.80	0.80	90	1	61.0	1 6 9/GR21	
SPMFRAN3	−53.20	13	−67.24	47.51	3.16	0.80	7	1	60.4	2 7	10
TRD00001	−84.70	13	−61.23	10.70	0.80	0.80	90	1	59.4		
URG00001	−71.70	13	−56.22	−32.52	1.02	0.89	11	1	60.0		
USAEH001	−61.70	13	−85.19	36.21	5.63	3.33	22	1	61.8	1 5 6	10
USAEH002	−101.20	13	−89.24	36.16	5.67	3.76	170	1	61.7	1 6 9/GR20	10
USAEH003	−110.20	13	−90.14	36.11	5.55	3.55	161	1	62.0	1 6 9/GR21	10
USAEH004	−119.20	13	−91.16	36.05	5.38	3.24	152	1	62.6	1 5 6	10
USAPSA02	−166.20	13	−117.80	40.58	4.03	0.82	135	1	63.2	9/GR1	
USAPSA03	−175.20	13	−118.27	40.12	3.62	0.80	136	1	65.0	9/GR2	
USAWH101	−148.20	13	−109.65	38.13	5.53	1.95	142	1	62.1	10	
USAWH102	−157.20	13	−111.41	38.57	5.51	1.54	138	1	63.2	10	
VENAND03	−115.20	13	−67.04	6.91	2.37	1.43	111	1	67.2	9/GR5	
VRG00001	−79.70	13	−64.37	18.48	0.80	0.80	90	1	58.3	4	

12 413.54 MHz (14)

1	2	3	4		5		6	7	8	9	
ALS00002	−165.80	14	−149.63	58.52	3.81	1.23	171	2	59.7	9/GR1	10
ALS00003	−174.80	14	−150.95	58.54	3.77	1.11	167	2	60.0	9/GR2	10
ARGNORT4	−93.80	14	−63.96	−30.01	3.86	1.99	48	2	65.6	10	
ARGNORT5	−54.80	14	−62.85	−29.80	3.24	2.89	47	2	63.5	10	
ATNBEAM1	−52.80	14	−66.44	14.87	1.83	0.80	39	2	61.0		
B CE311	−63.80	14	−40.60	−6.07	3.04	2.06	174	2	61.6	8 9/GR7	10
B CE312	−44.80	14	−40.26	−6.06	3.44	2.09	174	2	61.0	8 9/GR9	10
B CE411	−63.80	14	−50.97	−15.26	3.86	1.38	49	2	62.6	8 9/GR7	10
B CE412	−44.80	14	−50.71	−15.30	3.57	1.56	52	2	62.7	8 9/GR9	10
B CE511	−63.80	14	−53.11	−2.98	2.42	2.15	107	2	63.1	8 9/GR7	10
B NO611	−73.80	14	−59.60	−11.62	2.86	1.69	165	1	62.8	8 9/GR8	10
B NO711	−73.80	14	−60.70	−1.78	3.54	1.78	126	1	62.8	8 9/GR8	10
B NO811	−73.80	14	−68.75	−4.71	2.37	1.65	73	1	62.8	8 9/GR8	
B SE911	−101.80	14	−45.99	−19.09	2.22	0.80	62	2	65.3	8	10
B SU111	−80.80	14	−51.10	−25.64	2.76	1.06	50	2	62.8	8 9/GR6	10
B SU112	−44.80	14	−50.76	−25.62	2.47	1.48	56	2	62.3	8 9/GR9	
B SU211	−80.80	14	−44.51	−16.94	3.22	1.37	60	2	62.5	8 9/GR6	10
B SU212	−44.80	14	−43.99	−16.97	3.27	1.92	59	2	61.3	8 9/GR9	
CAN01101	−137.80	14	−125.60	57.24	3.45	1.27	157	2	59.5	9/GR10	10
CAN01201	−137.80	14	−111.92	55.89	3.33	0.98	151	2	59.6	9/GR10	10
CAN01202	−72.30	14	−107.64	55.62	2.75	1.11	32	2	59.6		
CAN01203	−128.80	14	−111.43	55.56	3.07	1.15	151	2	59.5	9/GR12	10
CAN01303	−128.80	14	−102.39	57.12	3.54	0.92	154	2	60.0	9/GR12	10
CAN01304	−90.80	14	−99.00	57.33	1.96	1.73	1	2	59.8	9/GR13	
CAN01403	−128.80	14	−89.70	52.02	4.67	0.80	148	2	61.8	9/GR12	10
CAN01404	−90.80	14	−84.78	52.41	3.09	2.06	153	2	60.4	9/GR13	10
CAN01405	−81.80	14	−84.02	52.34	2.82	2.30	172	2	60.3	9/GR14	10
CAN01504	−90.80	14	−72.68	53.78	3.57	1.67	157	2	60.2	9/GR13	10
CAN01505	−81.80	14	−71.76	53.76	3.30	1.89	162	2	60.1	9/GR14	10
CAN01605	−81.80	14	−61.54	49.50	2.66	1.39	144	2	60.3	9/GR14	10
CAN01606	−70.30	14	−61.32	49.51	2.41	1.65	148	2	60.2	10	
CHLCONT4	−105.80	14	−69.59	−23.20	2.21	0.80	68	2	59.1	9/GR16	
CHLCONT6	−105.80	14	−73.52	−55.52	3.65	1.31	39	2	59.6	9/GR16	
CRBBAH01	−92.30	14	−76.09	24.13	1.83	0.80	141	1	61.7	9/GR18	
CRBBER01	−92.30	14	−64.76	32.13	0.80	0.80	90	1	56.7	9/GR18	
CRBBLZ01	−92.30	14	−88.61	17.26	0.80	0.80	90	1	58.6	9/GR18	
CRBEC001	−92.30	14	−60.07	8.26	4.20	0.86	115	1	64.2	9/GR18	10
CRBJMC01	−92.30	14	−79.45	17.97	0.99	0.80	151	1	61.1	9/GR18	
CTR00201	−130.80	14	−84.33	9.67	0.82	0.80	119	2	65.6		
EQAC0001	−94.80	14	−78.31	−1.52	1.48	1.15	65	1	63.0	9/GR19	
EQAG0001	−94.80	14	−90.36	−0.57	0.94	0.89	99	1	61.0	9/GR19	
GUY00302	−33.80	14	−59.07	4.77	1.43	0.85	91	2	63.5		
HNDIFRB2	−107.30	14	−86.23	15.16	1.14	0.85	8	1	63.4		
HTI00002	−83.30	14	−73.28	18.96	0.82	0.80	11	2	60.9		
HWA00002	−165.80	14	−165.79	23.32	4.20	0.80	160	2	58.8	9/GR1	10
HWA00003	−174.80	14	−166.10	23.42	4.25	0.80	159	2	58.8	9/GR2	10
MEX01NTE	−77.80	14	−105.80	25.99	2.88	2.07	155	2	60.5	1	
MEX02NTE	−135.80	14	−107.36	26.32	3.80	1.57	149	2	61.2	1	10
MEX02SUR	−126.80	14	−96.39	19.88	3.19	1.87	158	2	62.5	1	10
PRU00004	−85.80	14	−74.19	−8.39	3.74	2.45	112	2	62.8	10	
PTRVIR01	−100.80	14	−65.85	18.12	0.80	0.80	90	2	60.6	1 6 9/GR20	
PTRVIR02	−109.80	14	−65.85	18.12	0.80	0.80	90	2	61.1	1 6 9/GR21	
TCA00001	−115.80	14	−71.79	21.53	0.80	0.80	90	2	60.4		
USAEH001	−61.30	14	−85.16	36.21	5.63	3.32	22	2	61.8	1 5 6	10
USAEH002	−100.80	14	−89.28	36.16	5.65	3.78	170	2	61.7	1 6 9/GR20	10
USAEH003	−109.80	14	−90.12	36.11	5.55	3.56	161	2	62.1	1 6 9/GR21	10
USAEH004	−118.80	14	−91.16	36.05	5.38	3.24	153	2	62.6	1 5 6	10
USAPSA02	−165.80	14	−117.79	40.58	4.04	0.82	135	2	63.2	9/GR1	
USAPSA03	−174.80	14	−118.20	40.15	3.63	0.80	136	2	64.9	9/GR2	
USAWH101	−147.80	14	−109.70	38.13	5.52	1.96	142	2	62.1	10	
USAWH102	−156.80	14	−111.40	38.57	5.51	1.55	138	2	63.2	10	
VCT00001	−79.30	14	−61.18	13.23	0.80	0.80	90	2	58.4		
VEN11VEN	−103.80	14	−66.79	6.90	2.50	1.77	122	2	65.1	10	

12 428.12 MHz (15)

1	2	3	4		5		6	7	8	9	
ALS00002	−166.20	15	−149.66	58.37	3.76	1.24	170	1	59.8	9/GR1	10
ALS00003	−175.20	15	−150.98	58.53	3.77	1.11	167	1	60.0	9/GR2	10
ARGINSU4	−94.20	15	−52.98	−59.81	3.40	0.80	19	1	59.9	9/GR3	
ARGINSU5	−55.20	15	−44.17	−59.91	3.77	0.80	13	1	59.3	9/GR4	10
ARGSUR04	−94.20	15	−65.04	−43.33	3.32	1.50	40	1	60.7	9/GR3	10
ARGSUR05	−55.20	15	−63.68	−43.01	2.54	2.38	152	1	60.1	9/GR4	10
ATGSJN01	−79.70	15	−61.79	17.07	0.80	0.80	90	1	58.4		
B CE311	−64.20	15	−40.60	−6.07	3.04	2.06	174	1	61.6	8 9/GR7	10
B CE312	−45.20	15	−40.27	−6.06	3.44	2.09	174	1	61.0	8 9/GR9	10
B CE411	−64.20	15	−50.97	−15.27	3.86	1.38	49	1	62.6	8 9/GR7	10
B CE412	−45.20	15	−50.71	−15.30	3.57	1.56	52	1	62.7	8 9/GR9	10
B CE511	−64.20	15	−53.10	−2.90	2.44	2.13	104	1	63.1	8 9/GR7	10
B NO611	−74.20	15	−59.60	−11.62	2.85	1.69	165	2	62.9	8 9/GR8	10
B NO711	−74.20	15	−60.70	−1.78	3.54	1.78	126	2	62.8	8 9/GR8	10
B NO811	−74.20	15	−68.76	−4.71	2.37	1.65	73	2	62.8	8 9/GR8	
B SU111	−81.20	15	−51.12	−25.63	2.76	1.05	50	1	62.9	8 9/GR6	10
B SU112	−45.20	15	−50.75	−25.62	2.47	1.48	56	1	62.3	8 9/GR9	
B SU211	−81.20	15	−44.51	−16.95	3.22	1.36	60	1	62.5	8 9/GR6	10
B SU212	−45.20	15	−44.00	−16.87	3.20	1.96	58	1	61.3	8 9/GR9	
BERBERMU	−96.20	15	−64.77	32.32	0.80	0.80	90	2	56.8		
BOLAND01	−115.20	15	−65.04	−16.76	2.49	1.27	76	1	67.9	9/GR5	
BOL00001	−87.20	15	−64.61	−16.71	2.52	2.19	85	1	63.8	10	
BRB00001	−92.70	15	−59.85	12.93	0.80	0.80	90	2	59.1		
CAN01101	−138.20	15	−125.63	57.24	3.45	1.27	157	1	59.5	9/GR10	10
CAN01201	−138.20	15	−112.04	55.95	3.35	0.97	151	1	59.6	9/GR10	10
CAN01202	−72.70	15	−107.70	55.63	2.74	1.12	32	1	59.6		
CAN01203	−129.20	15	−111.48	55.61	3.08	1.15	151	1	59.5	9/GR12	10
CAN01303	−129.20	15	−102.42	57.12	3.54	0.91	154	1	60.1	9/GR12	10
CAN01304	−91.20	15	−99.12	57.36	1.98	1.72	2	1	59.8	9/GR13	
CAN01403	−129.20	15	−89.75	52.02	4.68	0.80	148	1	61.8	9/GR12	10
CAN01404	−91.20	15	−84.82	52.42	3.10	2.05	152	1	60.4	9/GR13	10
CAN01405	−82.20	15	−84.00	52.39	2.84	2.29	172	1	60.3	9/GR14	10
CAN01504	−91.20	15	−72.66	53.77	3.57	1.67	156	1	60.2	9/GR13	10
CAN01505	−82.20	15	−71.77	53.79	3.30	1.89	162	1	60.1	9/GR14	10
CAN01605	−82.20	15	−61.50	49.55	2.65	1.40	143	1	60.3	9/GR14	10
CAN01606	−70.70	15	−61.30	49.55	2.40	1.65	148	1	60.2	10	
CHLCONT5	−106.20	15	−72.23	−35.57	2.60	0.80	55	1	59.4	9/GR17	
CHLPAC02	−106.20	15	−80.06	−30.06	1.36	0.80	69	1	59.2	9/GR17	
CLMAND01	−115.20	15	−74.72	5.93	3.85	1.63	114	1	65.0	9/GR5	
CLM00001	−103.20	15	−74.50	5.87	3.98	1.96	118	1	63.6	10	
CUB00001	−89.20	15	−79.81	21.62	2.24	0.80	168	1	61.1		
EQACAND1	−115.20	15	−78.40	−1.61	1.37	0.95	75	1	64.1	9/GR5	
EQAGAND1	−115.20	15	−90.34	−0.62	0.90	0.81	89	1	61.3	9/GR5	
GRD00002	−42.20	15	−61.58	12.29	0.80	0.80	90	1	58.8		
GRD00059	−57.20	15	−61.58	12.29	0.80	0.80	90	1	58.5		
GRLDNK01	−53.20	15	−44.89	66.56	2.70	0.82	173	1	60.0	2	10
GUY00201	−84.70	15	−59.19	4.78	1.44	0.85	95	1	63.5		
HWA00002	−166.20	15	−165.79	23.42	4.20	0.80	160	1	58.8	9/GR1	10
HWA00003	−175.20	15	−166.10	23.42	4.25	0.80	159	1	58.8	9/GR2	10
MEX01NTE	−78.20	15	−105.81	26.01	2.89	2.08	155	1	60.5	1	
MEX01SUR	−69.20	15	−94.84	19.82	3.05	2.09	4	1	62.3	1	10
MEX02NTE	−136.20	15	−107.21	26.31	3.84	1.55	148	1	61.2	1	10
MEX02SUR	−127.20	15	−96.39	19.88	3.18	1.87	157	1	62.6	1	10
PAQPAC01	−106.20	15	−109.18	−27.53	0.80	0.80	90	1	56.2	9/GR17	
PRG00002	−99.20	15	−58.66	−23.32	1.45	1.04	76	1	60.2		
PRUAND02	−115.20	15	−74.69	−8.39	3.41	1.79	95	1	64.0	9/GR5	
PTRVIR01	−101.20	15	−65.85	18.12	0.80	0.80	90	1	60.6	1 6 9/GR20	
PTRVIR02	−110.20	15	−65.86	18.12	0.80	0.80	90	1	61.0	1 6 9/GR21	
URG00001	−71.70	15	−56.22	−32.52	1.02	0.89	11	1	60.0		
USAEH001	−61.70	15	−85.19	36.21	5.63	3.33	22	1	61.8	1 5 6	10
USAEH002	−101.20	15	−89.24	36.16	5.67	3.76	170	1	61.7	1 6 9/GR20	10
USAEH003	−110.20	15	−90.14	36.11	5.55	3.55	161	1	62.1	1 6 9/GR21	10
USAEH004	−119.20	15	−91.16	36.05	5.38	3.24	152	1	62.6	1 5 6	10
USAPSA02	−166.20	15	−117.80	40.58	4.03	0.82	135	1	63.3	9/GR1	
USAPSA03	−175.20	15	−118.27	40.12	3.62	0.80	136	1	65.0	9/GR2	
USAWH101	−148.20	15	−109.65	38.13	5.53	1.95	142	1	62.1	10	
USAWH102	−157.20	15	−111.41	38.57	5.51	1.54	138	1	63.2	10	
VENAND03	−115.20	15	−67.04	6.91	2.37	1.43	111	1	67.3	9/GR5	

12 442.70 MHz (16)

1	2	3	4		5		6	7	8	9	
ALS00002	−165.80	16	−149.63	58.52	3.81	1.23	171	2	59.8	9/GR1	10
ALS00003	−174.80	16	−150.95	58.54	3.77	1.11	167	2	60.0	9/GR2	10
ARGNORT4	−93.80	16	−63.96	−30.01	3.86	1.99	48	2	65.7	10	
ARGNORT5	−54.80	16	−62.85	−29.80	3.24	2.89	47	2	63.5	10	
B CE311	−63.80	16	−40.60	−6.07	3.04	2.06	174	2	61.6	8 9/GR7	10
B CE312	−44.80	16	−40.26	−6.06	3.44	2.09	174	2	61.0	8 9/GR9	10
B CE411	−63.80	16	−50.97	−15.26	3.86	1.38	49	2	62.6	8 9/GR7	10
B CE412	−44.80	16	−50.71	−15.30	3.57	1.56	52	2	62.8	8 9/GR9	10
B CE511	−63.80	16	−53.11	−2.98	2.42	2.15	107	2	63.1	8 9/GR7	10
B NO611	−73.80	16	−59.60	−11.62	2.86	1.69	165	1	62.9	8 9/GR8	10
B NO711	−73.80	16	−60.70	−1.78	3.54	1.78	126	1	62.8	8 9/GR8	10
B NO811	−73.80	16	−68.75	−4.71	2.37	1.65	73	1	62.8	8 9/GR8	
B SE911	−101.80	16	−45.99	−19.09	2.22	0.80	62	2	65.3	8	10
B SU111	−80.80	16	−51.10	−25.64	2.76	1.06	50	2	62.9	8 9/GR6	10
B SU112	−44.80	16	−50.76	−25.62	2.47	1.48	56	2	62.3	8 9/GR9	
B SU211	−80.80	16	−44.51	−16.94	3.22	1.37	60	2	62.5	8 9/GR6	10
B SU212	−44.80	16	−43.99	−16.97	3.27	1.92	59	2	61.3	8 9/GR9	
CAN01101	−137.80	16	−125.60	57.24	3.45	1.27	157	2	59.5	9/GR10	10
CAN01201	−137.80	16	−111.92	55.89	3.33	0.98	151	2	59.6	9/GR10	10
CAN01202	−72.30	16	−107.64	55.62	2.75	1.11	32	2	59.6		
CAN01203	−128.80	16	−111.43	55.56	3.07	1.15	151	2	59.5	9/GR12	10
CAN01303	−128.80	16	−102.39	57.12	3.54	0.92	154	2	60.1	9/GR12	10
CAN01304	−90.80	16	−99.00	57.33	1.96	1.73	1	2	59.8	9/GR13	
CAN01403	−128.80	16	−89.70	52.02	4.67	0.80	148	2	61.8	9/GR12	10
CAN01404	−90.80	16	−84.78	52.41	3.09	2.06	153	2	60.4	9/GR13	10
CAN01405	−81.80	16	−84.02	52.34	2.82	2.30	172	2	60.3	9/GR14	10
CAN01504	−90.80	16	−72.68	53.78	3.57	1.67	157	2	60.2	9/GR13	10
CAN01505	−81.80	16	−71.76	53.76	3.30	1.89	162	2	60.2	9/GR14	10
CAN01605	−81.80	16	−61.54	49.50	2.66	1.39	144	2	60.3	9/GR14	10
CAN01606	−70.30	16	−61.32	49.51	2.41	1.65	148	2	60.2	10	
CHLCONT4	−105.80	16	−69.59	−23.20	2.21	0.80	68	2	59.1	9/GR16	
CHLCONT6	−105.80	16	−73.52	−55.52	3.65	1.31	39	2	59.6	9/GR16	
CRBBAH01	−92.30	16	−76.09	24.13	1.83	0.80	141	1	61.7	9/GR18	
CRBBER01	−92.30	16	−64.76	32.13	0.80	0.80	90	1	56.8	9/GR18	
CRBBLZ01	−92.30	16	−88.61	17.26	0.80	0.80	90	1	58.7	9/GR18	
CRBEC001	−92.30	16	−60.07	8.26	4.20	0.86	115	1	64.3	9/GR18	10
CRBJMC01	−92.30	16	−79.45	17.97	0.99	0.80	151	1	61.1	9/GR18	
CYM00001	−115.80	16	−80.58	19.57	0.80	0.80	90	2	59.6		
DOMIFRB2	−83.30	16	−70.51	18.79	0.98	0.80	167	2	61.1		
EQAC0001	−94.80	16	−78.31	−1.52	1.48	1.15	65	1	63.0	9/GR19	
EQAG0001	−94.80	16	−90.36	−0.57	0.94	0.89	99	1	61.0	9/GR19	
GUFMGG02	−52.80	16	−56.42	8.47	4.16	0.81	123	2	62.7	2 7	10
HWA00002	−165.80	16	−165.79	23.32	4.20	0.80	160	2	58.8	9/GR1	10
HWA00003	−174.80	16	−166.10	23.42	4.25	0.80	159	2	58.8	9/GR2	10
JMC00005	−33.80	16	−77.27	18.12	0.80	0.80	90	2	60.6		
LCAIFRB1	−79.30	16	−61.15	13.90	0.80	0.80	90	2	58.4		
MEX01NTE	−77.80	16	−105.80	25.99	2.88	2.07	155	2	60.5	1	
MEX02NTE	−135.80	16	−107.36	26.32	3.80	1.57	149	2	61.2	1	10
MEX02SUR	−126.80	16	−96.39	19.88	3.19	1.87	158	2	62.5	1	10
PRU00004	−85.80	16	−74.19	−8.39	3.74	2.45	112	2	62.9	10	
PTRVIR01	−100.80	16	−65.85	18.12	0.80	0.80	90	2	60.6	1 6 9/GR20	
PTRVIR02	−109.80	16	−65.85	18.12	0.80	0.80	90	2	61.1	1 6 9/GR21	
SLVIFRB2	−107.30	16	−88.91	13.59	0.80	0.80	90	1	61.7		
USAEH001	−61.30	16	−85.16	36.21	5.63	3.32	22	2	61.9	1 5 6	10
USAEH002	−100.80	16	−89.28	36.16	5.65	3.78	170	2	61.7	1 6 9/GR20	10
USAEH003	−109.80	16	−90.12	36.11	5.55	3.56	161	2	62.1	1 6 9/GR21	10
USAEH004	−118.80	16	−91.16	36.05	5.38	3.24	153	2	62.6	1 5 6	10
USAPSA02	−165.80	16	−117.79	40.58	4.04	0.82	135	2	63.3	9/GR1	
USAPSA03	−174.80	16	−118.20	40.15	3.63	0.80	136	2	65.0	9/GR2	
USAWH101	−147.80	16	−109.70	38.13	5.52	1.96	142	2	62.1	10	
USAWH102	−156.80	16	−111.40	38.57	5.51	1.55	138	2	63.2	10	
VEN11VEN	−103.80	16	−66.79	6.90	2.50	1.77	122	2	65.2	10	

12 457.28 MHz (17)

1	2	3	4		5		6	7	8	9	
ALS00002	−166.20	17	−149.66	58.37	3.76	1.24	170	1	59.9	9/GR1	10
ALS00003	−175.20	17	−150.98	58.53	3.77	1.11	167	1	60.2	9/GR2	10
ARGINSU4	−94.20	17	−52.98	−59.81	3.40	0.80	19	1	60.1	9/GR3	
ARGINSU5	−55.20	17	−44.17	−59.91	3.77	0.80	13	1	59.5	9/GR4	10
ARGSUR04	−94.20	17	−65.04	−43.33	3.32	1.50	40	1	60.9	9/GR3	10
ARGSUR05	−55.20	17	−63.68	−43.01	2.54	2.38	152	1	60.2	9/GR4	10
B CE311	−64.20	17	−40.60	−6.07	3.04	2.06	174	1	61.9	8 9/GR7	10
B CE312	−45.20	17	−40.27	−6.06	3.44	2.09	174	1	61.2	8 9/GR9	10
B CE411	−64.20	17	−50.97	−15.27	3.86	1.38	49	1	62.9	8 9/GR7	10
B CE412	−45.20	17	−50.71	−15.30	3.57	1.56	52	1	63.0	8 9/GR9	10
B CE511	−64.20	17	−53.10	−2.90	2.44	2.13	104	1	63.4	8 9/GR7	10
B NO611	−74.20	17	−59.60	−11.62	2.85	1.69	165	2	63.1	8 9/GR8	10
B NO711	−74.20	17	−60.70	−1.78	3.54	1.78	126	2	63.1	8 9/GR8	10
B NO811	−74.20	17	−68.76	−4.71	2.37	1.65	73	2	63.1	8 9/GR8	
B SU111	−81.20	17	−51.12	−25.63	2.76	1.05	50	1	63.2	8 9/GR6	10
B SU112	−45.20	17	−50.75	−25.62	2.47	1.48	56	1	62.5	8 9/GR9	
B SU211	−81.20	17	−44.51	−16.95	3.22	1.36	60	1	62.8	8 9/GR6	10
B SU212	−45.20	17	−44.00	−16.87	3.20	1.96	58	1	61.6	8 9/GR9	
BERBERMU	−96.20	17	−64.77	32.32	0.80	0.80	90	2	57.0		
BERBER02	−31.00	17	−64.77	32.32	0.80	0.80	90	1	57.1	2	10
BOLAND01	−115.20	17	−65.04	−16.76	2.49	1.27	76	1	68.0	9/GR5	
CAN01101	−138.20	17	−125.63	57.24	3.45	1.27	157	1	59.7	9/GR10	10
CAN01201	−138.20	17	−112.04	55.95	3.35	0.97	151	1	59.8	9/GR10	10
CAN01202	−72.70	17	−107.70	55.63	2.74	1.12	32	1	59.8		
CAN01203	−129.20	17	−111.48	55.61	3.08	1.15	151	1	59.7	9/GR12	10
CAN01303	−129.20	17	−102.42	57.12	3.54	0.91	154	1	60.2	9/GR12	10
CAN01304	−91.20	17	−99.12	57.36	1.98	1.72	2	1	60.0	9/GR13	
CAN01403	−129.20	17	−89.75	52.02	4.68	0.80	148	1	62.1	9/GR12	10
CAN01404	−91.20	17	−84.82	52.42	3.10	2.05	152	1	60.6	9/GR13	10
CAN01405	−82.20	17	−84.00	52.39	2.84	2.29	172	1	60.5	9/GR14	10
CAN01504	−91.20	17	−72.66	53.77	3.57	1.67	156	1	60.4	9/GR13	10
CAN01505	−82.20	17	−71.77	53.79	3.30	1.89	162	1	60.3	9/GR14	10
CAN01605	−82.20	17	−61.50	49.55	2.65	1.40	143	1	60.5	9/GR14	10
CAN01606	−70.70	17	−61.30	49.55	2.40	1.65	148	1	60.4	10	
CHLCONT5	−106.20	17	−72.23	−35.57	2.60	0.80	55	1	59.6	9/GR17	
CHLPAC02	−106.20	17	−80.06	−30.06	1.36	0.80	69	1	59.4	9/GR17	
CLMAND01	−115.20	17	−74.72	5.93	3.85	1.63	114	1	65.3	9/GR5	
CLM00001	−103.20	17	−74.50	5.87	3.98	1.96	118	1	63.9	10	
EQACAND1	−115.20	17	−78.40	−1.61	1.37	0.95	75	1	64.4	9/GR5	
EQAGAND1	−115.20	17	−90.34	−0.62	0.90	0.81	89	1	61.5	9/GR5	
FLKFALKS	−31.00	17	−59.90	−51.64	0.80	0.80	90	1	58.2	2	
HWA00002	−166.20	17	−165.79	23.42	4.20	0.80	160	1	59.0	9/GR1	10
HWA00003	−175.20	17	−166.10	23.42	4.25	0.80	159	1	58.9	9/GR2	10
JMC00002	−92.70	17	−77.30	18.12	0.80	0.80	90	2	60.1		
KNA00001	−79.70	17	−62.46	17.44	0.80	0.80	90	1	58.6		
MEX01NTE	−78.20	17	−105.81	26.01	2.89	2.08	155	1	60.7	1	
MEX01SUR	−69.20	17	−94.84	19.82	3.05	2.09	4	1	62.5	1	10
MEX02NTE	−136.20	17	−107.21	26.31	3.84	1.55	148	1	61.4	1	10
MEX02SUR	−127.20	17	−96.39	19.88	3.18	1.87	157	1	62.8	1	10
PAQPAC01	−106.20	17	−109.18	−27.53	0.80	0.80	90	1	56.4	9/GR17	
PRG00002	−99.20	17	−58.66	−23.32	1.45	1.04	76	1	60.4		
PRUAND02	−115.20	17	−74.69	−8.39	3.41	1.79	95	1	64.3	9/GR5	
PTRVIR01	−101.20	17	−65.85	18.12	0.80	0.80	90	1	60.8	1 6 9/GR20	
PTRVIR02	−110.20	17	−65.86	18.12	0.80	0.80	90	1	61.3	1 6 9/GR21	
SPMFRAN3	−53.20	17	−67.24	47.51	3.16	0.80	7	1	60.6	2 7	10
SURINAM2	−84.70	17	−55.69	4.35	1.00	0.80	86	1	63.5		
URG00001	−71.70	17	−56.22	−32.52	1.02	0.89	11	1	60.2		
USAEH001	−61.70	17	−85.19	36.21	5.63	3.33	22	1	62.1	1 5 6	10
USAEH002	−101.20	17	−89.24	36.16	5.67	3.76	170	1	62.0	1 6 9/GR20	10
USAEH003	−110.20	17	−90.14	36.11	5.55	3.55	161	1	62.3	1 6 9/GR21	10
USAEH004	−119.20	17	−91.16	36.05	5.38	3.24	152	1	62.9	1 5 6	10
USAPSA02	−166.20	17	−117.80	40.58	4.03	0.82	135	1	63.5	9/GR1	
USAPSA03	−175.20	17	−118.27	40.12	3.62	0.80	136	1	65.3	9/GR2	
USAWH101	−148.20	17	−109.65	38.13	5.53	1.95	142	1	62.3	10	
USAWH102	−157.20	17	−111.41	38.57	5.51	1.54	138	1	63.5	10	
VENAND03	−115.20	17	−67.04	6.91	2.37	1.43	111	1	67.6	9/GR5	

12 471.86 MHz (18)

1	2	3	4		5		6	7	8	9	
ALS00002	−165.80	18	−149.63	58.52	3.81	1.23	171	2	59.9	9/GR1	10
ALS00003	−174.80	18	−150.95	58.54	3.77	1.11	167	2	60.2	9/GR2	10
ARGNORT4	−93.80	18	−63.96	−30.01	3.86	1.99	48	2	66.0	10	
ARGNORT5	−54.80	18	−62.85	−29.80	3.24	2.89	47	2	63.8	10	
ATNBEAM1	−52.80	18	−66.44	14.87	1.83	0.80	39	2	61.3		
B CE311	−63.80	18	−40.60	−6.07	3.04	2.06	174	2	61.9	8 9/GR7	10
B CE312	−44.80	18	−40.26	−6.06	3.44	2.09	174	2	61.2	8 9/GR9	10
B CE411	−63.80	18	−50.97	−15.26	3.86	1.38	49	2	62.9	8 9/GR7	10
B CE412	−44.80	18	−50.71	−15.30	3.57	1.56	52	2	63.0	8 9/GR9	10
B CE511	−63.80	18	−53.11	−2.98	2.42	2.15	107	2	63.4	8 9/GR7	10
B NO611	−73.80	18	−59.60	−11.62	2.86	1.69	165	1	63.1	8 9/GR8	10
B NO711	−73.80	18	−60.70	−1.78	3.54	1.78	126	1	63.1	8 9/GR8	10
B NO811	−73.80	18	−68.75	−4.71	2.37	1.65	73	1	63.1	8 9/GR8	
B SE911	−101.80	18	−45.99	−19.09	2.22	0.80	62	2	65.7	8	10
B SU111	−80.80	18	−51.10	−25.64	2.76	1.06	50	2	63.1	8 9/GR6	10
B SU112	−44.80	18	−50.76	−25.62	2.47	1.48	56	2	62.6	8 9/GR9	
B SU211	−80.80	18	−44.51	−16.94	3.22	1.37	60	2	62.8	8 9/GR6	10
B SU212	−44.80	18	−43.99	−16.97	3.27	1.92	59	2	61.6	8 9/GR9	
BLZ00001	−115.80	18	−88.68	17.27	0.80	0.80	90	2	59.2		
CAN01101	−137.80	18	−125.60	57.24	3.45	1.27	157	2	59.7	9/GR10	10
CAN01201	−137.80	18	−111.92	55.89	3.33	0.98	151	2	59.8	9/GR10	10
CAN01202	−72.30	18	−107.64	55.62	2.75	1.11	32	2	59.8		
CAN01203	−128.80	18	−111.43	55.56	3.07	1.15	151	2	59.7	9/GR12	10
CAN01303	−128.80	18	−102.39	57.12	3.54	0.92	154	2	60.3	9/GR12	10
CAN01304	−90.80	18	−99.00	57.33	1.96	1.73	1	2	60.0	9/GR13	
CAN01403	−128.80	18	−89.70	52.02	4.67	0.80	148	2	62.1	9/GR12	10
CAN01404	−90.80	18	−84.78	52.41	3.09	2.06	153	2	60.6	9/GR13	10
CAN01405	−81.80	18	−84.02	52.34	2.82	2.30	172	2	60.5	9/GR14	10
CAN01504	−90.80	18	−72.68	53.78	3.57	1.67	157	2	60.4	9/GR13	10
CAN01505	−81.80	18	−71.76	53.76	3.30	1.89	162	2	60.3	9/GR14	10
CAN01605	−81.80	18	−61.54	49.50	2.66	1.39	144	2	60.5	9/GR14	10
CAN01606	−70.30	18	−61.32	49.51	2.41	1.65	148	2	60.4	10	
CHLCONT4	−105.80	18	−69.59	−23.20	2.21	0.80	68	2	59.3	9/GR16	
CHLCONT6	−105.80	18	−73.52	−55.52	3.65	1.31	39	2	59.7	9/GR16	
CRBBAH01	−92.30	18	−76.09	24.13	1.83	0.80	141	1	61.9	9/GR18	
CRBBER01	−92.30	18	−64.76	32.13	0.80	0.80	90	1	56.9	9/GR18	
CRBBLZ01	−92.30	18	−88.61	17.26	0.80	0.80	90	1	58.9	9/GR18	
CRBEC001	−92.30	18	−60.07	8.26	4.20	0.86	115	1	64.6	9/GR18	10
CRBJMC01	−92.30	18	−79.45	17.97	0.99	0.80	151	1	61.3	9/GR18	
CTR00201	−130.80	18	−84.33	9.67	0.82	0.80	119	2	66.0		
DMAIFRB1	−79.30	18	−61.30	15.35	0.80	0.80	90	2	58.7		
EQAC0001	−94.80	18	−78.31	−1.52	1.48	1.15	65	1	63.3	9/GR19	
EQAG0001	−94.80	18	−90.36	−0.57	0.94	0.89	99	1	61.2	9/GR19	
HWA00002	−165.80	18	−165.79	23.32	4.20	0.80	160	2	59.0	9/GR1	10
HWA00003	−174.80	18	−166.10	23.42	4.25	0.80	159	2	59.0	9/GR2	10
MEX01NTE	−77.80	18	−105.80	25.99	2.88	2.07	155	2	60.7	1	
MEX02NTE	−135.80	18	−107.36	26.32	3.80	1.57	149	2	61.4	1	10
MEX02SUR	−126.80	18	−96.39	19.88	3.19	1.87	158	2	62.8	1	10
NCG00003	−107.30	18	−84.99	12.90	1.05	1.01	176	1	63.6		
PRU00004	−85.80	18	−74.19	−8.39	3.74	2.45	112	2	63.1	10	
PTRVIR01	−100.80	18	−65.85	18.12	0.80	0.80	90	2	60.8	1 6 9/GR20	
PTRVIR02	−109.80	18	−65.85	18.12	0.80	0.80	90	2	61.4	1 6 9/GR21	
USAEH001	−61.30	18	−85.16	36.21	5.63	3.32	22	2	62.1	1 5 6	10
USAEH002	−100.80	18	−89.28	36.16	5.65	3.78	170	2	62.0	1 6 9/GR20	10
USAEH003	−109.80	18	−90.12	36.11	5.55	3.56	161	2	62.3	1 6 9/GR21	10
USAEH004	−118.80	18	−91.16	36.05	5.38	3.24	153	2	62.9	1 5 6	10
USAPSA02	−165.80	18	−117.79	40.58	4.04	0.82	135	2	63.5	9/GR1	
USAPSA03	−174.80	18	−118.20	40.15	3.63	0.80	136	2	65.3	9/GR2	
USAWH101	−147.80	18	−109.70	38.13	5.52	1.96	142	2	62.3	10	
USAWH102	−156.80	18	−111.40	38.57	5.51	1.55	138	2	63.5	10	
VEN11VEN	−103.80	18	−66.79	6.90	2.50	1.77	122	2	65.5	10	

12 486.44 MHz (19)

1	2	3	4		5		6	7	8	9	
ALS00002	−166.20	19	−149.66	58.37	3.76	1.24	170	1	60.0	9/GR1	10
ALS00003	−175.20	19	−150.98	58.53	3.77	1.11	167	1	60.2	9/GR2	10
ARGINSU4	−94.20	19	−52.98	−59.81	3.40	0.80	19	1	60.1	9/GR3	
ARGINSU5	−55.20	19	−44.17	−59.91	3.77	0.80	13	1	59.5	9/GR4	10
ARGSUR04	−94.20	19	−65.04	−43.33	3.32	1.50	40	1	60.9	9/GR3	10
ARGSUR05	−55.20	19	−63.68	−43.01	2.54	2.38	152	1	60.3	9/GR4	10
B CE311	−64.20	19	−40.60	−6.07	3.04	2.06	174	1	61.9	8 9/GR7	10
B CE312	−45.20	19	−40.27	−6.06	3.44	2.09	174	1	61.3	8 9/GR9	10
B CE411	−64.20	19	−50.97	−15.27	3.86	1.38	49	1	62.9	8 9/GR7	10
B CE412	−45.20	19	−50.71	−15.30	3.57	1.56	52	1	63.1	8 9/GR9	10
B CE511	−64.20	19	−53.10	−2.90	2.44	2.13	104	1	63.4	8 9/GR7	10
B NO611	−74.20	19	−59.60	−11.62	2.85	1.69	165	2	63.2	8 9/GR8	10
B NO711	−74.20	19	−60.70	−1.78	3.54	1.78	126	2	63.2	8 9/GR8	10
B NO811	−74.20	19	−68.76	−4.71	2.37	1.65	73	2	63.1	8 9/GR8	
B SU111	−81.20	19	−51.12	−25.63	2.76	1.05	50	1	63.2	8 9/GR6	10
B SU112	−45.20	19	−50.75	−25.62	2.47	1.48	56	1	62.6	8 9/GR9	
B SU211	−81.20	19	−44.51	−16.95	3.22	1.36	60	1	62.8	8 9/GR6	10
B SU212	−45.20	19	−44.00	−16.87	3.20	1.96	58	1	61.6	8 9/GR9	
BERBERMU	−96.20	19	−64.77	32.32	0.80	0.80	90	2	57.0		
BOLAND01	−115.20	19	−65.04	−16.76	2.49	1.27	76	1	68.1	9/GR5	
BOL00001	−87.20	19	−64.61	−16.71	2.52	2.19	85	1	64.2	10	
BRB00001	−92.70	19	−59.85	12.93	0.80	0.80	90	2	59.4		
CAN01101	−138.20	19	−125.63	57.24	3.45	1.27	157	1	59.7	9/GR10	10
CAN01201	−138.20	19	−112.04	55.95	3.35	0.97	151	1	59.8	9/GR10	10
CAN01202	−72.70	19	−107.70	55.63	2.74	1.12	32	1	59.8		
CAN01203	−129.20	19	−111.48	55.61	3.08	1.15	151	1	59.7	9/GR12	10
CAN01303	−129.20	19	−102.42	57.12	3.54	0.91	154	1	60.3	9/GR12	10
CAN01304	−91.20	19	−99.12	57.36	1.98	1.72	2	1	60.1	9/GR13	
CAN01403	−129.20	19	−89.75	52.02	4.68	0.80	148	1	62.1	9/GR12	10
CAN01404	−91.20	19	−84.82	52.42	3.10	2.05	152	1	60.6	9/GR13	10
CAN01405	−82.20	19	−84.00	52.39	2.84	2.29	172	1	60.5	9/GR14	10
CAN01504	−91.20	19	−72.66	53.77	3.57	1.67	156	1	60.4	9/GR13	10
CAN01505	−82.20	19	−71.77	53.79	3.30	1.89	162	1	60.4	9/GR14	10
CAN01605	−82.20	19	−61.50	49.55	2.65	1.40	143	1	60.5	9/GR14	10
CAN01606	−70.70	19	−61.30	49.55	2.40	1.65	148	1	60.5	10	
CHLCONT5	−106.20	19	−72.23	−35.57	2.60	0.80	55	1	59.6	9/GR17	
CHLPAC02	−106.20	19	−80.06	−30.06	1.36	0.80	69	1	59.4	9/GR17	
CLMAND01	−115.20	19	−74.72	5.93	3.85	1.63	114	1	65.4	9/GR5	
CLM00001	−103.20	19	−74.50	5.87	3.98	1.96	118	1	63.9	10	
CUB00001	−89.20	19	−79.81	21.62	2.24	0.80	168	1	61.3		
EQACAND1	−115.20	19	−78.40	−1.61	1.37	0.95	75	1	64.4	9/GR5	
EQAGAND1	−115.20	19	−90.34	−0.62	0.90	0.81	89	1	61.6	9/GR5	
GRD00059	−57.20	19	−61.58	12.29	0.80	0.80	90	1	58.7		
GRLDNK01	−53.20	19	−44.89	66.56	2.70	0.82	173	1	60.2	2	10
GUY00201	−84.70	19	−59.19	4.78	1.44	0.85	95	1	63.8		
HWA00002	−166.20	19	−165.79	23.42	4.20	0.80	160	1	59.0	9/GR1	10
HWA00003	−175.20	19	−166.10	23.42	4.25	0.80	159	1	59.0	9/GR2	10
MEX01NTE	−78.20	19	−105.81	26.01	2.89	2.08	155	1	60.8	1	
MEX01SUR	−69.20	19	−94.84	19.82	3.05	2.09	4	1	62.5	1	10
MEX02NTE	−136.20	19	−107.21	26.31	3.84	1.55	148	1	61.5	1	10
MEX02SUR	−127.20	19	−96.39	19.88	3.18	1.87	157	1	62.8	1	10
MSR00001	−79.70	19	−61.73	16.75	0.80	0.80	90	1	58.9	4	
PAQPAC01	−106.20	19	−109.18	−27.53	0.80	0.80	90	1	56.4	9/GR17	
PRG00002	−99.20	19	−58.66	−23.32	1.45	1.04	76	1	60.5		
PRUAND02	−115.20	19	−74.69	−8.39	3.41	1.79	95	1	64.3	9/GR5	
PTRVIR01	−101.20	19	−65.85	18.12	0.80	0.80	90	1	60.8	1 6 9/GR20	
PTRVIR02	−110.20	19	−65.86	18.12	0.80	0.80	90	1	61.3	1 6 9/GR21	
URG00001	−71.70	19	−56.22	−32.52	1.02	0.89	11	1	60.2		
USAEH001	−61.70	19	−85.19	36.21	5.63	3.33	22	1	62.1	1 5 6	10
USAEH002	−101.20	19	−89.24	36.16	5.67	3.76	170	1	62.0	1 6 9/GR20	10
USAEH003	−110.20	19	−90.14	36.11	5.55	3.55	161	1	62.4	1 6 9/GR21	10
USAEH004	−119.20	19	−91.16	36.05	5.38	3.24	152	1	62.9	1 5 6	10
USAPSA02	−166.20	19	−117.80	40.58	4.03	0.82	135	1	63.6	9/GR1	
USAPSA03	−175.20	19	−118.27	40.12	3.62	0.80	136	1	65.4	9/GR2	
USAWH101	−148.20	19	−109.65	38.13	5.53	1.95	142	1	62.4	10	
USAWH102	−157.20	19	−111.41	38.57	5.51	1.54	138	1	63.5	10	
VENAND03	−115.20	19	−67.04	6.91	2.37	1.43	111	1	67.7	9/GR5	

12 501.02 MHz (20)

1	2	3	4		5		6	7	8	9	
ALS00002	−165.80	20	−149.63	58.52	3.81	1.23	171	2	59.9	9/GR1	10
ALS00003	−174.80	20	−150.95	58.54	3.77	1.11	167	2	60.2	9/GR2	10
ARGNORT4	−93.80	20	−63.96	−30.01	3.86	1.99	48	2	66.1	10	
ARGNORT5	−54.80	20	−62.85	−29.80	3.24	2.89	47	2	63.9	10	
B CE311	−63.80	20	−40.60	−6.07	3.04	2.06	174	2	61.9	8 9/GR7	10
B CE312	−44.80	20	−40.26	−6.06	3.44	2.09	174	2	61.3	8 9/GR9	10 11
B CE411	−63.80	20	−50.97	−15.26	3.86	1.38	49	2	62.9	8 9/GR7	10
B CE412	−44.80	20	−50.71	−15.30	3.57	1.56	52	2	63.1	8 9/GR9	10 12
B CE511	−63.80	20	−53.11	−2.98	2.42	2.15	107	2	63.4	8 9/GR7	10
B NO611	−73.80	20	−59.60	−11.62	2.86	1.69	165	1	63.2	8 9/GR8	10
B NO711	−73.80	20	−60.70	−1.78	3.54	1.78	126	1	63.2	8 9/GR8	10
B NO811	−73.80	20	−68.75	−4.71	2.37	1.65	73	1	63.2	8 9/GR8	
B SE911	−101.80	20	−45.99	−19.09	2.22	0.80	62	2	65.7	8	10
B SU111	−80.80	20	−51.10	−25.64	2.76	1.06	50	2	63.2	8 9/GR6	10
B SU112	−44.80	20	−50.76	−25.62	2.47	1.48	56	2	62.6	8 9/GR9	11
B SU211	−80.80	20	−44.51	−16.94	3.22	1.37	60	2	62.8	8 9/GR6	10
B SU212	−44.80	20	−43.99	−16.97	3.27	1.92	59	2	61.6	8 9/GR9	12
CAN01101	−137.80	20	−125.60	57.24	3.45	1.27	157	2	59.7	9/GR10	10
CAN01201	−137.80	20	−111.92	55.89	3.33	0.98	151	2	59.8	9/GR10	10
CAN01202	−72.30	20	−107.64	55.62	2.75	1.11	32	2	59.8		
CAN01203	−128.80	20	−111.43	55.56	3.07	1.15	151	2	59.7	9/GR12	10
CAN01303	−128.80	20	−102.39	57.12	3.54	0.92	154	2	60.3	9/GR12	10
CAN01304	−90.80	20	−99.00	57.33	1.96	1.73	1	2	60.0	9/GR13	
CAN01403	−128.80	20	−89.70	52.02	4.67	0.80	148	2	62.1	9/GR12	10
CAN01404	−90.80	20	−84.78	52.41	3.09	2.06	153	2	60.6	9/GR13	10
CAN01405	−81.80	20	−84.02	52.34	2.82	2.30	172	2	60.5	9/GR14	10
CAN01504	−90.80	20	−72.68	53.78	3.57	1.67	157	2	60.4	9/GR13	10
CAN01505	−81.80	20	−71.76	53.76	3.30	1.89	162	2	60.4	9/GR14	10
CAN01605	−81.80	20	−61.54	49.50	2.66	1.39	144	2	60.5	9/GR14	10
CAN01606	−70.30	20	−61.32	49.51	2.41	1.65	148	2	60.5	10	
CHLCONT4	−105.80	20	−69.59	−23.20	2.21	0.80	68	2	59.3	9/GR16	
CHLCONT6	−105.80	20	−73.52	−55.52	3.65	1.31	39	2	59.8	9/GR16	
CRBBAH01	−92.30	20	−76.09	24.13	1.83	0.80	141	1	62.0	9/GR18	
CRBBER01	−92.30	20	−64.76	32.13	0.80	0.80	90	1	57.0	9/GR18	
CRBBLZ01	−92.30	20	−88.61	17.26	0.80	0.80	90	1	58.9	9/GR18	
CRBEC001	−92.30	20	−60.07	8.26	4.20	0.86	115	1	64.6	9/GR18	10
CRBJMC01	−92.30	20	−79.45	17.97	0.99	0.80	151	1	61.4	9/GR18	
EQAC0001	−94.80	20	−78.31	−1.52	1.48	1.15	65	1	63.3	9/GR19	
EQAG0001	−94.80	20	−90.36	−0.57	0.94	0.89	99	1	61.3	9/GR19	
GRD00003	−79.30	20	−61.62	12.34	0.80	0.80	90	2	58.9		
GTMIFRB2	−107.30	20	−90.50	15.64	1.03	0.80	84	1	61.4		
GUFMGG02	−52.80	20	−56.42	8.47	4.16	0.81	123	2	63.0	2 7	10
HWA00002	−165.80	20	−165.79	23.32	4.20	0.80	160	2	59.0	9/GR1	10
HWA00003	−174.80	20	−166.10	23.42	4.25	0.80	159	2	59.0	9/GR2	10
MEX01NTE	−77.80	20	−105.80	25.99	2.88	2.07	155	2	60.8	1	
MEX02NTE	−135.80	20	−107.36	26.32	3.80	1.57	149	2	61.5	1	10
MEX02SUR	−126.80	20	−96.39	19.88	3.19	1.87	158	2	62.8	1	10
PNRIFRB2	−121.00	20	−80.15	8.46	1.01	0.80	170	1	65.1		
PRU00004	−85.80	20	−74.19	−8.39	3.74	2.45	112	2	63.2	10	
PTRVIR01	−100.80	20	−65.85	18.12	0.80	0.80	90	2	60.9	1 6 9/GR20	
PTRVIR02	−109.80	20	−65.85	18.12	0.80	0.80	90	2	61.4	1 6 9/GR21	
USAEH001	−61.30	20	−85.16	36.21	5.63	3.32	22	2	62.1	1 5 6	10
USAEH002	−100.80	20	−89.28	36.16	5.65	3.78	170	2	62.0	1 6 9/GR20	10
USAEH003	−109.80	20	−90.12	36.11	5.55	3.56	161	2	62.4	1 6 9/GR21	10
USAEH004	−118.80	20	−91.16	36.05	5.38	3.24	153	2	62.9	1 5 6	10
USAPSA02	−165.80	20	−117.79	40.58	4.04	0.82	135	2	63.6	9/GR1	
USAPSA03	−174.80	20	−118.20	40.15	3.63	0.80	136	2	65.3	9/GR2	
USAWH101	−147.80	20	−109.70	38.13	5.52	1.96	142	2	62.4	10	
USAWH102	−156.80	20	−111.40	38.57	5.51	1.55	138	2	63.5	10	
VEN02VEN	−103.80	20	−63.50	15.50	0.80	0.80	90	2	60.1	9/GR22	
VEN11VEN	−103.80	20	−66.79	6.90	2.50	1.77	122	2	65.6	9/GR22	10

12 515.60 MHz (21)

1	2	3	4		5		6	7	8	9	
ALS00002	−166.20	21	−149.66	58.37	3.76	1.24	170	1	59.9	9/GR1	10
ALS00003	−175.20	21	−150.98	58.53	3.77	1.11	167	1	60.2	9/GR2	10
ARGINSU4	−94.20	21	−52.98	−59.81	3.40	0.80	19	1	60.1	9/GR3	
ARGINSU5	−55.20	21	−44.17	−59.91	3.77	0.80	13	1	59.5	9/GR4	
ARGSUR04	−94.20	21	−65.04	−43.33	3.32	1.50	40	1	60.9	9/GR3	
ARGSUR05	−55.20	21	−63.68	−43.01	2.54	2.38	152	1	60.2	9/GR4	
B CE311	−64.20	21	−40.60	−6.07	3.04	2.06	174	1	61.9	8 9/GR7	
B CE312	−45.20	21	−40.27	−6.06	3.44	2.09	174	1	61.2	8 9/GR9	10 11
B CE411	−64.20	21	−50.97	−15.27	3.86	1.38	49	1	62.9	8 9/GR7	
B CE412	−45.20	21	−50.71	−15.30	3.57	1.56	52	1	63.0	8 9/GR9	10 12
B CE511	−64.20	21	−53.10	−2.90	2.44	2.13	104	1	63.4	8 9/GR7	
B NO611	−74.20	21	−59.60	−11.62	2.85	1.69	165	2	63.1	8 9/GR8	
B NO711	−74.20	21	−60.70	−1.78	3.54	1.78	126	2	63.1	8 9/GR8	
B NO811	−74.20	21	−68.76	−4.71	2.37	1.65	73	2	63.1	8 9/GR8	
B SU111	−81.20	21	−51.12	−25.63	2.76	1.05	50	1	63.2	8 9/GR6	
B SU112	−45.20	21	−50.75	−25.62	2.47	1.48	56	1	62.5	8 9/GR9	11
B SU211	−81.20	21	−44.51	−16.95	3.22	1.36	60	1	62.8	8 9/GR6	
B SU212	−45.20	21	−44.00	−16.87	3.20	1.96	58	1	61.6	8 9/GR9	12
BERBERMU	−96.20	21	−64.77	32.32	0.80	0.80	90	2	57.0		
BOLAND01	−115.20	21	−65.04	−16.76	2.49	1.27	76	1	68.0	9/GR5	
CAN01101	−138.20	21	−125.63	57.24	3.45	1.27	157	1	59.7	9/GR10	10
CAN01201	−138.20	21	−112.04	55.95	3.35	0.97	151	1	59.8	9/GR10	10
CAN01202	−72.70	21	−107.70	55.63	2.74	1.12	32	1	59.8		
CAN01203	−129.20	21	−111.48	55.61	3.08	1.15	151	1	59.7	9/GR12	10
CAN01303	−129.20	21	−102.42	57.12	3.54	0.91	154	1	60.2	9/GR12	10
CAN01304	−91.20	21	−99.12	57.36	1.98	1.72	2	1	60.0	9/GR13	
CAN01403	−129.20	21	−89.75	52.02	4.68	0.80	148	1	62.1	9/GR12	10
CAN01404	−91.20	21	−84.82	52.42	3.10	2.05	152	1	60.6	9/GR13	
CAN01405	−82.20	21	−84.00	52.39	2.84	2.29	172	1	60.5	9/GR14	
CAN01504	−91.20	21	−72.66	53.77	3.57	1.67	156	1	60.4	9/GR13	
CAN01505	−82.20	21	−71.77	53.79	3.30	1.89	162	1	60.3	9/GR14	
CAN01605	−82.20	21	−61.50	49.55	2.65	1.40	143	1	60.5	9/GR14	
CAN01606	−70.70	21	−61.30	49.55	2.40	1.65	148	1	60.4		
CHLCONT5	−106.20	21	−72.23	−35.57	2.60	0.80	55	1	59.6	9/GR17	
CHLPAC02	−106.20	21	−80.06	−30.06	1.36	0.80	69	1	59.4	9/GR17	
CLMAND01	−115.20	21	−74.72	5.93	3.85	1.63	114	1	65.3	9/GR5	10
CLM00001	−103.20	21	−74.50	5.87	3.98	1.96	118	1	63.9	10	
EQACAND1	−115.20	21	−78.40	−1.61	1.37	0.95	75	1	64.4	9/GR5	
EQAGAND1	−115.20	21	−90.34	−0.62	0.90	0.81	89	1	61.5	9/GR5	
HWA00002	−166.20	21	−165.79	23.42	4.20	0.80	160	1	59.0	9/GR1	10
HWA00003	−175.20	21	−166.10	23.42	4.25	0.80	159	1	58.9	9/GR2	10
JMC00002	−92.70	21	−77.30	18.12	0.80	0.80	90	2	60.1		
KNA00001	−79.70	21	−62.46	17.44	0.80	0.80	90	1	58.6		
MEX01NTE	−78.20	21	−105.81	26.01	2.89	2.08	155	1	60.7	1	
MEX01SUR	−69.20	21	−94.84	19.82	3.05	2.09	4	1	62.5	1	
MEX02NTE	−136.20	21	−107.21	26.31	3.84	1.55	148	1	61.4	1	10
MEX02SUR	−127.20	21	−96.39	19.88	3.18	1.87	157	1	62.8	1	10
PAQPAC01	−106.20	21	−109.18	−27.53	0.80	0.80	90	1	56.4	9/GR17	
PRG00002	−99.20	21	−58.66	−23.32	1.45	1.04	76	1	60.4		
PRUAND02	−115.20	21	−74.69	−8.39	3.41	1.79	95	1	64.3	9/GR5	
PTRVIR01	−101.20	21	−65.85	18.12	0.80	0.80	90	1	60.8	1 6 9/GR20	
PTRVIR02	−110.20	21	−65.86	18.12	0.80	0.80	90	1	61.3	1 6 9/GR21	
SPMFRAN3	−53.20	21	−67.24	47.51	3.16	0.80	7	1	60.6	2 7	
SURINAM2	−84.70	21	−55.69	4.35	1.00	0.80	86	1	63.5		
URG00001	−71.70	21	−56.22	−32.52	1.02	0.89	11	1	60.2		
USAEH001	−61.70	21	−85.19	36.21	5.63	3.33	22	1	62.1	1 5 6	
USAEH002	−101.20	21	−89.24	36.16	5.67	3.76	170	1	62.0	1 6 9/GR20	10
USAEH003	−110.20	21	−90.14	36.11	5.55	3.55	161	1	62.3	1 6 9/GR21	10
USAEH004	−119.20	21	−91.16	36.05	5.38	3.24	152	1	62.9	1 5 6	10
USAPSA02	−166.20	21	−117.80	40.58	4.03	0.82	135	1	63.5	9/GR1	
USAPSA03	−175.20	21	−118.27	40.12	3.62	0.80	136	1	65.3	9/GR2	
USAWH101	−148.20	21	−109.65	38.13	5.53	1.95	142	1	62.3	10	
USAWH102	−157.20	21	−111.41	38.57	5.51	1.54	138	1	63.5	10	
VENAND03	−115.20	21	−67.04	6.91	2.37	1.43	111	1	67.6	9/GR5	10

12 530.18 MHz (22)

1	2	3	4		5		6	7	8	9	
ALS00002	−165.80	22	−149.63	58.52	3.81	1.23	171	2	59.9	9/GR1	10
ALS00003	−174.80	22	−150.95	58.54	3.77	1.11	167	2	60.2	9/GR2	10
ARGNORT4	−93.80	22	−63.96	−30.01	3.86	1.99	48	2	66.0		
ARGNORT5	−54.80	22	−62.85	−29.80	3.24	2.89	47	2	63.8		
ATNBEAM1	−52.80	22	−66.44	14.87	1.83	0.80	39	2	61.3		
B CE311	−63.80	22	−40.60	−6.07	3.04	2.06	174	2	61.9	8 9/GR7	
B CE312	−44.80	22	−40.26	−6.06	3.44	2.09	174	2	61.2	8 9/GR9	10 11
B CE411	−63.80	22	−50.97	−15.26	3.86	1.38	49	2	62.9	8 9/GR7	
B CE412	−44.80	22	−50.71	−15.30	3.57	1.56	52	2	63.0	8 9/GR9	10 12
B CE511	−63.80	22	−53.11	−2.98	2.42	2.15	107	2	63.4	8 9/GR7	
B NO611	−73.80	22	−59.60	−11.62	2.86	1.69	165	1	63.1	8 9/GR8	
B NO711	−73.80	22	−60.70	−1.78	3.54	1.78	126	1	63.1	8 9/GR8	
B NO811	−73.80	22	−68.75	−4.71	2.37	1.65	73	1	63.1	8 9/GR8	
B SE911	−101.80	22	−45.99	−19.09	2.22	0.80	62	2	65.7	8	
B SU111	−80.80	22	−51.10	−25.64	2.76	1.06	50	2	63.1	8 9/GR6	
B SU112	−44.80	22	−50.76	−25.62	2.47	1.48	56	2	62.6	8 9/GR9	11
B SU211	−80.80	22	−44.51	−16.94	3.22	1.37	60	2	62.8	8 9/GR6	
B SU212	−44.80	22	−43.99	−16.97	3.27	1.92	59	2	61.6	8 9/GR9	12
BLZ00001	−115.80	22	−88.68	17.27	0.80	0.80	90	2	59.2		
CAN01101	−137.80	22	−125.60	57.24	3.45	1.27	157	2	59.7	9/GR10	10
CAN01201	−137.80	22	−111.92	55.89	3.33	0.98	151	2	59.8	9/GR10	10
CAN01202	−72.30	22	−107.64	55.62	2.75	1.11	32	2	59.8		
CAN01203	−128.80	22	−111.43	55.56	3.07	1.15	151	2	59.7	9/GR12	10
CAN01303	−128.80	22	−102.39	57.12	3.54	0.92	154	2	60.3	9/GR12	10
CAN01304	−90.80	22	−99.00	57.33	1.96	1.73	1	2	60.0	9/GR13	
CAN01403	−128.80	22	−89.70	52.02	4.67	0.80	148	2	62.1	9/GR12	10
CAN01404	−90.80	22	−84.78	52.41	3.09	2.06	153	2	60.6	9/GR13	
CAN01405	−81.80	22	−84.02	52.34	2.82	2.30	172	2	60.5	9/GR14	
CAN01504	−90.80	22	−72.68	53.78	3.57	1.67	157	2	60.4	9/GR13	
CAN01505	−81.80	22	−71.76	53.76	3.30	1.89	162	2	60.3	9/GR14	
CAN01605	−81.80	22	−61.54	49.50	2.66	1.39	144	2	60.5	9/GR14	
CAN01606	−70.30	22	−61.32	49.51	2.41	1.65	148	2	60.4		
CHLCONT4	−105.80	22	−69.59	−23.20	2.21	0.80	68	2	59.3	9/GR16	
CHLCONT6	−105.80	22	−73.52	−55.52	3.65	1.31	39	2	59.7	9/GR16	
CRBBAH01	−92.30	22	−76.09	24.13	1.83	0.80	141	1	61.9	9/GR18	
CRBBER01	−92.30	22	−64.76	32.13	0.80	0.80	90	1	56.9	9/GR18	
CRBBLZ01	−92.30	22	−88.61	17.26	0.80	0.80	90	1	58.9	9/GR18	
CRBEC001	−92.30	22	−60.07	8.26	4.20	0.86	115	1	64.6	9/GR18	
CRBJMC01	−92.30	22	−79.45	17.97	0.99	0.80	151	1	61.3	9/GR18	
CTR00201	−130.80	22	−84.33	9.67	0.82	0.80	119	2	66.0		
DMAIFRB1	−79.30	22	−61.30	15.35	0.80	0.80	90	2	58.7		
EQAC0001	−94.80	22	−78.31	−1.52	1.48	1.15	65	1	63.3	9/GR19	
EQAG0001	−94.80	22	−90.36	−0.57	0.94	0.89	99	1	61.2	9/GR19	
HWA00002	−165.80	22	−165.79	23.32	4.20	0.80	160	2	59.0	9/GR1	10
HWA00003	−174.80	22	−166.10	23.42	4.25	0.80	159	2	59.0	9/GR2	10
MEX01NTE	−77.80	22	−105.80	25.99	2.88	2.07	155	2	60.7	1	
MEX02NTE	−135.80	22	−107.36	26.32	3.80	1.57	149	2	61.4	1	10
MEX02SUR	−126.80	22	−96.39	19.88	3.19	1.87	158	2	62.8	1	10
NCG00003	−107.30	22	−84.99	12.90	1.05	1.01	176	1	63.6		
PRU00004	−85.80	22	−74.19	−8.39	3.74	2.45	112	2	63.1		
PTRVIR01	−100.80	22	−65.85	18.12	0.80	0.80	90	2	60.8	1 6 9/GR20	
PTRVIR02	−109.80	22	−65.85	18.12	0.80	0.80	90	2	61.4	1 6 9/GR21	
USAEH001	−61.30	22	−85.16	36.21	5.63	3.32	22	2	62.1	1 5 6	
USAEH002	−100.80	22	−89.28	36.16	5.65	3.78	170	2	62.0	1 6 9/GR20	10
USAEH003	−109.80	22	−90.12	36.11	5.55	3.56	161	2	62.3	1 6 9/GR21	10
USAEH004	−118.80	22	−91.16	36.05	5.38	3.24	153	2	62.9	1 5 6	10
USAPSA02	−165.80	22	−117.79	40.58	4.04	0.82	135	2	63.5	9/GR1	
USAPSA03	−174.80	22	−118.20	40.15	3.63	0.80	136	2	65.3	9/GR2	
USAWH101	−147.80	22	−109.70	38.13	5.52	1.96	142	2	62.3	10	
USAWH102	−156.80	22	−111.40	38.57	5.51	1.55	138	2	63.5	10	
VEN11VEN	−103.80	22	−66.79	6.90	2.50	1.77	122	2	65.5	10	

12 544.76 MHz (23)

1	2	3	4		5		6	7	8	9	
ALS00002	−166.20	23	−149.66	58.37	3.76	1.24	170	1	60.0	9/GR1	10
ALS00003	−175.20	23	−150.98	58.53	3.77	1.11	167	1	60.2	9/GR2	10
ARGINSU4	−94.20	23	−52.98	−59.81	3.40	0.80	19	1	60.1	9/GR3	
ARGINSU5	−55.20	23	−44.17	−59.91	3.77	0.80	13	1	59.5	9/GR4	
ARGSUR04	−94.20	23	−65.04	−43.33	3.32	1.50	40	1	60.9	9/GR3	
ARGSUR05	−55.20	23	−63.68	−43.01	2.54	2.38	152	1	60.3	9/GR4	
B CE311	−64.20	23	−40.60	−6.07	3.04	2.06	174	1	61.9	8 9/GR7	
B CE312	−45.20	23	−40.27	−6.06	3.44	2.09	174	1	61.3	8 9/GR9	10 11
B CE411	−64.20	23	−50.97	−15.27	3.86	1.38	49	1	62.9	8 9/GR7	
B CE412	−45.20	23	−50.71	−15.30	3.57	1.56	52	1	63.1	8 9/GR9	10 12
B CE511	−64.20	23	−53.10	−2.90	2.44	2.13	104	1	63.4	8 9/GR7	
B NO611	−74.20	23	−59.60	−11.62	2.85	1.69	165	2	63.2	8 9/GR8	
B NO711	−74.20	23	−60.70	−1.78	3.54	1.78	126	2	63.2	8 9/GR8	
B NO811	−74.20	23	−68.76	−4.71	2.37	1.65	73	2	63.1	8 9/GR8	
B SU111	−81.20	23	−51.12	−25.63	2.76	1.05	50	1	63.2	8 9/GR6	
B SU112	−45.20	23	−50.75	−25.62	2.47	1.48	56	1	62.6	8 9/GR9	11
B SU211	−81.20	23	−44.51	−16.95	3.22	1.36	60	1	62.8	8 9/GR6	
B SU212	−45.20	23	−44.00	−16.87	3.20	1.96	58	1	61.6	8 9/GR9	12
BERBERMU	−96.20	23	−64.77	32.32	0.80	0.80	90	2	57.0		
BOLAND01	−115.20	23	−65.04	−16.76	2.49	1.27	76	1	68.1	9/GR5	
BOL00001	−87.20	23	−64.61	−16.71	2.52	2.19	85	1	64.2		
BRB00001	−92.70	23	−59.85	12.93	0.80	0.80	90	2	59.4		
CAN01101	−138.20	23	−125.63	57.24	3.45	1.27	157	1	59.7	9/GR10	10
CAN01201	−138.20	23	−112.04	55.95	3.35	0.97	151	1	59.8	9/GR10	10
CAN01202	−72.70	23	−107.70	55.63	2.74	1.12	32	1	59.8		
CAN01203	−129.20	23	−111.48	55.61	3.08	1.15	151	1	59.7	9/GR12	10
CAN01303	−129.20	23	−102.42	57.12	3.54	0.91	154	1	60.3	9/GR12	10
CAN01304	−91.20	23	−99.12	57.36	1.98	1.72	2	1	60.1	9/GR13	
CAN01403	−129.20	23	−89.75	52.02	4.68	0.80	148	1	62.1	9/GR12	10
CAN01404	−91.20	23	−84.82	52.42	3.10	2.05	152	1	60.6	9/GR13	
CAN01405	−82.20	23	−84.00	52.39	2.84	2.29	172	1	60.5	9/GR14	
CAN01504	−91.20	23	−72.66	53.77	3.57	1.67	156	1	60.4	9/GR13	
CAN01505	−82.20	23	−71.77	53.79	3.30	1.89	162	1	60.4	9/GR14	
CAN01605	−82.20	23	−61.50	49.55	2.65	1.40	143	1	60.5	9/GR14	
CAN01606	−70.70	23	−61.30	49.55	2.40	1.65	148	1	60.5		
CHLCONT5	−106.20	23	−72.23	−35.57	2.60	0.80	55	1	59.6	9/GR17	
CHLPAC02	−106.20	23	−80.06	−30.06	1.36	0.80	69	1	59.4	9/GR17	
CLMAND01	−115.20	23	−74.72	5.93	3.85	1.63	114	1	65.4	9/GR5	10
CLM00001	−103.20	23	−74.50	5.87	3.98	1.96	118	1	63.9	10	
CUB00001	−89.20	23	−79.81	21.62	2.24	0.80	168	1	61.3		
EQACAND1	−115.20	23	−78.40	−1.61	1.37	0.95	75	1	64.4	9/GR5	
EQAGAND1	−115.20	23	−90.34	−0.62	0.90	0.81	89	1	61.6	9/GR5	
GRD00059	−57.20	23	−61.58	12.29	0.80	0.80	90	1	58.7		
GRLDNK01	−53.20	23	−44.89	66.56	2.70	0.82	173	1	60.2	2	
GUY00201	−84.70	23	−59.19	4.78	1.44	0.85	95	1	63.8		
HWA00002	−166.20	23	−165.79	23.42	4.20	0.80	160	1	59.0	9/GR1	10
HWA00003	−175.20	23	−166.10	23.42	4.25	0.80	159	1	59.0	9/GR2	10
MEX01NTE	−78.20	23	−105.81	26.01	2.89	2.08	155	1	60.8	1	
MEX01SUR	−69.20	23	−94.84	19.82	3.05	2.09	4	1	62.5	1	
MEX02NTE	−136.20	23	−107.21	26.31	3.84	1.55	148	1	61.5	1	10
MEX02SUR	−127.20	23	−96.39	19.88	3.18	1.87	157	1	62.8	1	10
MSR00001	−79.70	23	−61.73	16.75	0.80	0.80	90	1	58.9	4	
PAQPAC01	−106.20	23	−109.18	−27.53	0.80	0.80	90	1	56.4	9/GR17	
PRG00002	−99.20	23	−58.66	−23.32	1.45	1.04	76	1	60.5		
PRUAND02	−115.20	23	−74.69	−8.39	3.41	1.79	95	1	64.3	9/GR5	
PTRVIR01	−101.20	23	−65.85	18.12	0.80	0.80	90	1	60.8	1 6 9/GR20	
PTRVIR02	−110.20	23	−65.86	18.12	0.80	0.80	90	1	61.3	1 6 9/GR21	
URG00001	−71.70	23	−56.22	−32.52	1.02	0.89	11	1	60.2		
USAEH001	−61.70	23	−85.19	36.21	5.63	3.33	22	1	62.1	1 5 6	
USAEH002	−101.20	23	−89.24	36.16	5.67	3.76	170	1	62.0	1 6 9/GR20	10
USAEH003	−110.20	23	−90.14	36.11	5.55	3.55	161	1	62.4	1 6 9/GR21	10
USAEH004	−119.20	23	−91.16	36.05	5.38	3.24	152	1	62.9	1 5 6	10
USAPSA02	−166.20	23	−117.80	40.58	4.03	0.82	135	1	63.6	9/GR1	
USAPSA03	−175.20	23	−118.27	40.12	3.62	0.80	136	1	65.4	9/GR2	
USAWH101	−148.20	23	−109.65	38.13	5.53	1.95	142	1	62.4	10	
USAWH102	−157.20	23	−111.41	38.57	5.51	1.54	138	1	63.5	10	
VENAND03	−115.20	23	−67.04	6.91	2.37	1.43	111	1	67.7	9/GR5	10

12 559.34 MHz (24)

1	2	3	4		5		6	7	8	9	
ALS00002	−165.80	24	−149.63	58.52	3.81	1.23	171	2	59.9	9/GR1	10
ALS00003	−174.80	24	−150.95	58.54	3.77	1.11	167	2	60.2	9/GR2	10
ARGNORT4	−93.80	24	−63.96	−30.01	3.86	1.99	48	2	66.1		
ARGNORT5	−54.80	24	−62.85	−29.80	3.24	2.89	47	2	63.9		
B CE311	−63.80	24	−40.60	−6.07	3.04	2.06	174	2	61.9	8 9/GR7	
B CE312	−44.80	24	−40.26	−6.06	3.44	2.09	174	2	61.3	8 9/GR9	10 11
B CE411	−63.80	24	−50.97	−15.26	3.86	1.38	49	2	62.9	8 9/GR7	
B CE412	−44.80	24	−50.71	−15.30	3.57	1.56	52	2	63.1	8 9/GR9	10 12
B CE511	−63.80	24	−53.11	−2.98	2.42	2.15	107	2	63.4	8 9/GR7	
B NO611	−73.80	24	−59.60	−11.62	2.86	1.69	165	1	63.2	8 9/GR8	
B NO711	−73.80	24	−60.70	−1.78	3.54	1.78	126	1	63.2	8 9/GR8	
B NO811	−73.80	24	−68.75	−4.71	2.37	1.65	73	1	63.2	8 9/GR8	
B SE911	−101.80	24	−45.99	−19.09	2.22	0.80	62	2	65.7	8	
B SU111	−80.80	24	−51.10	−25.64	2.76	1.06	50	2	63.2	8 9/GR6	
B SU112	−44.80	24	−50.76	−25.62	2.47	1.48	56	2	62.6	8 9/GR9	11
B SU211	−80.80	24	−44.51	−16.94	3.22	1.37	60	2	62.8	8 9/GR6	
B SU212	−44.80	24	−43.99	−16.97	3.27	1.92	59	2	61.6	8 9/GR9	12
CAN01101	−137.80	24	−125.60	57.24	3.45	1.27	157	2	59.7	9/GR10	10
CAN01201	−137.80	24	−111.92	55.89	3.33	0.98	151	2	59.8	9/GR10	10
CAN01202	−72.30	24	−107.64	55.62	2.75	1.11	32	2	59.8		
CAN01203	−128.80	24	−111.43	55.56	3.07	1.15	151	2	59.7	9/GR12	10
CAN01303	−128.80	24	−102.39	57.12	3.54	0.92	154	2	60.3	9/GR12	10
CAN01304	−90.80	24	−99.00	57.33	1.96	1.73	1	2	60.0	9/GR13	
CAN01403	−128.80	24	−89.70	52.02	4.67	0.80	148	2	62.1	9/GR12	10
CAN01404	−90.80	24	−84.78	52.41	3.09	2.06	153	2	60.6	9/GR13	
CAN01405	−81.80	24	−84.02	52.34	2.82	2.30	172	2	60.5	9/GR14	
CAN01504	−90.80	24	−72.68	53.78	3.57	1.67	157	2	60.4	9/GR13	
CAN01505	−81.80	24	−71.76	53.76	3.30	1.89	162	2	60.4	9/GR14	
CAN01605	−81.80	24	−61.54	49.50	2.66	1.39	144	2	60.5	9/GR14	
CAN01606	−70.30	24	−61.32	49.51	2.41	1.65	148	2	60.5		
CHLCONT4	−105.80	24	−69.59	−23.20	2.21	0.80	68	2	59.3	9/GR16	
CHLCONT6	−105.80	24	−73.52	−55.52	3.65	1.31	39	2	59.8	9/GR16	
CRBBAH01	−92.30	24	−76.09	24.13	1.83	0.80	141	1	62.0	9/GR18	
CRBBER01	−92.30	24	−64.76	32.13	0.80	0.80	90	1	57.0	9/GR18	
CRBBLZ01	−92.30	24	−88.61	17.26	0.80	0.80	90	1	58.9	9/GR18	
CRBEC001	−92.30	24	−60.07	8.26	4.20	0.86	115	1	64.6	9/GR18	
CRBJMC01	−92.30	24	−79.45	17.97	0.99	0.80	151	1	61.4	9/GR18	
EQAC0001	−94.80	24	−78.31	−1.52	1.48	1.15	65	1	63.3	9/GR19	
EQAG0001	−94.80	24	−90.36	−0.57	0.94	0.89	99	1	61.3	9/GR19	
GRD00003	−79.30	24	−61.62	12.34	0.80	0.80	90	2	58.9		
GTMIFRB2	−107.30	24	−90.50	15.64	1.03	0.80	84	1	61.4		
GUFMGG02	−52.80	24	−56.42	8.47	4.16	0.81	123	2	63.0	2 7	
HWA00002	−165.80	24	−165.79	23.32	4.20	0.80	160	2	59.0	9/GR1	10
HWA00003	−174.80	24	−166.10	23.42	4.25	0.80	159	2	59.0	9/GR2	10
MEX01NTE	−77.80	24	−105.80	25.99	2.88	2.07	155	2	60.8	1	
MEX02NTE	−135.80	24	−107.36	26.32	3.80	1.57	149	2	61.5	1	10
MEX02SUR	−126.80	24	−96.39	19.88	3.19	1.87	158	2	62.8	1	10
PNRIFRB2	−121.00	24	−80.15	8.46	1.01	0.80	170	1	65.1		
PRU00004	−85.80	24	−74.19	−8.39	3.74	2.45	112	2	63.2		
PTRVIR01	−100.80	24	−65.85	18.12	0.80	0.80	90	2	60.9	1 6 9/GR20	
PTRVIR02	−109.80	24	−65.85	18.12	0.80	0.80	90	2	61.4	1 6 9/GR21	
USAEH001	−61.30	24	−85.16	36.21	5.63	3.32	22	2	62.1	1 5 6	
USAEH002	−100.80	24	−89.28	36.16	5.65	3.78	170	2	62.0	1 6 9/GR20	10
USAEH003	−109.80	24	−90.12	36.11	5.55	3.56	161	2	62.4	1 6 9/GR21	10
USAEH004	−118.80	24	−91.16	36.05	5.38	3.24	153	2	62.9	1 5 6	10
USAPSA02	−165.80	24	−117.79	40.58	4.04	0.82	135	2	63.6	9/GR1	
USAPSA03	−174.80	24	−118.20	40.15	3.63	0.80	136	2	65.3	9/GR2	
USAWH101	−147.80	24	−109.70	38.13	5.52	1.96	142	2	62.4	10	
USAWH102	−156.80	24	−111.40	38.57	5.51	1.55	138	2	63.5	10	
VEN02VEN	−103.80	24	−63.50	15.50	0.80	0.80	90	2	60.1	9/GR22	
VEN11VEN	−103.80	24	−66.79	6.90	2.50	1.77	122	2	65.6	9/GR22	10

12 573.92 MHz (25)

1	2	3	4		5		6	7	8	9	
ALS00002	−166.20	25	−149.66	58.37	3.76	1.24	170	1	59.9	9/GR1	10
ALS00003	−175.20	25	−150.98	58.53	3.77	1.11	167	1	60.2	9/GR2	10
ARGINSU4	−94.20	25	−52.98	−59.81	3.40	0.80	19	1	60.1	9/GR3	
ARGINSU5	−55.20	25	−44.17	−59.91	3.77	0.80	13	1	59.5	9/GR4	
ARGSUR04	−94.20	25	−65.04	−43.33	3.32	1.50	40	1	60.9	9/GR3	
ARGSUR05	−55.20	25	−63.68	−43.01	2.54	2.38	152	1	60.2	9/GR4	
B CE311	−64.20	25	−40.60	−6.07	3.04	2.06	174	1	61.9	8 9/GR7	
B CE312	−45.20	25	−40.27	−6.06	3.44	2.09	174	1	61.2	8 9/GR9	10 11
B CE411	−64.20	25	−50.97	−15.27	3.86	1.38	49	1	62.9	8 9/GR7	
B CE412	−45.20	25	−50.71	−15.30	3.57	1.56	52	1	63.0	8 9/GR9	10 12
B CE511	−64.20	25	−53.10	−2.90	2.44	2.13	104	1	63.4	8 9/GR7	
B NO611	−74.20	25	−59.60	−11.62	2.85	1.69	165	2	63.1	8 9/GR8	
B NO711	−74.20	25	−60.70	−1.78	3.54	1.78	126	2	63.1	8 9/GR8	
B NO811	−74.20	25	−68.76	−4.71	2.37	1.65	73	2	63.1	8 9/GR8	
B SU111	−81.20	25	−51.12	−25.63	2.76	1.05	50	1	63.2	8 9/GR6	
B SU112	−45.20	25	−50.75	−25.62	2.47	1.48	56	1	62.5	8 9/GR9	11
B SU211	−81.20	25	−44.51	−16.95	3.22	1.36	60	1	62.8	8 9/GR6	
B SU212	−45.20	25	−44.00	−16.87	3.20	1.96	58	1	61.6	8 9/GR9	12
BERBERMU	−96.20	25	−64.77	32.32	0.80	0.80	90	2	57.0		
BOLAND01	−115.20	25	−65.04	−16.76	2.49	1.27	76	1	68.0	9/GR5	
CAN01101	−138.20	25	−125.63	57.24	3.45	1.27	157	1	59.7	9/GR10	10
CAN01201	−138.20	25	−112.04	55.95	3.35	0.97	151	1	59.8	9/GR10	10
CAN01202	−72.70	25	−107.70	55.63	2.74	1.12	32	1	59.8		
CAN01203	−129.20	25	−111.48	55.61	3.08	1.15	151	1	59.7	9/GR12	10
CAN01303	−129.20	25	−102.42	57.12	3.54	0.91	154	1	60.2	9/GR12	10
CAN01304	−91.20	25	−99.12	57.36	1.98	1.72	2	1	60.0	9/GR13	
CAN01403	−129.20	25	−89.75	52.02	4.68	0.80	148	1	62.1	9/GR12	10
CAN01404	−91.20	25	−84.82	52.42	3.10	2.05	152	1	60.6	9/GR13	
CAN01405	−82.20	25	−84.00	52.39	2.84	2.29	172	1	60.5	9/GR14	
CAN01504	−91.20	25	−72.66	53.77	3.57	1.67	156	1	60.4	9/GR13	
CAN01505	−82.20	25	−71.77	53.79	3.30	1.89	162	1	60.3	9/GR14	
CAN01605	−82.20	25	−61.50	49.55	2.65	1.40	143	1	60.5	9/GR14	
CAN01606	−70.70	25	−61.30	49.55	2.40	1.65	148	1	60.4		
CHLCONT5	−106.20	25	−72.23	−35.57	2.60	0.80	55	1	59.6	9/GR17	
CHLPAC02	−106.20	25	−80.06	−30.06	1.36	0.80	69	1	59.4	9/GR17	
CLMAND01	−115.20	25	−74.72	5.93	3.85	1.63	114	1	65.3	9/GR5	10
CLM00001	−103.20	25	−74.50	5.87	3.98	1.96	118	1	63.9	10	
EQACAND1	−115.20	25	−78.40	−1.61	1.37	0.95	75	1	64.4	9/GR5	
EQAGAND1	−115.20	25	−90.34	−0.62	0.90	0.81	89	1	61.5	9/GR5	
HWA00002	−166.20	25	−165.79	23.42	4.20	0.80	160	1	59.0	9/GR1	10
HWA00003	−175.20	25	−166.10	23.42	4.25	0.80	159	1	58.9	9/GR2	10
JMC00002	−92.70	25	−77.30	18.12	0.80	0.80	90	2	60.1		
KNA00001	−79.70	25	−62.46	17.44	0.80	0.80	90	1	58.6		
MEX01NTE	−78.20	25	−105.81	26.01	2.89	2.08	155	1	60.7	1	
MEX01SUR	−69.20	25	−94.84	19.82	3.05	2.09	4	1	62.5	1	
MEX02NTE	−136.20	25	−107.21	26.31	3.84	1.55	148	1	61.4	1	10
MEX02SUR	−127.20	25	−96.39	19.88	3.18	1.87	157	1	62.8	1	10
PAQPAC01	−106.20	25	−109.18	−27.53	0.80	0.80	90	1	56.4	9/GR17	
PRG00002	−99.20	25	−58.66	−23.32	1.45	1.04	76	1	60.4		
PRUAND02	−115.20	25	−74.69	−8.39	3.41	1.79	95	1	64.3	9/GR5	
PTRVIR01	−101.20	25	−65.85	18.12	0.80	0.80	90	1	60.8	1 6 9/GR20	
PTRVIR02	−110.20	25	−65.86	18.12	0.80	0.80	90	1	61.3	1 6 9/GR21	
SPMFRAN3	−53.20	25	−67.24	47.51	3.16	0.80	7	1	60.6	2 7	
SURINAM2	−84.70	25	−55.69	4.35	1.00	0.80	86	1	63.5		
URG00001	−71.70	25	−56.22	−32.52	1.02	0.89	11	1	60.2		
USAEH001	−61.70	25	−85.19	36.21	5.63	3.33	22	1	62.1	1 5 6	
USAEH002	−101.20	25	−89.24	36.16	5.67	3.76	170	1	62.0	1 6 9/GR20	10
USAEH003	−110.20	25	−90.14	36.11	5.55	3.55	161	1	62.3	1 6 9/GR21	10
USAEH004	−119.20	25	−91.16	36.05	5.38	3.24	152	1	62.9	1 5 6	10
USAPSA02	−166.20	25	−117.80	40.58	4.03	0.82	135	1	63.5	9/GR1	
USAPSA03	−175.20	25	−118.27	40.12	3.62	0.80	136	1	65.3	9/GR2	
USAWH101	−148.20	25	−109.65	38.13	5.53	1.95	142	1	62.3	10	
USAWH102	−157.20	25	−111.41	38.57	5.51	1.54	138	1	63.5	10	
VENAND03	−115.20	25	−67.04	6.91	2.37	1.43	111	1	67.6	9/GR5	10

12 588.50 MHz (26)

1	2	3	4		5		6	7	8	9	
ALS00002	−165.80	26	−149.63	58.52	3.81	1.23	171	2	59.9	9/GR1	10
ALS00003	−174.80	26	−150.95	58.54	3.77	1.11	167	2	60.2	9/GR2	10
ARGNORT4	−93.80	26	−63.96	−30.01	3.86	1.99	48	2	66.0		
ARGNORT5	−54.80	26	−62.85	−29.80	3.24	2.89	47	2	63.8		
ATNBEAM1	−52.80	26	−66.44	14.87	1.83	0.80	39	2	61.3		
B CE311	−63.80	26	−40.60	−6.07	3.04	2.06	174	2	61.9	8 9/GR7	
B CE312	−44.80	26	−40.26	−6.06	3.44	2.09	174	2	61.2	8 9/GR9	10 11
B CE411	−63.80	26	−50.97	−15.26	3.86	1.38	49	2	62.9	8 9/GR7	
B CE412	−44.80	26	−50.71	−15.30	3.57	1.56	52	2	63.0	8 9/GR9	10 12
B CE511	−63.80	26	−53.11	−2.98	2.42	2.15	107	2	63.4	8 9/GR7	
B NO611	−73.80	26	−59.60	−11.62	2.86	1.69	165	1	63.1	8 9/GR8	
B NO711	−73.80	26	−60.70	−1.78	3.54	1.78	126	1	63.1	8 9/GR8	
B NO811	−73.80	26	−68.75	−4.71	2.37	1.65	73	1	63.1	8 9/GR8	
B SE911	−101.80	26	−45.99	−19.09	2.22	0.80	62	2	65.7	8	
B SU111	−80.80	26	−51.10	−25.64	2.76	1.06	50	2	63.1	8 9/GR6	
B SU112	−44.80	26	−50.76	−25.62	2.47	1.48	56	2	62.6	8 9/GR9	11
B SU211	−80.80	26	−44.51	−16.94	3.22	1.37	60	2	62.8	8 9/GR6	
B SU212	−44.80	26	−43.99	−16.97	3.27	1.92	59	2	61.6	8 9/GR9	12
BLZ00001	−115.80	26	−88.68	17.27	0.80	0.80	90	2	59.2		
CAN01101	−137.80	26	−125.60	57.24	3.45	1.27	157	2	59.7	9/GR10	10
CAN01201	−137.80	26	−111.92	55.89	3.33	0.98	151	2	59.8	9/GR10	10
CAN01202	−72.30	26	−107.64	55.62	2.75	1.11	32	2	59.8		
CAN01203	−128.80	26	−111.43	55.56	3.07	1.15	151	2	59.7	9/GR12	10
CAN01303	−128.80	26	−102.39	57.12	3.54	0.92	154	2	60.3	9/GR12	10
CAN01304	−90.80	26	−99.00	57.33	1.96	1.73	1	2	60.0	9/GR13	
CAN01403	−128.80	26	−89.70	52.02	4.67	0.80	148	2	62.1	9/GR12	10
CAN01404	−90.80	26	−84.78	52.41	3.09	2.06	153	2	60.6	9/GR13	
CAN01405	−81.80	26	−84.02	52.34	2.82	2.30	172	2	60.5	9/GR14	
CAN01504	−90.80	26	−72.68	53.78	3.57	1.67	157	2	60.4	9/GR13	
CAN01505	−81.80	26	−71.76	53.76	3.30	1.89	162	2	60.3	9/GR14	
CAN01605	−81.80	26	−61.54	49.50	2.66	1.39	144	2	60.5	9/GR14	
CAN01606	−70.30	26	−61.32	49.51	2.41	1.65	148	2	60.4		
CHLCONT4	−105.80	26	−69.59	−23.20	2.21	0.80	68	2	59.3	9/GR16	
CHLCONT6	−105.80	26	−73.52	−55.52	3.65	1.31	39	2	59.7	9/GR16	
CRBBAH01	−92.30	26	−76.09	24.13	1.83	0.80	141	1	61.9	9/GR18	
CRBBER01	−92.30	26	−64.76	32.13	0.80	0.80	90	1	56.9	9/GR18	
CRBBLZ01	−92.30	26	−88.61	17.26	0.80	0.80	90	1	58.9	9/GR18	
CRBEC001	−92.30	26	−60.07	8.26	4.20	0.86	115	1	64.6	9/GR18	
CRBJMC01	−92.30	26	−79.45	17.97	0.99	0.80	151	1	61.3	9/GR18	
CTR00201	−130.80	26	−84.33	9.67	0.82	0.80	119	2	66.0		
DMAIFRB1	−79.30	26	−61.30	15.35	0.80	0.80	90	2	58.7		
EQAC0001	−94.80	26	−78.31	−1.52	1.48	1.15	65	1	63.3	9/GR19	
EQAG0001	−94.80	26	−90.36	−0.57	0.94	0.89	99	1	61.2	9/GR19	
HWA00002	−165.80	26	−165.79	23.32	4.20	0.80	160	2	59.0	9/GR1	10
HWA00003	−174.80	26	−166.10	23.42	4.25	0.80	159	2	59.0	9/GR2	10
MEX01NTE	−77.80	26	−105.80	25.99	2.88	2.07	155	2	60.7	1	
MEX02NTE	−135.80	26	−107.36	26.32	3.80	1.57	149	2	61.4	1	10
MEX02SUR	−126.80	26	−96.39	19.88	3.19	1.87	158	2	62.8	1	10
NCG00003	−107.30	26	−84.99	12.90	1.05	1.01	176	1	63.6		
PRU00004	−85.80	26	−74.19	−8.39	3.74	2.45	112	2	63.1		
PTRVIR01	−100.80	26	−65.85	18.12	0.80	0.80	90	2	60.8	1 6 9/GR20	
PTRVIR02	−109.80	26	−65.85	18.12	0.80	0.80	90	2	61.4	1 6 9/GR21	
USAEH001	−61.30	26	−85.16	36.21	5.63	3.32	22	2	62.1	1 5 6	
USAEH002	−100.80	26	−89.28	36.16	5.65	3.78	170	2	62.0	1 6 9/GR20	10
USAEH003	−109.80	26	−90.12	36.11	5.55	3.56	161	2	62.3	1 6 9/GR21	10
USAEH004	−118.80	26	−91.16	36.05	5.38	3.24	153	2	62.9	1 5 6	10
USAPSA02	−165.80	26	−117.79	40.58	4.04	0.82	135	2	63.5	9/GR1	
USAPSA03	−174.80	26	−118.20	40.15	3.63	0.80	136	2	65.3	9/GR2	
USAWH101	−147.80	26	−109.70	38.13	5.52	1.96	142	2	62.3	10	
USAWH102	−156.80	26	−111.40	38.57	5.51	1.55	138	2	63.5	10	
VEN11VEN	−103.80	26	−66.79	6.90	2.50	1.77	122	2	65.5	10	

12 603.08 MHz (27)

1	2	3	4		5		6	7	8	9	
ALS00002	−166.20	27	−149.66	58.37	3.76	1.24	170	1	60.0	9/GR1	10
ALS00003	−175.20	27	−150.98	58.53	3.77	1.11	167	1	60.2	9/GR2	10
ARGINSU4	−94.20	27	−52.98	−59.81	3.40	0.80	19	1	60.1	9/GR3	
ARGINSU5	−55.20	27	−44.17	−59.91	3.77	0.80	13	1	59.5	9/GR4	
ARGSUR04	−94.20	27	−65.04	−43.33	3.32	1.50	40	1	60.9	9/GR3	
ARGSUR05	−55.20	27	−63.68	−43.01	2.54	2.38	152	1	60.3	9/GR4	
B CE311	−64.20	27	−40.60	−6.07	3.04	2.06	174	1	61.9	8 9/GR7	
B CE312	−45.20	27	−40.27	−6.06	3.44	2.09	174	1	61.3	8 9/GR9	10 11
B CE411	−64.20	27	−50.97	−15.27	3.86	1.38	49	1	62.9	8 9/GR7	
B CE412	−45.20	27	−50.71	−15.30	3.57	1.56	52	1	63.1	8 9/GR9	10 12
B CE511	−64.20	27	−53.10	−2.90	2.44	2.13	104	1	63.4	8 9/GR7	
B NO611	−74.20	27	−59.60	−11.62	2.85	1.69	165	2	63.2	8 9/GR8	
B NO711	−74.20	27	−60.70	−1.78	3.54	1.78	126	2	63.2	8 9/GR8	
B NO811	−74.20	27	−68.76	−4.71	2.37	1.65	73	2	63.1	8 9/GR8	
B SU111	−81.20	27	−51.12	−25.63	2.76	1.05	50	1	63.2	8 9/GR6	
B SU112	−45.20	27	−50.75	−25.62	2.47	1.48	56	1	62.6	8 9/GR9	11
B SU211	−81.20	27	−44.51	−16.95	3.22	1.36	60	1	62.8	8 9/GR6	
B SU212	−45.20	27	−44.00	−16.87	3.20	1.96	58	1	61.6	8 9/GR9	12
BERBERMU	−96.20	27	−64.77	32.32	0.80	0.80	90	2	57.0		
BOLAND01	−115.20	27	−65.04	−16.76	2.49	1.27	76	1	68.1	9/GR5	
BOL00001	−87.20	27	−64.61	−16.71	2.52	2.19	85	1	64.2		
BRB00001	−92.70	27	−59.85	12.93	0.80	0.80	90	2	59.4		
CAN01101	−138.20	27	−125.63	57.24	3.45	1.27	157	1	59.7	9/GR10	10
CAN01201	−138.20	27	−112.04	55.95	3.35	0.97	151	1	59.8	9/GR10	10
CAN01202	−72.70	27	−107.70	55.63	2.74	1.12	32	1	59.8		
CAN01203	−129.20	27	−111.48	55.61	3.08	1.15	151	1	59.7	9/GR12	10
CAN01303	−129.20	27	−102.42	57.12	3.54	0.91	154	1	60.3	9/GR12	10
CAN01304	−91.20	27	−99.12	57.36	1.98	1.72	2	1	60.1	9/GR13	
CAN01403	−129.20	27	−89.75	52.02	4.68	0.80	148	1	62.1	9/GR12	10
CAN01404	−91.20	27	−84.82	52.42	3.10	2.05	152	1	60.6	9/GR13	
CAN01405	−82.20	27	−84.00	52.39	2.84	2.29	172	1	60.5	9/GR14	
CAN01504	−91.20	27	−72.66	53.77	3.57	1.67	156	1	60.4	9/GR13	
CAN01505	−82.20	27	−71.77	53.79	3.30	1.89	162	1	60.4	9/GR14	
CAN01605	−82.20	27	−61.50	49.55	2.65	1.40	143	1	60.5	9/GR14	
CAN01606	−70.70	27	−61.30	49.55	2.40	1.65	148	1	60.5		
CHLCONT5	−106.20	27	−72.23	−35.57	2.60	0.80	55	1	59.6	9/GR17	
CHLPAC02	−106.20	27	−80.06	−30.06	1.36	0.80	69	1	59.4	9/GR17	
CLMAND01	−115.20	27	−74.72	5.93	3.85	1.63	114	1	65.4	9/GR5	10
CLM00001	−103.20	27	−74.50	5.87	3.98	1.96	118	1	63.9	10	
CUB00001	−89.20	27	−79.81	21.62	2.24	0.80	168	1	61.3		
EQACAND1	−115.20	27	−78.40	−1.61	1.37	0.95	75	1	64.4	9/GR5	
EQAGAND1	−115.20	27	−90.34	−0.62	0.90	0.81	89	1	61.6	9/GR5	
GRD00059	−57.20	27	−61.58	12.29	0.80	0.80	90	1	58.7		
GRLDNK01	−53.20	27	−44.89	66.56	2.70	0.82	173	1	60.2	2	
GUY00201	−84.70	27	−59.19	4.78	1.44	0.85	95	1	63.8		
HWA00002	−166.20	27	−165.79	23.42	4.20	0.80	160	1	59.0	9/GR1	10
HWA00003	−175.20	27	−166.10	23.42	4.25	0.80	159	1	59.0	9/GR2	10
MEX01NTE	−78.20	27	−105.81	26.01	2.89	2.08	155	1	60.8	1	
MEX01SUR	−69.20	27	−94.84	19.82	3.05	2.09	4	1	62.5	1	
MEX02NTE	−136.20	27	−107.21	26.31	3.84	1.55	148	1	61.5	1	10
MEX02SUR	−127.20	27	−96.39	19.88	3.18	1.87	157	1	62.8	1	10
MSR00001	−79.70	27	−61.73	16.75	0.80	0.80	90	1	58.9	4	
PAQPAC01	−106.20	27	−109.18	−27.53	0.80	0.80	90	1	56.4	9/GR17	
PRG00002	−99.20	27	−58.66	−23.32	1.45	1.04	76	1	60.5		
PRUAND02	−115.20	27	−74.69	−8.39	3.41	1.79	95	1	64.3	9/GR5	
PTRVIR01	−101.20	27	−65.85	18.12	0.80	0.80	90	1	60.8	1 6 9/GR20	
PTRVIR02	−110.20	27	−65.86	18.12	0.80	0.80	90	1	61.3	1 6 9/GR21	
URG00001	−71.70	27	−56.22	−32.52	1.02	0.89	11	1	60.2		
USAEH001	−61.70	27	−85.19	36.21	5.63	3.33	22	1	62.1	1 5 6	
USAEH002	−101.20	27	−89.24	36.16	5.67	3.76	170	1	62.0	1 6 9/GR20	10
USAEH003	−110.20	27	−90.14	36.11	5.55	3.55	161	1	62.4	1 6 9/GR21	10
USAEH004	−119.20	27	−91.16	36.05	5.38	3.24	152	1	62.9	1 5 6	10
USAPSA02	−166.20	27	−117.80	40.58	4.03	0.82	135	1	63.6	9/GR1	
USAPSA03	−175.20	27	−118.27	40.12	3.62	0.80	136	1	65.4	9/GR2	
USAWH101	−148.20	27	−109.65	38.13	5.53	1.95	142	1	62.4	10	
USAWH102	−157.20	27	−111.41	38.57	5.51	1.54	138	1	63.5	10	
VENAND03	−115.20	27	−67.04	6.91	2.37	1.43	111	1	67.7	9/GR5	10

12 617.66 MHz (28)

1	2	3	4		5		6	7	8	9	
ALS00002	−165.80	28	−149.63	58.52	3.81	1.23	171	2	59.9	9/GR1	10
ALS00003	−174.80	28	−150.95	58.54	3.77	1.11	167	2	60.2	9/GR2	10
ARGNORT4	−93.80	28	−63.96	−30.01	3.86	1.99	48	2	66.1		
ARGNORT5	−54.80	28	−62.85	−29.80	3.24	2.89	47	2	63.9		
B CE311	−63.80	28	−40.60	−6.07	3.04	2.06	174	2	61.9	8 9/GR7	
B CE312	−44.80	28	−40.26	−6.06	3.44	2.09	174	2	61.3	8 9/GR9	10 11
B CE411	−63.80	28	−50.97	−15.26	3.86	1.38	49	2	62.9	8 9/GR7	
B CE412	−44.80	28	−50.71	−15.30	3.57	1.56	52	2	63.1	8 9/GR9	10 12
B CE511	−63.80	28	−53.11	−2.98	2.42	2.15	107	2	63.4	8 9/GR7	
B NO611	−73.80	28	−59.60	−11.62	2.86	1.69	165	1	63.2	8 9/GR8	
B NO711	−73.80	28	−60.70	−1.78	3.54	1.78	126	1	63.2	8 9/GR8	
B NO811	−73.80	28	−68.75	−4.71	2.37	1.65	73	1	63.2	8 9/GR8	
B SE911	−101.80	28	−45.99	−19.09	2.22	0.80	62	2	65.7	8	
B SU111	−80.80	28	−51.10	−25.64	2.76	1.06	50	2	63.2	8 9/GR6	
B SU112	−44.80	28	−50.76	−25.62	2.47	1.48	56	2	62.6	8 9/GR9	11
B SU211	−80.80	28	−44.51	−16.94	3.22	1.37	60	2	62.8	8 9/GR6	
B SU212	−44.80	28	−43.99	−16.97	3.27	1.92	59	2	61.6	8 9/GR9	12
CAN01101	−137.80	28	−125.60	57.24	3.45	1.27	157	2	59.7	9/GR10	10
CAN01201	−137.80	28	−111.92	55.89	3.33	0.98	151	2	59.8	9/GR10	10
CAN01202	−72.30	28	−107.64	55.62	2.75	1.11	32	2	59.8		
CAN01203	−128.80	28	−111.43	55.56	3.07	1.15	151	2	59.7	9/GR12	10
CAN01303	−128.80	28	−102.39	57.12	3.54	0.92	154	2	60.3	9/GR12	10
CAN01304	−90.80	28	−99.00	57.33	1.96	1.73	1	2	60.0	9/GR13	
CAN01403	−128.80	28	−89.70	52.02	4.67	0.80	148	2	62.1	9/GR12	10
CAN01404	−90.80	28	−84.78	52.41	3.09	2.06	153	2	60.6	9/GR13	
CAN01405	−81.80	28	−84.02	52.34	2.82	2.30	172	2	60.5	9/GR14	
CAN01504	−90.80	28	−72.68	53.78	3.57	1.67	157	2	60.4	9/GR13	
CAN01505	−81.80	28	−71.76	53.76	3.30	1.89	162	2	60.4	9/GR14	
CAN01605	−81.80	28	−61.54	49.50	2.66	1.39	144	2	60.5	9/GR14	
CAN01606	−70.30	28	−61.32	49.51	2.41	1.65	148	2	60.5		
CHLCONT4	−105.80	28	−69.59	−23.20	2.21	0.80	68	2	59.3	9/GR16	
CHLCONT6	−105.80	28	−73.52	−55.52	3.65	1.31	39	2	59.8	9/GR16	
CRBBAH01	−92.30	28	−76.09	24.13	1.83	0.80	141	1	62.0	9/GR18	
CRBBER01	−92.30	28	−64.76	32.13	0.80	0.80	90	1	57.0	9/GR18	
CRBBLZ01	−92.30	28	−88.61	17.26	0.80	0.80	90	1	58.9	9/GR18	
CRBEC001	−92.30	28	−60.07	8.26	4.20	0.86	115	1	64.6	9/GR18	
CRBJMC01	−92.30	28	−79.45	17.97	0.99	0.80	151	1	61.4	9/GR18	
EQAC0001	−94.80	28	−78.31	−1.52	1.48	1.15	65	1	63.3	9/GR19	
EQAG0001	−94.80	28	−90.36	−0.57	0.94	0.89	99	1	61.3	9/GR19	
GRD00003	−79.30	28	−61.62	12.34	0.80	0.80	90	2	58.9		
GTMIFRB2	−107.30	28	−90.50	15.64	1.03	0.80	84	1	61.4		
GUFMGG02	−52.80	28	−56.42	8.47	4.16	0.81	123	2	63.0	2 7	
HWA00002	−165.80	28	−165.79	23.32	4.20	0.80	160	2	59.0	9/GR1	10
HWA00003	−174.80	28	−166.10	23.42	4.25	0.80	159	2	59.0	9/GR2	10
MEX01NTE	−77.80	28	−105.80	25.99	2.88	2.07	155	2	60.8	1	
MEX02NTE	−135.80	28	−107.36	26.32	3.80	1.57	149	2	61.5	1	10
MEX02SUR	−126.80	28	−96.39	19.88	3.19	1.87	158	2	62.8	1	10
PNRIFRB2	−121.00	28	−80.15	8.46	1.01	0.80	170	1	65.1		
PRU00004	−85.80	28	−74.19	−8.39	3.74	2.45	112	2	63.2		
PTRVIR01	−100.80	28	−65.85	18.12	0.80	0.80	90	2	60.9	1 6 9/GR20	
PTRVIR02	−109.80	28	−65.85	18.12	0.80	0.80	90	2	61.4	1 6 9/GR21	
USAEH001	−61.30	28	−85.16	36.21	5.63	3.32	22	2	62.1	1 5 6	
USAEH002	−100.80	28	−89.28	36.16	5.65	3.78	170	2	62.0	1 6 9/GR20	10
USAEH003	−109.80	28	−90.12	36.11	5.55	3.56	161	2	62.4	1 6 9/GR21	10
USAEH004	−118.80	28	−91.16	36.05	5.38	3.24	153	2	62.9	1 5 6	10
USAPSA02	−165.80	28	−117.79	40.58	4.04	0.82	135	2	63.6	9/GR1	
USAPSA03	−174.80	28	−118.20	40.15	3.63	0.80	136	2	65.3	9/GR2	
USAWH101	−147.80	28	−109.70	38.13	5.52	1.96	142	2	62.4	10	
USAWH102	−156.80	28	−111.40	38.57	5.51	1.55	138	2	63.5	10	
VEN02VEN	−103.80	28	−63.50	15.50	0.80	0.80	90	2	60.1	9/GR22	
VEN11VEN	−103.80	28	−66.79	6.90	2.50	1.77	122	2	65.6	9/GR22	10

12 632.24 MHz (29)

1	2	3	4		5		6	7	8	9	
ALS00002	−166.20	29	−149.66	58.37	3.76	1.24	170	1	59.9	9/GR1	10
ALS00003	−175.20	29	−150.98	58.53	3.77	1.11	167	1	60.2	9/GR2	10
ARGINSU4	−94.20	29	−52.98	−59.81	3.40	0.80	19	1	60.1	9/GR3	
ARGINSU5	−55.20	29	−44.17	−59.91	3.77	0.80	13	1	59.5	9/GR4	
ARGSUR04	−94.20	29	−65.04	−43.33	3.32	1.50	40	1	60.9	9/GR3	
ARGSUR05	−55.20	29	−63.68	−43.01	2.54	2.38	152	1	60.2	9/GR4	
B CE311	−64.20	29	−40.60	−6.07	3.04	2.06	174	1	61.9	8 9/GR7	
B CE312	−45.20	29	−40.27	−6.06	3.44	2.09	174	1	61.2	8 9/GR9	10 11
B CE411	−64.20	29	−50.97	−15.27	3.86	1.38	49	1	62.9	8 9/GR7	
B CE412	−45.20	29	−50.71	−15.30	3.57	1.56	52	1	63.0	8 9/GR9	10 12
B CE511	−64.20	29	−53.10	−2.90	2.44	2.13	104	1	63.4	8 9/GR7	
B NO611	−74.20	29	−59.60	−11.62	2.85	1.69	165	2	63.1	8 9/GR8	
B NO711	−74.20	29	−60.70	−1.78	3.54	1.78	126	2	63.1	8 9/GR8	
B NO811	−74.20	29	−68.76	−4.71	2.37	1.65	73	2	63.1	8 9/GR8	
B SU111	−81.20	29	−51.12	−25.63	2.76	1.05	50	1	63.2	8 9/GR6	
B SU112	−45.20	29	−50.75	−25.62	2.47	1.48	56	1	62.5	8 9/GR9	11
B SU211	−81.20	29	−44.51	−16.95	3.22	1.36	60	1	62.8	8 9/GR6	
B SU212	−45.20	29	−44.00	−16.87	3.20	1.96	58	1	61.6	8 9/GR9	12
BERBERMU	−96.20	29	−64.77	32.32	0.80	0.80	90	2	57.0		
BOLAND01	−115.20	29	−65.04	−16.76	2.49	1.27	76	1	68.0	9/GR5	
CAN01101	−138.20	29	−125.63	57.24	3.45	1.27	157	1	59.7	9/GR10	10
CAN01201	−138.20	29	−112.04	55.95	3.35	0.97	151	1	59.8	9/GR10	10
CAN01202	−72.70	29	−107.70	55.63	2.74	1.12	32	1	59.8		
CAN01203	−129.20	29	−111.48	55.61	3.08	1.15	151	1	59.7	9/GR12	10
CAN01303	−129.20	29	−102.42	57.12	3.54	0.91	154	1	60.2	9/GR12	10
CAN01304	−91.20	29	−99.12	57.36	1.98	1.72	2	1	60.0	9/GR13	
CAN01403	−129.20	29	−89.75	52.02	4.68	0.80	148	1	62.1	9/GR12	10
CAN01404	−91.20	29	−84.82	52.42	3.10	2.05	152	1	60.6	9/GR13	
CAN01405	−82.20	29	−84.00	52.39	2.84	2.29	172	1	60.5	9/GR14	
CAN01504	−91.20	29	−72.66	53.77	3.57	1.67	156	1	60.4	9/GR13	
CAN01505	−82.20	29	−71.77	53.79	3.30	1.89	162	1	60.3	9/GR14	
CAN01605	−82.20	29	−61.50	49.55	2.65	1.40	143	1	60.5	9/GR14	
CAN01606	−70.70	29	−61.30	49.55	2.40	1.65	148	1	60.4		
CHLCONT5	−106.20	29	−72.23	−35.57	2.60	0.80	55	1	59.6	9/GR17	
CHLPAC02	−106.20	29	−80.06	−30.06	1.36	0.80	69	1	59.4	9/GR17	
CLMAND01	−115.20	29	−74.72	5.93	3.85	1.63	114	1	65.3	9/GR5	10
CLM00001	−103.20	29	−74.50	5.87	3.98	1.96	118	1	63.9	10	
EQACAND1	−115.20	29	−78.40	−1.61	1.37	0.95	75	1	64.4	9/GR5	
EQAGAND1	−115.20	29	−90.34	−0.62	0.90	0.81	89	1	61.5	9/GR5	
HWA00002	−166.20	29	−165.79	23.42	4.20	0.80	160	1	59.0	9/GR1	10
HWA00003	−175.20	29	−166.10	23.42	4.25	0.80	159	1	58.9	9/GR2	10
JMC00002	−92.70	29	−77.30	18.12	0.80	0.80	90	2	60.1		
KNA00001	−79.70	29	−62.46	17.44	0.80	0.80	90	1	58.6		
MEX01NTE	−78.20	29	−105.81	26.01	2.89	2.08	155	1	60.7	1	
MEX01SUR	−69.20	29	−94.84	19.82	3.05	2.09	4	1	62.5	1	
MEX02NTE	−136.20	29	−107.21	26.31	3.84	1.55	148	1	61.4	1	10
MEX02SUR	−127.20	29	−96.39	19.88	3.18	1.87	157	1	62.8	1	10
PAQPAC01	−106.20	29	−109.18	−27.53	0.80	0.80	90	1	56.4	9/GR17	
PRG00002	−99.20	29	−58.66	−23.32	1.45	1.04	76	1	60.4		
PRUAND02	−115.20	29	−74.69	−8.39	3.41	1.79	95	1	64.3	9/GR5	
PTRVIR01	−101.20	29	−65.85	18.12	0.80	0.80	90	1	60.8	1 6 9/GR20	
PTRVIR02	−110.20	29	−65.86	18.12	0.80	0.80	90	1	61.3	1 6 9/GR21	
SPMFRAN3	−53.20	29	−67.24	47.51	3.16	0.80	7	1	60.6	2 7	
SURINAM2	−84.70	29	−55.69	4.35	1.00	0.80	86	1	63.5		
URG00001	−71.70	29	−56.22	−32.52	1.02	0.89	11	1	60.2		
USAEH001	−61.70	29	−85.19	36.21	5.63	3.33	22	1	62.1	1 5 6	
USAEH002	−101.20	29	−89.24	36.16	5.67	3.76	170	1	62.0	1 6 9/GR20	10
USAEH003	−110.20	29	−90.14	36.11	5.55	3.55	161	1	62.3	1 6 9/GR21	10
USAEH004	−119.20	29	−91.16	36.05	5.38	3.24	152	1	62.9	1 5 6	10
USAPSA02	−166.20	29	−117.80	40.58	4.03	0.82	135	1	63.5	9/GR1	
USAPSA03	−175.20	29	−118.27	40.12	3.62	0.80	136	1	65.3	9/GR2	
USAWH101	−148.20	29	−109.65	38.13	5.53	1.95	142	1	62.3	10	
USAWH102	−157.20	29	−111.41	38.57	5.51	1.54	138	1	63.5	10	
VENAND03	−115.20	29	−67.04	6.91	2.37	1.43	111	1	67.6	9/GR5	10

12 646.82 MHz (30)

1	2	3	4		5		6	7	8	9	
ALS00002	−165.80	30	−149.63	58.52	3.81	1.23	171	2	59.9	9/GR1	10
ALS00003	−174.80	30	−150.95	58.54	3.77	1.11	167	2	60.2	9/GR2	10
ARGNORT4	−93.80	30	−63.96	−30.01	3.86	1.99	48	2	66.0		
ARGNORT5	−54.80	30	−62.85	−29.80	3.24	2.89	47	2	63.8		
ATNBEAM1	−52.80	30	−66.44	14.87	1.83	0.80	39	2	61.3		
B CE311	−63.80	30	−40.60	−6.07	3.04	2.06	174	2	61.9	8 9/GR7	
B CE312	−44.80	30	−40.26	−6.06	3.44	2.09	174	2	61.2	8 9/GR9	10 11
B CE411	−63.80	30	−50.97	−15.26	3.86	1.38	49	2	62.9	8 9/GR7	
B CE412	−44.80	30	−50.71	−15.30	3.57	1.56	52	2	63.0	8 9/GR9	10 12
B CE511	−63.80	30	−53.11	−2.98	2.42	2.15	107	2	63.4	8 9/GR7	
B NO611	−73.80	30	−59.60	−11.62	2.86	1.69	165	1	63.1	8 9/GR8	
B NO711	−73.80	30	−60.70	−1.78	3.54	1.78	126	1	63.1	8 9/GR8	
B NO811	−73.80	30	−68.75	−4.71	2.37	1.65	73	1	63.1	8 9/GR8	
B SE911	−101.80	30	−45.99	−19.09	2.22	0.80	62	2	65.7	8	
B SU111	−80.80	30	−51.10	−25.64	2.76	1.06	50	2	63.1	8 9/GR6	
B SU112	−44.80	30	−50.76	−25.62	2.47	1.48	56	2	62.6	8 9/GR9	11
B SU211	−80.80	30	−44.51	−16.94	3.22	1.37	60	2	62.8	8 9/GR6	
B SU212	−44.80	30	−43.99	−16.97	3.27	1.92	59	2	61.6	8 9/GR9	12
BLZ00001	−115.80	30	−88.68	17.27	0.80	0.80	90	2	59.2		
CAN01101	−137.80	30	−125.60	57.24	3.45	1.27	157	2	59.7	9/GR10	10
CAN01201	−137.80	30	−111.92	55.89	3.33	0.98	151	2	59.8	9/GR10	10
CAN01202	−72.30	30	−107.64	55.62	2.75	1.11	32	2	59.8		
CAN01203	−128.80	30	−111.43	55.56	3.07	1.15	151	2	59.7	9/GR12	10
CAN01303	−128.80	30	−102.39	57.12	3.54	0.92	154	2	60.3	9/GR12	10
CAN01304	−90.80	30	−99.00	57.33	1.96	1.73	1	2	60.0	9/GR13	
CAN01403	−128.80	30	−89.70	52.02	4.67	0.80	148	2	62.1	9/GR12	10
CAN01404	−90.80	30	−84.78	52.41	3.09	2.06	153	2	60.6	9/GR13	
CAN01405	−81.80	30	−84.02	52.34	2.82	2.30	172	2	60.5	9/GR14	
CAN01504	−90.80	30	−72.68	53.78	3.57	1.67	157	2	60.4	9/GR13	
CAN01505	−81.80	30	−71.76	53.76	3.30	1.89	162	2	60.3	9/GR14	
CAN01605	−81.80	30	−61.54	49.50	2.66	1.39	144	2	60.5	9/GR14	
CAN01606	−70.30	30	−61.32	49.51	2.41	1.65	148	2	60.4		
CHLCONT4	−105.80	30	−69.59	−23.20	2.21	0.80	68	2	59.3	9/GR16	
CHLCONT6	−105.80	30	−73.52	−55.52	3.65	1.31	39	2	59.7	9/GR16	
CRBBAH01	−92.30	30	−76.09	24.13	1.83	0.80	141	1	61.9	9/GR18	
CRBBER01	−92.30	30	−64.76	32.13	0.80	0.80	90	1	56.9	9/GR18	
CRBBLZ01	−92.30	30	−88.61	17.26	0.80	0.80	90	1	58.9	9/GR18	
CRBEC001	−92.30	30	−60.07	8.26	4.20	0.86	115	1	64.6	9/GR18	
CRBJMC01	−92.30	30	−79.45	17.97	0.99	0.80	151	1	61.3	9/GR18	
CTR00201	−130.80	30	−84.33	9.67	0.82	0.80	119	2	66.0		
DMAIFRB1	−79.30	30	−61.30	15.35	0.80	0.80	90	2	58.7		
EQAC0001	−94.80	30	−78.31	−1.52	1.48	1.15	65	1	63.3	9/GR19	
EQAG0001	−94.80	30	−90.36	−0.57	0.94	0.89	99	1	61.2	9/GR19	
HWA00002	−165.80	30	−165.79	23.32	4.20	0.80	160	2	59.0	9/GR1	10
HWA00003	−174.80	30	−166.10	23.42	4.25	0.80	159	2	59.0	9/GR2	10
MEX01NTE	−77.80	30	−105.80	25.99	2.88	2.07	155	2	60.7	1	
MEX02NTE	−135.80	30	−107.36	26.32	3.80	1.57	149	2	61.4	1	10
MEX02SUR	−126.80	30	−96.39	19.88	3.19	1.87	158	2	62.8	1	10
NCG00003	−107.30	30	−84.99	12.90	1.05	1.01	176	1	63.6		
PRU00004	−85.80	30	−74.19	−8.39	3.74	2.45	112	2	63.1		
PTRVIR01	−100.80	30	−65.85	18.12	0.80	0.80	90	2	60.8	1 6 9/GR20	
PTRVIR02	−109.80	30	−65.85	18.12	0.80	0.80	90	2	61.4	1 6 9/GR21	
USAEH001	−61.30	30	−85.16	36.21	5.63	3.32	22	2	62.1	1 5 6	
USAEH002	−100.80	30	−89.28	36.16	5.65	3.78	170	2	62.0	1 6 9/GR20	10
USAEH003	−109.80	30	−90.12	36.11	5.55	3.56	161	2	62.3	1 6 9/GR21	10
USAEH004	−118.80	30	−91.16	36.05	5.38	3.24	153	2	62.9	1 5 6	10
USAPSA02	−165.80	30	−117.79	40.58	4.04	0.82	135	2	63.5	9/GR1	
USAPSA03	−174.80	30	−118.20	40.15	3.63	0.80	136	2	65.3	9/GR2	
USAWH101	−147.80	30	−109.70	38.13	5.52	1.96	142	2	62.3	10	
USAWH102	−156.80	30	−111.40	38.57	5.51	1.55	138	2	63.5	10	
VEN11VEN	−103.80	30	−66.79	6.90	2.50	1.77	122	2	65.5	10	

12 661.40 MHz (31)

1	2	3	4		5		6	7	8	9	
ALS00002	−166.20	31	−149.66	58.37	3.76	1.24	170	1	60.0	9/GR1	10
ALS00003	−175.20	31	−150.98	58.53	3.77	1.11	167	1	60.2	9/GR2	10
ARGINSU4	−94.20	31	−52.98	−59.81	3.40	0.80	19	1	60.1	9/GR3	
ARGINSU5	−55.20	31	−44.17	−59.91	3.77	0.80	13	1	59.5	9/GR4	
ARGSUR04	−94.20	31	−65.04	−43.33	3.32	1.50	40	1	60.9	9/GR3	
ARGSUR05	−55.20	31	−63.68	−43.01	2.54	2.38	152	1	60.3	9/GR4	
B CE311	−64.20	31	−40.60	−6.07	3.04	2.06	174	1	61.9	8 9/GR7	
B CE312	−45.20	31	−40.27	−6.06	3.44	2.09	174	1	61.3	8 9/GR9	10 11
B CE411	−64.20	31	−50.97	−15.27	3.86	1.38	49	1	62.9	8 9/GR7	
B CE412	−45.20	31	−50.71	−15.30	3.57	1.56	52	1	63.1	8 9/GR9	10 12
B CE511	−64.20	31	−53.10	−2.90	2.44	2.13	104	1	63.4	8 9/GR7	
B NO611	−74.20	31	−59.60	−11.62	2.85	1.69	165	2	63.2	8 9/GR8	
B NO711	−74.20	31	−60.70	−1.78	3.54	1.78	126	2	63.2	8 9/GR8	
B NO811	−74.20	31	−68.76	−4.71	2.37	1.65	73	2	63.1	8 9/GR8	
B SU111	−81.20	31	−51.12	−25.63	2.76	1.05	50	1	63.2	8 9/GR6	
B SU112	−45.20	31	−50.75	−25.62	2.47	1.48	56	1	62.6	8 9/GR9	11
B SU211	−81.20	31	−44.51	−16.95	3.22	1.36	60	1	62.8	8 9/GR6	
B SU212	−45.20	31	−44.00	−16.87	3.20	1.96	58	1	61.6	8 9/GR9	12
BERBERMU	−96.20	31	−64.77	32.32	0.80	0.80	90	2	57.0		
BOLAND01	−115.20	31	−65.04	−16.76	2.49	1.27	76	1	68.1	9/GR5	
BOL00001	−87.20	31	−64.61	−16.71	2.52	2.19	85	1	64.2		
BRB00001	−92.70	31	−59.85	12.93	0.80	0.80	90	2	59.4		
CAN01101	−138.20	31	−125.63	57.24	3.45	1.27	157	1	59.7	9/GR10	10
CAN01201	−138.20	31	−112.04	55.95	3.35	0.97	151	1	59.8	9/GR10	10
CAN01202	−72.70	31	−107.70	55.63	2.74	1.12	32	1	59.8		
CAN01203	−129.20	31	−111.48	55.61	3.08	1.15	151	1	59.7	9/GR12	10
CAN01303	−129.20	31	−102.42	57.12	3.54	0.91	154	1	60.3	9/GR12	10
CAN01304	−91.20	31	−99.12	57.36	1.98	1.72	2	1	60.1	9/GR13	
CAN01403	−129.20	31	−89.75	52.02	4.68	0.80	148	1	62.1	9/GR12	10
CAN01404	−91.20	31	−84.82	52.42	3.10	2.05	152	1	60.6	9/GR13	
CAN01405	−82.20	31	−84.00	52.39	2.84	2.29	172	1	60.5	9/GR14	
CAN01504	−91.20	31	−72.66	53.77	3.57	1.67	156	1	60.4	9/GR13	
CAN01505	−82.20	31	−71.77	53.79	3.30	1.89	162	1	60.4	9/GR14	
CAN01605	−82.20	31	−61.50	49.55	2.65	1.40	143	1	60.5	9/GR14	
CAN01606	−70.70	31	−61.30	49.55	2.40	1.65	148	1	60.5		
CHLCONT5	−106.20	31	−72.23	−35.57	2.60	0.80	55	1	59.6	9/GR17	
CHLPAC02	−106.20	31	−80.06	−30.06	1.36	0.80	69	1	59.4	9/GR17	
CLMAND01	−115.20	31	−74.72	5.93	3.85	1.63	114	1	65.4	9/GR5	10
CLM00001	−103.20	31	−74.50	5.87	3.98	1.96	118	1	63.9	10	
CUB00001	−89.20	31	−79.81	21.62	2.24	0.80	168	1	61.3		
EQACAND1	−115.20	31	−78.40	−1.61	1.37	0.95	75	1	64.4	9/GR5	
EQAGAND1	−115.20	31	−90.34	−0.62	0.90	0.81	89	1	61.6	9/GR5	
GRD00059	−57.20	31	−61.58	12.29	0.80	0.80	90	1	58.7		
GRLDNK01	−53.20	31	−44.89	66.56	2.70	0.82	173	1	60.2	2	
GUY00201	−84.70	31	−59.19	4.78	1.44	0.85	95	1	63.8		
HWA00002	−166.20	31	−165.79	23.42	4.20	0.80	160	1	59.0	9/GR1	10
HWA00003	−175.20	31	−166.10	23.42	4.25	0.80	159	1	59.0	9/GR2	10
MEX01NTE	−78.20	31	−105.81	26.01	2.89	2.08	155	1	60.8	1	
MEX01SUR	−69.20	31	−94.84	19.82	3.05	2.09	4	1	62.5	1	
MEX02NTE	−136.20	31	−107.21	26.31	3.84	1.55	148	1	61.5	1	10
MEX02SUR	−127.20	31	−96.39	19.88	3.18	1.87	157	1	62.8	1	10
MSR00001	−79.70	31	−61.73	16.75	0.80	0.80	90	1	58.9	4	
PAQPAC01	−106.20	31	−109.18	−27.53	0.80	0.80	90	1	56.4	9/GR17	
PRG00002	−99.20	31	−58.66	−23.32	1.45	1.04	76	1	60.5		
PRUAND02	−115.20	31	−74.69	−8.39	3.41	1.79	95	1	64.3	9/GR5	
PTRVIR01	−101.20	31	−65.85	18.12	0.80	0.80	90	1	60.8	1 6 9/GR20	
PTRVIR02	−110.20	31	−65.86	18.12	0.80	0.80	90	1	61.3	1 6 9/GR21	
URG00001	−71.70	31	−56.22	−32.52	1.02	0.89	11	1	60.2		
USAEH001	−61.70	31	−85.19	36.21	5.63	3.33	22	1	62.1	1 5 6	
USAEH002	−101.20	31	−89.24	36.16	5.67	3.76	170	1	62.0	1 6 9/GR20	10
USAEH003	−110.20	31	−90.14	36.11	5.55	3.55	161	1	62.4	1 6 9/GR21	10
USAEH004	−119.20	31	−91.16	36.05	5.38	3.24	152	1	62.9	1 5 6	10
USAPSA02	−166.20	31	−117.80	40.58	4.03	0.82	135	1	63.6	9/GR1	
USAPSA03	−175.20	31	−118.27	40.12	3.62	0.80	136	1	65.4	9/GR2	
USAWH101	−148.20	31	−109.65	38.13	5.53	1.95	142	1	62.4	10	
USAWH102	−157.20	31	−111.41	38.57	5.51	1.54	138	1	63.5	10	
VENAND03	−115.20	31	−67.04	6.91	2.37	1.43	111	1	67.7	9/GR5	10

12 675.98 MHz (32)

1	2	3	4		5		6	7	8	9	
ALS00002	−165.80	32	−149.63	58.52	3.81	1.23	171	2	59.9	9/GR1	10
ALS00003	−174.80	32	−150.95	58.54	3.77	1.11	167	2	60.2	9/GR2	10
ARGNORT4	−93.80	32	−63.96	−30.01	3.86	1.99	48	2	66.1		
ARGNORT5	−54.80	32	−62.85	−29.80	3.24	2.89	47	2	63.9		
B CE311	−63.80	32	−40.60	−6.07	3.04	2.06	174	2	61.9	8 9/GR7	
B CE312	−44.80	32	−40.26	−6.06	3.44	2.09	174	2	61.3	8 9/GR9	10 11
B CE411	−63.80	32	−50.97	−15.26	3.86	1.38	49	2	62.9	8 9/GR7	
B CE412	−44.80	32	−50.71	−15.30	3.57	1.56	52	2	63.1	8 9/GR9	10 12
B CE511	−63.80	32	−53.11	−2.98	2.42	2.15	107	2	63.4	8 9/GR7	
B NO611	−73.80	32	−59.60	−11.62	2.86	1.69	165	1	63.2	8 9/GR8	
B NO711	−73.80	32	−60.70	−1.78	3.54	1.78	126	1	63.2	8 9/GR8	
B NO811	−73.80	32	−68.75	−4.71	2.37	1.65	73	1	63.2	8 9/GR8	
B SE911	−101.80	32	−45.99	−19.09	2.22	0.80	62	2	65.7	8	
B SU111	−80.80	32	−51.10	−25.64	2.76	1.06	50	2	63.2	8 9/GR6	
B SU112	−44.80	32	−50.76	−25.62	2.47	1.48	56	2	62.6	8 9/GR9	11
B SU211	−80.80	32	−44.51	−16.94	3.22	1.37	60	2	62.8	8 9/GR6	
B SU212	−44.80	32	−43.99	−16.97	3.27	1.92	59	2	61.6	8 9/GR9	12
CAN01101	−137.80	32	−125.60	57.24	3.45	1.27	157	2	59.7	9/GR10	10
CAN01201	−137.80	32	−111.92	55.89	3.33	0.98	151	2	59.8	9/GR10	10
CAN01202	−72.30	32	−107.64	55.62	2.75	1.11	32	2	59.8		
CAN01203	−128.80	32	−111.43	55.56	3.07	1.15	151	2	59.7	9/GR12	10
CAN01303	−128.80	32	−102.39	57.12	3.54	0.92	154	2	60.3	9/GR12	10
CAN01304	−90.80	32	−99.00	57.33	1.96	1.73	1	2	60.0	9/GR13	
CAN01403	−128.80	32	−89.70	52.02	4.67	0.80	148	2	62.1	9/GR12	10
CAN01404	−90.80	32	−84.78	52.41	3.09	2.06	153	2	60.6	9/GR13	
CAN01405	−81.80	32	−84.02	52.34	2.82	2.30	172	2	60.5	9/GR14	
CAN01504	−90.80	32	−72.68	53.78	3.57	1.67	157	2	60.4	9/GR13	
CAN01505	−81.80	32	−71.76	53.76	3.30	1.89	162	2	60.4	9/GR14	
CAN01605	−81.80	32	−61.54	49.50	2.66	1.39	144	2	60.5	9/GR14	
CAN01606	−70.30	32	−61.32	49.51	2.41	1.65	148	2	60.5		
CHLCONT4	−105.80	32	−69.59	−23.20	2.21	0.80	68	2	59.3	9/GR16	
CHLCONT6	−105.80	32	−73.52	−55.52	3.65	1.31	39	2	59.8	9/GR16	
CRBBAH01	−92.30	32	−76.09	24.13	1.83	0.80	141	1	62.0	9/GR18	
CRBBER01	−92.30	32	−64.76	32.13	0.80	0.80	90	1	57.0	9/GR18	
CRBBLZ01	−92.30	32	−88.61	17.26	0.80	0.80	90	1	58.9	9/GR18	
CRBEC001	−92.30	32	−60.07	8.26	4.20	0.86	115	1	64.6	9/GR18	
CRBJMC01	−92.30	32	−79.45	17.97	0.99	0.80	151	1	61.4	9/GR18	
EQAC0001	−94.80	32	−78.31	−1.52	1.48	1.15	65	1	63.3	9/GR19	
EQAG0001	−94.80	32	−90.36	−0.57	0.94	0.89	99	1	61.3	9/GR19	
GRD00003	−79.30	32	−61.62	12.34	0.80	0.80	90	2	58.9		
GTMIFRB2	−107.30	32	−90.50	15.64	1.03	0.80	84	1	61.4		
GUFMGG02	−52.80	32	−56.42	8.47	4.16	0.81	123	2	63.0	2 7	
HWA00002	−165.80	32	−165.79	23.32	4.20	0.80	160	2	59.0	9/GR1	10
HWA00003	−174.80	32	−166.10	23.42	4.25	0.80	159	2	59.0	9/GR2	10
MEX01NTE	−77.80	32	−105.80	25.99	2.88	2.07	155	2	60.8	1	
MEX02NTE	−135.80	32	−107.36	26.32	3.80	1.57	149	2	61.5	1	10
MEX02SUR	−126.80	32	−96.39	19.88	3.19	1.87	158	2	62.8	1	10
PNRIFRB2	−121.00	32	−80.15	8.46	1.01	0.80	170	1	65.1		
PRU00004	−85.80	32	−74.19	−8.39	3.74	2.45	112	2	63.2		
PTRVIR01	−100.80	32	−65.85	18.12	0.80	0.80	90	2	60.9	1 6 9/GR20	
PTRVIR02	−109.80	32	−65.85	18.12	0.80	0.80	90	2	61.4	1 6 9/GR21	
USAEH001	−61.30	32	−85.16	36.21	5.63	3.32	22	2	62.1	1 5 6	
USAEH002	−100.80	32	−89.28	36.16	5.65	3.78	170	2	62.0	1 6 9/GR20	10
USAEH003	−109.80	32	−90.12	36.11	5.55	3.56	161	2	62.4	1 6 9/GR21	10
USAEH004	−118.80	32	−91.16	36.05	5.38	3.24	153	2	62.9	1 5 6	10
USAPSA02	−165.80	32	−117.79	40.58	4.04	0.82	135	2	63.6	9/GR1	
USAPSA03	−174.80	32	−118.20	40.15	3.63	0.80	136	2	65.3	9/GR2	
USAWH101	−147.80	32	−109.70	38.13	5.52	1.96	142	2	62.4	10	
USAWH102	−156.80	32	−111.40	38.57	5.51	1.55	138	2	63.5	10	
VEN02VEN	−103.80	32	−63.50	15.50	0.80	0.80	90	2	60.1	9/GR22	
VEN11VEN	−103.80	32	−66.79	6.90	2.50	1.77	122	2	65.6	9/GR22	10

ARTICLE 11 (REV.WRC-23)

Plan for the broadcasting-satellite service in the frequency bands 11.7-12.2 GHz in Region 3 and 11.7-12.5 GHz in Region 1

11.1 COLUMN HEADINGS OF THE PLAN

Col. 1 *Notifying administration symbol.*

Col. 2 *Beam identification* (Column 2, normally, contains the symbol designating the administration or the geographical area taken from Table B1 of the Preface to the International Frequency Information Circular (BR IFIC), followed by the symbol designating the service area).

Col. 3 *Nominal orbital position*, in degrees and hundredths of a degree from the Greenwich meridian (negative values indicate longitudes which are west of the Greenwich meridian; positive values indicate longitudes which are east of the Greenwich meridian).

Col. 4 *Nominal intersection of the beam axis with the Earth* (boresight or aim point in the case of a non-elliptical beam), longitude and latitude, in degrees and hundredths of a degree.

Col. 5 *Space station transmitting antenna characteristics* (elliptical beams). This column contains three numerical values corresponding to the major axis, the minor axis and the major axis orientation respectively of the elliptical cross-section half-power beamwidth, in degrees and hundredths of a degree. Orientation of the ellipse is determined as follows: in a plane normal to the beam axis, the direction of a major axis of the ellipse is specified as the angle measured anticlockwise from a line parallel to the equatorial plane to the major axis of the ellipse, to the nearest degree.

Col. 6 *Space station transmitting antenna pattern code.*

The codes used for the antenna pattern of the transmitting space station (downlink) antenna are defined as follows:

MOD13FRTSS	Figure 13 in Annex 5 (Recommendation ITU-R BO.1445)
R13TSS	Figure 9 and § 3.13.3 in Annex 5
R123SS	Figure 10 and § 3.13.3 in Annex 5
R123FR	Figure 11 and § 3.13.3 in Annex 5

In cases where the “Space station transmitting antenna pattern code” field is blank, the necessary antenna pattern data are provided by shaped beam data submitted by the administration. These data are stored in Column 7. A particular shaped beam is identified by the combination of Column 1, Column 7 and Column 13. In such cases the maximum cross-polar gain is given under Column 8 in the “Cross-polar gain” field.

In cases where the "Space station transmitting antenna pattern code" field contains a code which starts with "CB_" characters, it is a composite beam. Any composite beam consists of two or more elliptical beams. Each composite beam is described in the special composite beam file as having the same name plus a GXT extension (e.g. the description of the CB_COMP_BM1 composite beam is stored in the CB_COMP_BM1.GXT file).

Col. 7 *Space station transmitting antenna shaped (non-elliptical and non-composite) beam identification*.

Col. 8 *Maximum space station transmitting antenna co-polar and cross-polar (in the case of shaped beam) isotropic gain (dBi)*.

Col. 9 *Earth station receiving antenna pattern code and maximum antenna co-polar gain (dBi).*

The codes used for receiving earth station (downlink) antenna patterns are defined as follows:

R13RES	Figure 7 and § 3.7.2 in Annex 5
MODRES	Figure 7*bis* and § 3.7.2 in Annex 5 (Recommendation ITU-R BO.1213)

Col. 10 *Polarization* (CL – circular left, CR – circular right, LE – linear referenced to the equatorial plane) and polarization angle in degrees and hundredths of a degree (in the case of linear polarization only).

Col. 11 *e.i.r.p*. in the direction of maximum radiation (dBW).

Col. 12 *Designation of emission*.

Col. 13 *Identity of the space station*.

Col. 14 *Group code* (an identification code which indicates that all assignments with the same group identification code will be treated as a group).

Group code: if an assignment is part of the group:

a) The equivalent protection margin to be used for the application of Article 4 shall be calculated on the following basis:

– for the calculation of interference to assignments that are part of a group, only the interference contributions from assignments that are not part of the same group are to be included; and

– for the calculation of interference from assignments belonging to a group to assignments that are not part of that same group, only the worst interference contribution from that group shall be used on a test point to test point basis.

b) If an administration notifies the same frequency in more than one beam of a group for use at the same time, the aggregate carrier-to-interference ratio (C/I) produced by all emissions from that group shall not exceed the C/I ratio calculated on the basis of § *a)* above.

Col. 15 *Assignment status.*

The assignment status codes used for beams are defined as follows:

P	Assignment in the Plan which has not been brought into use and/or the date of bringing into use has not been confirmed to the Bureau. For this category of assignments, WRC-2000 protection ratios are applied (21 dB co-channel and 16 dB adjacent channel).
PE	Assignment in the Plan which is in conformity with Appendix 30, has been notified, brought into use and the date of bringing into use has been confirmed to the Bureau before 12 May 2000. For this category of assignments, WRC-97 protection ratios are applied (24 dB co-channel and 16 dB adjacent channel).

Col. 16 *Remarks*.

11.2 TEXT FOR NOTES IN THE REMARKS COLUMN OF THE PLAN (REV.WRC-15)

1 To be dedicated to the Islamic programme envisaged in WARC SAT-77 documents.

2 Not used.

3 Provisional beam. These assignments have been included in the Plan by WRC-97. These assignments are for exclusive use by Palestine, subject to the Israeli-Palestinian Interim Agreement of 28 September 1995, Resolution 741 of the Council notwithstanding and Resolution 99 (Minneapolis, 1998) of the Plenipotentiary Conference.

4 Assignment intended to ensure coverage of Algeria, Libya, Morocco, Mauritania and Tunisia, with the agreement of the countries concerned. If required, it may be used with the characteristics of the beam TUN15000.

5 This assignment shall be brought into use only when the limits referred to in Table 1 are not exceeded or with the agreement of the administrations identified in Table 2, whose networks/beams listed in this Table may be affected, with respect to (see also the Note to § 11.2):

a) assignments in the Region 2 Plan on 12 May 2000; *or*

b) assignments in the terrestrial services which are recorded in the Master Register with a favourable finding or received by the Bureau prior to 12 May 2000 for recording in the Master Register and which subsequently receive a favourable finding based on the Plan as it existed on 12 May 2000; *or*

c) assignments in the fixed-satellite service which:

– are recorded in the Master Register prior to 12 May 2000 with a favourable finding; *or*

– have been coordinated under the provisions of No. **9.7** (or No. **1060**) or § 7.2.1 of Article 7 prior to 12 May 2000; or

– are in process of coordination under the provisions of No. **9.7** (or No. **1060**) or § 7.2.1 of Article 7 prior to 31 July 2000 for which complete Appendix **4** data (or Appendix **3** data, as appropriate) have been received by the Bureau under the relevant provisions of Article **9** (or Article **11**, as appropriate):

  – filings received by the Bureau prior to 12 May 2000 at 1700 h (Istanbul time) shall be taken into account in the pertinent compatibility analysis by applying the pfd criteria referred to in Table 1; *or*

  – filings received by the Bureau after 12 May 2000 at 1700 h (Istanbul time), but before 31 July 2000, shall be taken into account by applying the sharing criteria of −138 dB(W/(m^2 · 27 MHz)) or the pfd criteria referred to in Table 1, whichever is higher.

6 This assignment shall not claim protection from interference caused by the assignments which pertain to networks/beams identified in Table 3 which are in conformity with the Region 2 Plan on 12 May 2000 (see also the Note to § 11.2).

7 This assignment shall not claim protection from interference caused by assignments in the fixed-satellite service which pertain to networks/beams identified in Table 3 (see also the Note to § 11.2) and:

a) either are recorded in the Master Register with a favourable finding prior to 12 May 2000;

b) or for which complete Appendix **4** data (or Appendix **3** data, as appropriate) under the relevant provisions of Article **9** (or No. **1060**, or § 7.2.1 of Article 7, as appropriate) have been received prior to 12 May 2000, which have been brought into use prior to 12 May 2000 and for which the complete due diligence information, in accordance with Annex 2 to Resolution **49 (Rev.WRC-15)***, has been received prior to 12 May 2000. (WRC-15)

8 This assignment shall not claim protection from the assignments of the administrations for terrestrial services identified in Table 4 which are recorded in the Master Register with a favourable finding, or received by the Bureau prior to 12 May 2000 for recording in the Master Register and which subsequently receive a favourable finding based on the Plan as it existed on 12 May 2000 (see also the Note to § 11.2).

* *Note by the Secretariat*: This Resolution was revised by WRC-19 and WRC-23.

9 (SUP - WRC-12)

10 Affected administrations and corresponding networks/beams are included in the relevant AP30/P Special Section. (WRC-23)

TABLE 1

Symbol	Criteria
a	§ 3 of Annex 1[1]
b	§ 4 of Annex 1[1]
c	§ 6 of Annex 1[1]

[1] These paragraphs and this Annex are contained in this Appendix as adopted by WRC-03.

NOTE – In cases where assignments from the WRC-97 Plan without remarks were included in the WRC-2000 Regions 1 and 3 Plan without change, or with conversion of modulation from analogue to digital, or a change from normal roll-off to fast roll-off antenna characteristics, the coordination status afforded by the WRC-97 Plan shall be preserved.

In cases where assignments from the WRC-97 Plan with remarks were included in the WRC-2000 Regions 1 and 3 Plan without change, or with conversion of modulation from analogue to digital, or a change from normal roll-off to fast roll-off antenna pattern, the compatibility will be reassessed using the revised criteria and methodology of WRC-2000 and the remarks of the WRC-97 Plan assignment will either be maintained or reduced on the basis of the results of this analysis.

In other cases the methodology described in Notes 5 to 8 shall be applied.

TABLE 2 (REV.WRC-23)

Affected administrations and corresponding networks/beams identified based on Note 5 in § 11.2 of Article 11

Beam name	Channels	Ref. Table 1	Affected administrations*	Affected networks/beams*
ARS34000	40	c	CHN, G, J, KOR, MLA, THA, UAE, USA	AM-SAT A4, ASIASAT-AKX, ASIASAT-CKX, ASIASAT-EKX, EMARSAT-1G, JCSAT-3A, JCSAT-3B, KOREASAT-1, MEASAT-1, MEASAT-91.5E, N-SAT-110E, N-SAT-128, SJC-1, THAICOM-A2B, THAICOM-G1K
BEL01800	26, 28, 30, 32, 34, 36, 38, 40	c	PAK	PAKSAT-1
BFA10700	22, 24	c	E	HISPASAT-1, HISPASAT-2C3 KU
CYP08600	1, 3, 5, 7, 9, 11, 13	c	USA	INTELSAT7 359E, INTELSAT8 359E
FSM00000	1, 3, 5, 7, 9, 11, 13	c	USA	INTELSAT7 157E
GMB30200	1, 5, 9, 13, 17	c	USA	USASAT-26A
GNB30400	22, 24	c	E	HISPASAT-1, HISPASAT-2C3 KU
GRC10500	2, 4, 6, 8, 10, 12	c	USA	INTELSAT7 359E, INTELSAT8 359E, INTELSAT10 359E
GUI19200	2, 4, 6, 8, 10, 12, 14, 16, 18, 20	c	USA	USASAT-26A
IRL21100	1, 3, 5, 7, 9, 11, 13, 15, 17, 19	c	USA	USASAT-26A
ISL04900	27	a	GUY	GUY00302
ISL04900	29, 39	a	JMC	JMC00005
ISL04900	31, 33, 35, 37	a	GUY, JMC	GUY00302, JMC00005
ISL04900	23	c	B, USA	B-SAT I, USASAT-14L
KIR__100	1, 3, 5, 7, 9, 11, 13	c	USA	INTELSAT7 177E, USASAT-14K
KIR__100	17	c	USA	USASAT-14K
MNG24800	31, 35	c	CHN, THA	APSTAR-4, THAICOM-A2B, THAICOM-G1K
NGR11500	2, 4, 6, 8, 10, 12, 14, 16, 18, 20	c	USA	USASAT-26A
NOR12000	1, 3, 5, 7, 9, 11, 13	c	USA	INTELSAT7 359E, INTELSAT8 359E, INTELSAT10 359E
POR__100	1, 3, 5, 7, 9, 11, 13, 15, 17, 19	c	USA	USASAT-26A
RUS-4	28, 29, 33, 37	c	KOR	KOREASAT-1, KOREASAT-2
SEN22200	23	c	USA	USASAT-26A
TGO22600	1, 3, 5, 7, 9, 11	c	USA	INTELSAT8 330.5E
TGO22600	13	c	E, USA	HISPASAT-1, HISPASAT-2C3 KU, INTELSAT8 330.5E
TGO22600	15, 17, 19	c	E	HISPASAT-1, HISPASAT-2C3 KU
TJK06900	26, 28, 30, 32, 34, 36, 38, 40	c	PAK	PAKSAT-1
TKM06800	26, 28, 30, 32, 34, 36, 38, 40	c	UAE	EMARSAT-1G
TON21500	2, 6, 10, 14, 18	c	USA	USASAT-14K

* Administrations and corresponding networks/beams whose assignment(s) may receive interference from the beam shown in the left-hand column.

TABLE 3 (REV.WRC-23)

Affecting administrations and corresponding networks/beams identified based on Notes 6 and 7 in § 11.2 of Article 11

Beam name	Channels	Note	Affecting administrations*	Affecting networks/beams*
AND34100	2, 6, 10, 12, 14, 16, 18, 20	7	USA	USASAT-26A
BFA10700	22, 24	7	E	HISPASAT-1, HISPASAT-2C3 KU
CYP08600	1, 3, 5, 7, 9, 11, 13	7	USA	INTELSAT7 359E
DNK090XR	29	6	JMC	JMC00005
DNK090XR	33	6	GUY, JMC	GUY00302, JMC00005
DNK091XR	31, 35	6	GUY, JMC	GUY00302, JMC00005
FJI19300	1, 3, 5, 7, 9, 11, 13	7	HOL	INTELSAT7 183E
GMB30200	1, 3, 5, 7, 9, 11, 13, 15, 17, 19	7	USA	USASAT-26A
GNB30400	22, 24	7	E	HISPASAT-1, HISPASAT-2C3 KU
GRC10500	2, 4, 6, 8, 10, 12	7	USA	INTELSAT7 359E
GUI19200	2, 4, 6, 8, 10, 12, 14, 16, 18, 20	7	USA	USASAT-26A
IRL21100	1, 3, 5, 7, 9, 11, 13, 15, 17, 19	7	USA	USASAT-26A
ISL04900	27	6	GUY	GUY00302
ISL04900	29, 39	6	JMC	JMC00005
ISL04900	31, 33, 35, 37	6	GUY, JMC	GUY00302, JMC00005
KIR__100	1, 3, 5, 7, 9, 11, 13	7	USA	INTELSAT7 177E
MNG24800	27	7	J	SUPERBIRD-C
MNG24800	29, 31, 33, 35, 37, 39	7	J, THA	THAICOM-A2B, SUPERBIRD-C
MTN__100	22, 24, 26	7	USA	USASAT-26A
NGR11500	2, 4, 6, 8, 10, 12, 14, 16, 18, 20	7	USA	USASAT-26A
NOR12000	1, 3, 5, 7, 9, 11, 13	7	USA	INTELSAT7 359E
POR__100	1, 3, 5, 7, 9, 11, 13, 15, 17, 19	7	USA	USASAT-26A
RUS-4	25	7	J	JCSAT-1R, SUPERBIRD-C
RUS-4	28, 29	7	J, KOR	SUPERBIRD-C, KOREASAT-1, KOREASAT-2
RUS-4	31, 33, 35, 37, 39	7	J, KOR	SUPERBIRD-C, KOREASAT-1, KOREASAT-2
SEN22200	23, 25	7	USA	USASAT-26A
SMO05700	1, 3, 5, 7, 9, 11, 13	7	HOL	INTELSAT7 183E
SMR31100	1, 3, 5, 7, 9, 11, 13, 15, 17, 19	7	USA	USASAT-26A
SRL25900	27	6	GUY	GUY00302
SRL25900	29, 39	6	JMC	JMC00005
SRL25900	31, 33, 35, 37	6	GUY, JMC	GUY00302, JMC00005
TGO22600	13	7	E	HISPASAT-2C3 KU
TGO22600	15, 17, 19	7	E	HISPASAT-1, HISPASAT-2C3 KU

* Administrations and corresponding networks/beams whose assignment(s) may cause interference to the beam shown in the left-hand column.

TABLE 4 (WRC-07)

Affecting administrations and corresponding terrestrial stations identified based on Note 8 in § 11.2 of Article 11

Beam name	Channels	Affecting administrations*	Affecting terrestrial stations*
EGY02600	2	ISR	HERZILIYA
F 09300	24, 26	SUI	GENEVE STUDIO C VOGT
I 08200	38, 40	AUT	EHRWALD
JOR22400	2	ISR	HERZILIYA, JERUSALEM
RUS-4	25, 26, 27, 28, 29, 31, 33, 35, 37, 39	J[1]	

* Administrations and corresponding terrestrial stations whose assignment(s) may cause interference to the beam shown in the left-hand column.

1 The identification of this administration is based on its typical terrestrial station assignments as recorded in the Master Register.

TABLE 5

Table showing correspondence between channel numbers and assigned frequencies

Channel No.	Assigned frequency (MHz)	Channel No.	Assigned frequency (MHz)
1	11 727.48	21	12 111.08
2	11 746.66	22	12 130.26
3	11 765.84	23	12 149.44
4	11 785.02	24	12 168.62
5	11 804.20	25	12 187.80
6	11 823.38	26	12 206.98
7	11 842.56	27	12 226.16
8	11 861.74	28	12 245.34
9	11 880.92	29	12 264.52
10	11 900.10	30	12 283.70
11	11 919.28	31	12 302.88
12	11 938.46	32	12 322.06
13	11 957.64	33	12 341.24
14	11 976.82	34	12 360.42
15	11 996.00	35	12 379.60
16	12 015.18	36	12 398.78
17	12 034.36	37	12 417.96
18	12 053.54	38	12 437.14
19	12 072.72	39	12 456.32
20	12 091.90	40	12 475.50

Note – Assigned frequency = 11 708.30 + 19.18 n, where n is the channel number.

TABLE 6A (REV.WRC-23)

Basic characteristics of the Regions 1 and 3 Plan (sorted by administration)

1	2	3	4		5			6	7	8		9		10		11	12	13	14	15	16
Admin. symbol	Beam identification	Orbital position	Boresight		Space station antenna characteristics			Space station antenna code	Shaped beam	Space station antenna gain		Earth station antenna		Polarization		e.i.r.p.	Designation of emission	Identity of the space station	Group code	Status	Remarks
			Long.	Lat.	Major axis	Minor axis	Orien-tation			Co-polar	Cross-polar	Code	Gain	Type	Angle						
AFG	AFG_100	50.00	65.88	33.86				CB_TSS_AFGA		42.71		MODRES	35.50	CL		58.4	27M0G7W			P	
AFS	AFS_SASAT3	−8.20	24.08	−28.16	2.77	1.31	37.04	R123SS		38.85		MODRES	35.50	CL		58.9	27M0G7W			P	
AGL	AGL29500	−24.80	16.06	−12.45	2.42	1.88	77.88	R13TSS		37.87		MODRES	35.50	CL		59.1	27M0G7W			P	
ALB	ALB_SAT	−33.60	19.87	41.11	0.65	0.60	130.56	R123SS		48.54		MODRES	35.50	CR		59.3	27M0G7W			P	10
ALG	ALG_100	−24.80	1.86	27.60				CB_TSS_ALGA		39.59		MODRES	35.50	CL		54.5	27M0G7W			P	
AND	AND34100	−37.00	1.60	42.50	0.60	0.60	0.00	R13TSS		48.88		MODRES	35.50	CL		56.5	27M0G7W			P	7
ARM	ARM06400	22.80	44.99	39.95	0.73	0.60	148.17	R13TSS		48.02		MODRES	35.50	CR		58.9	27M0G7W			P	
ARS	ARS_BSS	7.90	44.04	23.34	3.63	1.84	137.74	R123SS		36.20		MODRES	35.50	CL		58.9	27M0G7W			P	10
ARS	ARS34000	17.00	52.30	24.80	2.68	0.70	143.00	R13TSS		41.71		MODRES	35.50	CL		59.2	27M0G7W		54	P	5
AUS	AUS00400	152.00	123.00	−24.20	3.06	2.17	102.00	R13TSS		36.22		MODRES	35.50	CR		58.2	27M0G7W		30	P	
AUS	AUS0040A	152.00	96.83	−12.19	0.60	0.60	0.00	R13TSS		48.88		MODRES	35.50	CR		58.9	27M0G7W		30	P	
AUS	AUS0040B	152.00	105.69	−10.45	0.60	0.60	0.00	R13TSS		48.88		MODRES	35.50	CR		58.9	27M0G7W		30	P	
AUS	AUS0040C	152.00	110.52	−66.28	0.60	0.60	0.00	R13TSS		48.88		MODRES	35.50	CR		58.9	27M0G7W		30	P	
AUS	AUS00500	152.00	133.90	−18.40	2.82	1.74	105.00	R13TSS		37.53		MODRES	35.50	CL		59.4	27M0G7W			P	
AUS	AUS00600	152.00	136.60	−30.90	2.41	1.52	161.00	R13TSS		38.80		MODRES	35.50	CL		58.4	27M0G7W			P	
AUS	AUS00700	164.00	145.20	−38.10	2.12	1.02	147.00	R13TSS		41.09		MODRES	35.50	CR		58.5	27M0G7W		31	P	
AUS	AUS0070A	164.00	158.94	−54.50	0.60	0.60	0.00	R13TSS		48.88		MODRES	35.50	CR		58.9	27M0G7W		31	P	
AUS	AUS00800	164.00	145.90	−21.70	3.62	1.63	136.00	R13TSS		36.73		MODRES	35.50	CL		58.8	27M0G7W			P	
AUS	AUS00900	164.00	147.50	−32.10	2.31	1.43	187.00	R13TSS		39.25		MODRES	35.50	CR		59.3	27M0G7W		32	P	
AUS	AUS0090A	164.00	159.06	−31.52	0.60	0.60	0.00	R13TSS		48.88		MODRES	35.50	CR		58.9	27M0G7W		32	P	
AUS	AUS0090B	164.00	167.93	−29.02	0.60	0.60	0.00	R13TSS		48.88		MODRES	35.50	CR		58.9	27M0G7W		32	P	
AUS	AUSA_100	152.00	132.38	−38.37				CB_TSS_AUSA		48.88		MODRES	35.50	CR		58.9	27M0G7W			P	
AUS	AUSB_100	164.00	132.38	−38.37				CB_TSS_AUSB		48.88		MODRES	35.50	CL		58.9	27M0G7W			P	
AUT	AUT01600	−18.80	10.31	49.47	1.82	0.92	151.78	MOD13FRTSS		42.19		MODRES	35.50	CR		59.1	27M0G7W			P	
AZE	AZERSAT-BSS-10E	10.00	47.20	40.35	0.79	0.60	152.23	R123SS		47.69		MODRES	35.50	CR		59.1	27M0G7W			P	10
BDI	BDI_SAT	−26.80	29.79	−3.19	0.60	0.60	0.00	R123SS		48.88		MODRES	35.50	CL		59.2	27M0G7W			P	
BEL	BEL01800	38.20	5.12	51.96	1.00	1.00	24.53	MOD13FRTSS		44.45		MODRES	35.50	CL		55.5	27M0G7W			P	5
BEN	BEN_SAT	−30.60	2.25	9.47	1.30	0.60	94.63	R123SS		45.53		MODRES	35.50	CL		58.8	27M0G7W			P	10
BFA	BFA10700	−30.00	−1.50	12.20	1.45	1.14	29.00	R13TSS		42.26		MODRES	35.50	CL		57.0	27M0G7W			P	5, 7
BGD	BGD22000	74.00	90.30	23.60	1.46	0.84	135.00	R13TSS		43.56		MODRES	35.50	CR		58.7	27M0G7W			P	
BHR	BHR25500	34.00	50.50	26.10	0.60	0.60	0.00	MOD13FRTSS		48.88		MODRES	35.50	CR		54.5	27M0G7W			P	
BIH	BIH_SAT	−26.50	17.10	43.85	0.73	0.60	143.98	R123SS		48.03		MODRES	35.50	CL		59.2	27M0G7W			P	10
BLR	BLR06200	37.80	27.91	53.06	1.21	0.60	11.47	R13TSS		45.83		MODRES	35.50	CL		58.9	27M0G7W			P	
BOT	BOT_001	−26.60	23.16	−22.38	1.80	0.96	59.49	R123SS		42.07		MODRES	35.50	CL		59.1	27M0G7W			P	10
BRM	BRM29800	104.00	96.97	18.67	3.33	1.66	91.58	R13TSS		37.04		MODRES	35.50	CL		58.9	27M0G7W			P	
BRU	BRU33000	74.00	114.70	4.40	0.60	0.60	0.00	R13TSS		48.88		MODRES	35.50	CR		57.5	27M0G7W			P	
BTN	BTN03100	86.00	90.44	27.05	0.72	0.60	175.47	R13TSS		48.11		MODRES	35.50	CR		58.9	27M0G7W			P	
BUL	BUL02000	1.9	21.00	44.70					E001	33.8	−2	MODRES	35.50	LE	****	47.5	33M0G7W			P	
CAF	CAF25800	−13.20	21.00	6.30	2.25	1.68	31.00	R13TSS		38.67		MODRES	35.50	CL		59.3	27M0G7W			P	
CBG	CBG29900	86.00	104.82	12.34	1.04	0.86	9.45	R13TSS		44.91		MODRES	35.50	CR		59.3	27M0G7W			P	

1	2	3	4		5			6	7	8		9		10		11	12	13	14	15	16
Admin. symbol	Beam identification	Orbital position	Boresight		Space station antenna characteristics			Space station antenna code	Shaped beam	Space station antenna gain		Earth station antenna		Polarization		e.i.r.p.	Designation of emission	Identity of the space station	Group code	Status	Remarks
			Long.	Lat.	Major axis	Minor axis	Orien-tation			Co-polar	Cross-polar	Code	Gain	Type	Angle						
CHN	CHN15500	62.00	88.18	31.20	3.03	1.24	163.23	R13TSS		38.69		MODRES	35.50	CL		57.9	27M0G7W			P	
CHN	CHN15800	134.00	113.29	39.70	2.80	1.55	35.44	R13TSS		38.07		MODRES	35.50	CR		57.0	27M0G7W			P	
CHN	CHN19000	122.00	114.17	23.32	0.91	0.60	2.88	MOD13FRTSS		47.08		MODRES	35.50	CR		58.9	27M0G7W			P	
CHN	CHN20000	122.00	113.55	22.20	0.60	0.60	0.00	MOD13FRTSS		48.88		MODRES	35.50	CL		57.0	27M0G7W			P	
CHN	CHNA_100	62.00	90.56	39.22				CB_TSS_CHNA		40.01		MODRES	35.50	CR		58.5	27M0G7W			P	
CHN	CHNC_100	134.00	105.77	27.56				CB_TSS_CHNC		39.51		MODRES	35.50	CL		57.1	27M0G7W			P	
CHN	CHNE_100	92.20	114.96	20.16				CB_TSS_CHNE		44.74		MODRES	35.50	CL		59.4	27M0G7W			P	
CHN	CHNF_100	92.20	123.54	45.78				CB_TSS_CHNF		43.71		MODRES	35.50	CR		60.4	27M0G7W			P	
CLN	CLN21900	50.00	80.60	7.70	1.18	0.60	106.00	R13TSS		45.95		MODRES	35.50	CL		56.7	27M0G7W			P	
CME	CME30000	−13.00	12.70	6.20	2.54	1.68	87.00	R13TSS		38.15		MODRES	35.50	CR		58.5	27M0G7W			P	
COD	COD_SAT1	−23.50	21.95	−4.43	3.53	2.20	83.44	R123SS		35.55		MODRES	35.50	CR		59.0	27M0G7W			P	10
COG	COG_SAT	−37.30	14.76	−0.74	1.77	0.68	74.77	R123SS		43.64		MODRES	35.50	CR		59.1	27M0G7W			P	
COM	COM_BSS	−3.70	43.73	−11.88	0.60	0.60	0.00	R123SS		48.88		MODRES	35.50	LE	0	59.0	27M0G7W			P	
CPV	CPV30100	−33.50	−24.12	16.09	0.77	0.63	94.46	R13TSS		47.56		MODRES	35.50	CL		57.2	27M0G7W			P	
CTI	CTI23700	−24.80	−5.78	7.19	1.50	1.26	111.74	R13TSS		41.67		MODRES	35.50	CL		58.8	27M0G7W			P	
CVA	CVA_BSS	−33.60	12.47	41.90	0.60	0.60	0.00	R123SS		48.88		MODRES	35.50	CL		59.3	27M0G7W			P	10
CYP	CYP08600	−1.20	33.45	35.12	0.60	0.60	0.00	MOD13FRTSS		48.88		MODRES	35.50	CR		56.1	27M0G7W			P	5, 7
CZE	CZE14401	−12.80	16.77	46.78	1.71	0.89	149.15	MOD13FRTSS		42.64		MODRES	35.50	CL		58.8	27M0G7W			P	
CZE	CZE14402	−12.80	16.77	46.78	1.71	0.89	149.15	MOD13FRTSS		42.64		MODRES	35.50	CR		58.8	27M0G7W			P	
CZE	CZE14403	−12.80	16.77	46.78	1.71	0.89	149.15	MOD13FRTSS		42.64		MODRES	35.50	CR		58.8	27M0G7W		37	P	
D	D 08700	−18.80	10.31	49.47	1.82	0.92	151.78	MOD13FRTSS		42.19		MODRES	35.50	CR		59.1	27M0G7W			P	
DJI	DJI_SAT	−17.46	42.58	11.72	0.60	0.60	0.00	R123SS		48.88		MODRES	35.50	CL		59.3	27M0G7W			P	10
DNK	DNK__100	−25.20	2.92	59.62				CB_TSS_DNKA		48.88		MODRES	35.50	CL		58.3	27M0G7W			P	
DNK	DNK090XR	−33.50	13.27	60.86	1.99	0.63	151.38	MOD13FRTSS		43.48		MODRES	35.50	CR		54.5	27M0G7W			P	6
DNK	DNK091XR	−33.50	−15.16	63.67	1.56	0.60	170.63	MOD13FRTSS		44.73		MODRES	35.50	CR		58.6	27M0G7W			P	6
E	E___100	−30.00	−9.40	34.15				CB_TSS_E__A		44.79		MODRES	35.50	CL		58.9	27M0G7W		01	P	
E	HISP33D1	−30.00	−4.00	39.00					COP	39.80	5.50	MODRES	35.50	CL		57.6	33M0G7W--	HISPASAT-1	01	PE	
E	HISP33D2	−30.00	−4.00	39.00					COP	39.80	5.50	MODRES	32.50	CL		57.6	33M0G7W--	HISPASAT-1	01	PE	
E	HISPA27D	−30.00	−4.00	39.00					COP	39.80	5.50	MODRES	38.43	CL		57.6	27M0G7W--	HISPASAT-1	01	PE	
E	HISPASA4	−30.00	−4.00	39.00					COP	39.80	5.50	MODRES	38.43	CL		57.6	27M0G7W	HISPASAT-1	01	PE	
EGY	EGY02600	−7.00	29.70	26.80	2.33	1.72	136.00	R13TSS		38.42		MODRES	35.50	CL		58.1	27M0G7W		12	P	8
ERI	ERI09200	22.80	39.41	14.98	1.67	0.95	145.48	R13TSS		42.44		MODRES	35.50	CR		58.9	27M0G7W			P	
EST	EST06100	44.50	25.06	58.60	0.77	0.60	12.27	R13TSS		47.81		MODRES	35.50	CR		58.7	27M0G7W			P	
ETH	ETH09200	36.00	40.29	8.95	2.87	2.16	174.06	R13TSS		36.52		MODRES	35.50	CL		58.7	27M0G7W			P	
F	F 09300	−7.00	3.52	45.41	2.22	1.15	159.34	R13TSS		40.39		MODRES	35.50	CL		58.8	27M0G7W		21	P	8
F	F___100	−7.00	50.00	−15.65				CB_TSS_F__A		48.88		MODRES	35.50	CR		58.9	27M0G7W			P	
F	NCL10000	140.00	166.00	−21.00	1.14	0.72	146.00	R13TSS		45.30		MODRES	35.50	CR		58.7	27M0G7W			P	
F	OCE10100	−160.00	−145.00	−16.30	4.34	3.54	4.00	R13TSS		32.58		MODRES	35.50	CL		58.5	27M0G7W			P	
F	WAL10200	140.00	−176.80	−14.00	0.74	0.60	29.00	R13TSS		47.97		MODRES	35.50	CR		59.4	27M0G7W			P	
FIN	FIN10300	22.80	22.50	64.50	1.38	0.76	171.00	MOD13FRTSS		44.24		MODRES	35.50	CL		54.5	27M0G7W		52	P	
FIN	FIN10400	22.80	15.87	61.15	2.24	0.91	16.70	MOD13FRTSS		41.37		MODRES	35.50	CL		54.5	27M0G7W		52	P	
FJI	FJI19300	−178.00	179.62	−17.87	1.16	0.92	155.22	R13TSS		44.16		MODRES	35.50	CR		58.7	27M0G7W			P	7
FSM	FSM00000	158.00	151.90	5.48	5.15	1.57	167.00	R13TSS		35.38		MODRES	35.50	CR		58.9	27M0G7W			P	5
G	G 02700	−33.50	−3.50	53.80	1.84	0.72	142.00	R13TSS		43.23		MODRES	35.50	CR		58.0	27M0G7W			P	
GAB	GAB_37.3W	−37.30	11.63	−0.69	1.22	0.71	82.94	R123SS		45.07		MODRES	35.50	CR		59.0	27M0G7W			P	
GEO	GEO_BSS	−4.10	43.22	42.30	0.96	0.60	153.15	R123SS		46.84		MODRES	35.50	LE	0	59.2	27M0G7W			P	
GHA	GHA10800	−25.00	−1.20	7.90	1.48	1.06	102.00	R13TSS		42.49		MODRES	35.50	CR		58.6	27M0G7W			P	

1	2	3	4		5			6	7	8		9		10		11	12	13	14	15	16
Admin. symbol	Beam identification	Orbital position	Boresight		Space station antenna characteristics			Space station antenna code	Shaped beam	Space station antenna gain		Earth station antenna		Polarization		e.i.r.p.	Designation of emission	Identity of the space station	Group code	Status	Remarks
			Long.	Lat.	Major axis	Minor axis	Orien-tation			Co-polar	Cross-polar	Code	Gain	Type	Angle						
GMB	GMB30200	−37.20	−15.10	13.40	0.79	0.60	4.00	R13TSS		47.69		MODRES	35.50	CL		58.3	27M0G7W			P	5, 7
GNB	GNB30400	−30.00	−15.00	12.00	0.90	0.60	172.00	R13TSS		47.12		MODRES	35.50	CL		58.1	27M0G7W			P	5, 7
GNE	GNE30300	−18.80	10.30	1.50	0.68	0.60	10.00	R13TSS		48.34		MODRES	35.50	CL		58.8	27M0G7W			P	
GRC	GRC10500	−1.20	24.51	38.08	1.70	0.95	152.97	MOD13FRTSS		42.40		MODRES	35.50	CL		56.3	27M0G7W			P	5, 7
GUI	GUI19200	−37.00	−11.00	10.20	1.58	1.04	147.00	R13TSS		42.29		MODRES	35.50	CR		58.4	27M0G7W			P	5, 7
HNG	HNG10601	−12.80	16.77	46.78	1.71	0.89	149.15	MOD13FRTSS		42.64		MODRES	35.50	CL		59.3	27M0G7W			P	
HNG	HNG10602	−12.80	16.77	46.78	1.71	0.89	149.15	MOD13FRTSS		42.64		MODRES	35.50	CR		59.3	27M0G7W			P	
HNG	HNG10603	−12.80	16.77	46.78	1.71	0.89	149.15	MOD13FRTSS		42.64		MODRES	35.50	CR		59.3	27M0G7W		37	P	
HOL	HOL21300	38.20	5.12	51.96	1.00	1.00	24.53	MOD13FRTSS		44.45		MODRES	35.50	CL		58.5	27M0G7W			P	
HRV	HRV14801	−12.80	16.77	46.78	1.71	0.89	149.15	MOD13FRTSS		42.64		MODRES	35.50	CL		58.8	27M0G7W			P	
HRV	HRV14802	−12.80	16.77	46.78	1.71	0.89	149.15	MOD13FRTSS		42.64		MODRES	35.50	CR		58.8	27M0G7W			P	
HRV	HRV14803	−12.80	16.77	46.78	1.71	0.89	149.15	MOD13FRTSS		42.64		MODRES	35.50	CR		58.8	27M0G7W		37	P	
I	I 08200	9.00	12.67	40.74	1.99	1.35	144.20	R13TSS		40.14		MODRES	35.50	CR		54.5	27M0G7W			P	8
IND	IND03700	68.00	93.00	25.50	1.46	1.13	40.00	R13TSS		42.27		MODRES	35.50	CL		58.9	27M0G7W			P	
IND	IND04700	68.00	93.30	11.10	1.92	0.60	96.00	R13TSS		43.83		MODRES	35.50	CR		58.4	27M0G7W			P	
IND	INDA_100	55.80	76.16	14.72				CB_TSS_INDA		45.66		MODRES	35.50	CR		58.8	27M0G7W			P	
IND	INDB_100	55.80	83.43	24.22				CB_TSS_INDB		43.15		MODRES	35.50	CL		58.9	27M0G7W			P	
IND	INDD_100	68.00	74.37	29.16				CB_TSS_INDD		41.80		MODRES	35.50	CR		59.3	27M0G7W			P	
INS	INSA_100	80.20	108.82	−0.73				CB_TSS_INSA		38.88		MODRES	35.50	CR		59.2	27M0G7W			P	
INS	INSB_100	104.00	129.75	−3.50				CB_TSS_INSB		37.53		MODRES	35.50	CL		58.8	27M0G7W			P	
IRL	IRL21100	−37.20	−8.25	53.22	0.72	0.60	157.56	R13TSS		48.08		MODRES	35.50	CL		59.2	27M0G7W			P	5, 7
IRN	IRN10900	34.00	54.20	32.40	3.82	1.82	149.00	R13TSS		36.03		MODRES	35.50	CL		57.8	27M0G7W			P	
IRQ	IRQ_SAT	−9.60	43.48	33.16	1.76	0.64	135.09	R123SS		43.93		MODRES	35.50	CR		59.2	27M0G7W			P	10
ISL	ISL04900	−33.50	−19.00	64.90	1.00	0.60	177.00	R13TSS		46.67		MODRES	35.50	CL		60.8	27M0G7W			P	5, 6
ISL	ISL05000	−33.50	−15.35	63.25	1.58	0.60	169.00	R13TSS		44.67		MODRES	35.50	CR		57.3	27M0G7W			P	
ISR	ISR11000	−4.00	34.95	31.32	0.73	0.60	110.02	R13TSS		48.01		MODRES	35.50	CR		58.8	27M0G7W			P	
J	000BS-3N	109.85	134.50	31.50	3.52	3.30	68.00	R13TSS		33.80		MODRES	35.50	CR		*	27M0G7W	BS-3N	02	PE	
J	J 10985	109.85	134.50	31.50	3.52	3.30	68.00	R13TSS		33.80		MODRES	35.50	CR		*	34M5G7W		02	P	
J	J 11100	110.00	134.50	31.50	3.52	3.30	68.00	R13TSS		33.80		MODRES	35.50	CR		*	34M5G7W		02	P	
J	J 1110E	110.00	134.50	31.50	3.52	3.30	68.00	R13TSS		33.80		MODRES	35.50	CR		*	27M0G7W	BS-3M	02	PE	
JOR	JOR22400	11.00	37.55	34.02	1.47	0.91	73.16	MOD13FRTSS		43.19		MODRES	35.50	CL		55.5	27M0G7W			P	8
KAZ	KAZ06600	56.40	65.73	46.40	4.58	1.76	177.45	R13TSS		35.38		MODRES	35.50	CR		58.9	27M0G7W			P	
KEN	KEN_SAT_001	−9.20	37.82	1.02	1.98	1.02	97.23	R123SS		41.39		MODRES	35.50	CL		59.0	27M0G7W			P	10
KGZ	KGZ07000	50.00	73.91	41.32	1.47	0.64	5.05	R13TSS		44.75		MODRES	35.50	CR		59.0	27M0G7W			P	
KIR	KIR__100	176.00	−170.31	−0.56				CB_TSS_KIRA		42.58		MODRES	35.50	CL		58.9	27M0G7W			P	5, 7
KOR	KO11201D	116.00	127.50	36.00	1.24	1.02	168.00	R13TSS		43.40		MODRES	38.43	CL		**	27M0G7W	KOREASAT-1	03	PE	
KOR	KOR11200	116.00	127.50	36.00	1.24	1.02	168.00	R13TSS		43.80		MODRES	35.50	CL		***	27M0G7W		03	P	
KOR	KOR11201	116.00	127.50	36.00	1.24	1.02	168.00	R13TSS		43.40		MODRES	38.43	CL		**	27M0G7W	KOREASAT-1	03	PE	
KRE	KRE28600	140.00	128.45	40.32	1.63	0.68	18.89	R13TSS		44.00		MODRES	35.50	CL		59.0	27M0G7W			P	
KWT	KWT11300	11.00	47.48	29.12	0.60	0.60	90.00	R13TSS		48.88		MODRES	35.50	CR		58.2	27M0G7W			P	
LAO	LAO28400	122.20	103.71	18.17	1.87	1.03	123.99	MOD13FRTSS		41.60		MODRES	35.50	CR		58.8	33M0G7W			P	
LBN	LBN27900	11.00	37.55	34.02	1.47	0.91	73.16	MOD13FRTSS		43.19		MODRES	35.50	CR		55.5	27M0G7W			P	
LBR	LBR24400	−33.50	−9.30	6.60	1.22	0.70	133.00	R13TSS		45.13		MODRES	35.50	CR		58.2	27M0G7W			P	
LBY	LBY__100	−24.80	17.62	26.55				CB_TSS_LBYA		40.30		MODRES	35.50	CL		58.0	27M0G7W			P	
LIE	LIE26300	−18.80	10.31	49.47	1.82	0.92	151.78	MOD13FRTSS		42.19		MODRES	35.50	CL		59.1	27M0G7W			P	
LSO	LSO_SAT	−16.00	28.25	−29.57	0.60	0.60	0.00	R123SS		48.88		MODRES	35.50	CL		59.1	27M0G7W			P	
LTU	LTU06100	23.20	24.51	56.09				CB_TSS_LTUA		48.21		MODRES	35.50	CL		56.9	27M0G7W			P	

1	2	3	4		5			6	7	8		9		10		11	12	13	14	15	16
Admin. symbol	Beam identification	Orbital position	Boresight		Space station antenna characteristics			Space station antenna code	Shaped beam	Space station antenna gain		Earth station antenna		Polarization		e.i.r.p.	Designation of emission	Identity of the space station	Group code	Status	Remarks
			Long.	Lat.	Major axis	Minor axis	Orien-tation			Co-polar	Cross-polar	Code	Gain	Type	Angle						
LUX	LUX11400	28.20	5.21	49.20	0.60	0.60	90.00	R13TSS		48.88		MODRES	35.50	CL		57.9	27M0G7W		09	P	
LVA	LVA06100	23.20	24.51	56.09				CB_TSS_LVAA		48.21		MODRES	35.50	CR		56.9	27M0G7W			P	
MAU	MAU_300	68.40	59.06	−15.94	2.70	1.78	135.44	R123SS		37.63		MODRES	35.50	CL		58.5	27M0G7W			P	10
MCO	MCO11600	34.20	7.93	43.59	1.28	0.60	21.73	MOD13FRTSS		45.58		MODRES	35.50	CL		58.6	27M0G7W			P	
MDA	MDA_SAT	−16.30	27.63	46.93	0.69	0.60	141.49	R123SS		48.28		MODRES	35.50	CR		59.3	27M0G7W			P	10
MDG	MDG_SAT	69.50	46.55	−18.07	2.47	1.36	90.92	R123SS		39.18		MODRES	35.50	LE	90	58.7	27M0G7W			P	10
MHL	MHL00000	146.00	167.64	9.83	2.07	0.90	157.42	R13TSS		41.75		MODRES	35.50	CR		59.0	27M0G7W			P	
MKD	MKD_BSS	−16.70	21.79	41.62	0.60	0.60	0.00	R123SS		48.88		MODRES	35.50	CL		59.1	27M0G7W			P	10
MLA	MLA__100	91.50	108.05	4.00				CB_TSS_MLAA		43.00		MODRES	35.50	CR		58.4	27M0G7W			P	
MLD	MLD30600	50.00	72.95	5.78	1.19	0.91	104.53	R13TSS		44.09		MODRES	35.50	CR		58.7	27M0G7W			P	
MLI	MLI_SAT_100	−42.00	-4.84	17.52	2.61	2.04	115.30	R123SS		37.18		MODRES	35.50	CL		58.9	27M0G7W			P	
MLT	MLT14700	22.80	14.40	35.90	0.60	0.60	0.00	R13TSS		48.88		MODRES	35.50	CR		56.0	27M0G7W			P	
MNG	MNG24800	74.00	102.20	46.60	3.60	1.13	169.00	R13TSS		38.35		MODRES	35.50	CR		59.0	27M0G7W			P	5, 7
MOZ	MOZ_SAT	−8.20	34.22	−17.64	3.37	1.20	62.10	R123SS		38.38		MODRES	35.50	CR		59.0	27M0G7W			P	
MRC	MRC20900	−25.20	−8.95	28.98	3.56	1.23	49.23	R13TSS		38.02		MODRES	35.50	CR		54.9	27M0G7W			P	
MTN	MTN__100	−36.80	−10.52	19.66				CB_TSS_MTNA		41.91		MODRES	35.50	CR		55.5	27M0G7W			P	7
MWI	MWI_SAT	−23.50	34.03	−13.26	1.37	0.60	83.29	R123SS		45.30		MODRES	35.50	CL		59.2	27M0G7W			P	
NGR	NGR11500	−37.20	7.63	17.01	2.20	1.80	102.40	R13TSS		38.48		MODRES	35.50	CL		59.5	27M0G7W			P	5, 7
NIG	NIG11903	−42.00	7.68	9.84	2.02	1.28	93.89	R123SS		40.32		MODRES	35.50	CR		59.1	27M0G7W			P	
NMB	NMB_SAT	−34.00	17.14	−21.04	2.55	1.27	65.23	R123SS		39.34		MODRES	35.50	CL		59.1	27M0G7W			P	10
NOR	NOR12000	−0.80	13.42	62.76	1.43	0.60	19.61	MOD13FRTSS		45.10		MODRES	35.50	CL		56.2	27M0G7W		06	P	5, 7
NOR	NOR12100	−0.80	18.00	60.23	1.67	0.83	23.85	R13TSS		43.02		MODRES	35.50	CL		57.8	27M0G7W		06	P	
NPL	NPL12200	50.00	83.70	28.30	1.72	0.60	163.00	R13TSS		44.31		MODRES	35.50	CR		59.6	27M0G7W			P	
NRU	NRU30900	134.00	167.00	−0.50	0.60	0.60	0.00	R13TSS		48.88		MODRES	35.50	CL		57.5	27M0G7W			P	
NZL	NZL__100	158.00	−170.68	−19.72				CB_TSS_NZLA		48.88		MODRES	35.50	CL		59.6	27M0G7W			P	
OMA	OMA12300	17.20	55.60	21.00	1.88	1.02	100.00	R13TSS		41.62		MODRES	35.50	CR		58.3	27M0G7W			P	
PAK	PAK12700	38.20	69.60	29.50	2.30	2.16	14.00	R13TSS		37.49		MODRES	35.50	CR		58.9	27M0G7W			P	
PHL	PHL28500	98.00	121.30	11.10	3.46	1.76	99.00	R13TSS		36.60		MODRES	35.50	CL		58.7	27M0G7W			P	
PLW	PLW00000	140.00	132.98	5.51	1.30	0.60	55.41	R13TSS		45.53		MODRES	35.50	CR		58.8	27M0G7W			P	
PNG	PNG13100	134.00	148.07	−6.65	3.13	2.30	168.32	MOD13FRTSS		35.87		MODRES	35.50	CR		54.5	27M0G7W			P	
POL	POL-BSS-4.2W	−4.20	19.59	51.86	1.42	0.65	160.11	R123SS		44.80		MODRES	35.50	LE	0	59.2	27M0G7W			P	10
POR	POR__100	−37.00	−15.92	37.65				CB_TSS_PORA		47.17		MODRES	35.50	CR		58.4	27M0G7W			P	5, 7
PSE	YYY00000	−13.20	34.99	31.86	0.60	0.60	90.00	R13TSS		48.88		MODRES	35.50	CL		58.9	27M0G7W			P	3
QAT	QAT24700	20.00	51.38	25.26	0.60	0.60	90.00	R13TSS		48.88		MODRES	35.50	CL		54.5	27M0G7W			P	
ROU	ROU_SAT	−23.40	25.03	45.59	1.13	0.60	149.23	R123SS		46.13		MODRES	35.50	CR		59.3	27M0G7W			P	10
RRW	BSS-RRW	−9.20	29.78	−2.10	0.60	0.60	0.00	R123SS		48.88		MODRES	35.50	CR		58.8	27M0G7W			P	
RUS	RSTREA11	36.00	38.00	53.00	2.20	2.20	0.00	R13TSS		37.70		MODRES	35.50	CL		53.0	27M0G7W	RST-1	05	PE	
RUS	RSTREA12	36.00	38.00	53.00	2.20	2.20	0.00	R13TSS		37.70		MODRES	35.50	CR		53.0	27M0G7W	RST-1	05	PE	
RUS	RSTRED11	36.00	38.00	53.00	2.20	2.20	0.00	R13TSS		37.70		MODRES	35.50	CL		53.0	27M0G7W	RST-1	05	PE	
RUS	RSTRED12	36.00	38.00	53.00	2.20	2.20	0.00	R13TSS		37.70		MODRES	35.50	CR		53.0	27M0G7W	RST-1	05	PE	
RUS	RSTRSD11	36.00	38.00	53.00	2.20	2.20	0.00	R13TSS		37.70		MODRES	35.50	CL		53.0	27M0G7W	RST-1	05	P	
RUS	RSTRSD12	36.00	38.00	53.00	2.20	2.20	0.00	R13TSS		37.70		MODRES	35.50	CR		53.0	27M0G7W	RST-1	05	P	
RUS	RSTRSD13	36.00	38.00	53.00	2.20	2.20	0.00	R13TSS		37.70		MODRES	39.02	CL		53.0	27M0G7W	RST-1	05	P	
RUS	RSTRSD14	36.00	38.00	53.00	2.20	2.20	0.00	R13TSS		37.70		MODRES	39.02	CR		53.0	27M0G7W	RST-1	05	P	
RUS	RSTRSD21	56.00	65.00	63.00	2.20	2.20	0.00	R123FR		37.70		MODRES	35.50	CL		55.0	27M0G7W	RST-2	14	P	
RUS	RSTRSD22	56.00	65.00	63.00	2.20	2.20	0.00	R123FR		37.70		MODRES	35.50	CR		55.0	27M0G7W	RST-2	14	P	
RUS	RSTRSD31	86.00	97.00	62.00	2.20	2.20	0.00	R13TSS		37.70		MODRES	35.50	CL		55.0	27M0G7W	RST-3	33	P	

1	2	3	4		5			6	7	8		9		10		11	12	13	14	15	16
Admin. symbol	Beam identification	Orbital position	Boresight		Space station antenna characteristics			Space station antenna code	Shaped beam	Space station antenna gain		Earth station antenna		Polarization		e.i.r.p.	Designation of emission	Identity of the space station	Group code	Status	Remarks
			Long.	Lat.	Major axis	Minor axis	Orien-tation			Co-polar	Cross-polar	Code	Gain	Type	Angle						
RUS	RSTRSD32	86.00	97.00	62.00	2.20	2.20	0.00	R13TSS		37.70		MODRES	35.50	CR		55.0	27M0G7W	RST-3	33	P	
RUS	RSTRSD51	140.00	158.00	56.00	2.20	2.20	0.00	R13TSS		37.70		MODRES	35.50	CL		55.0	27M0G7W	RST-5	35	P	
RUS	RSTRSD52	140.00	158.00	56.00	2.20	2.20	0.00	R13TSS		37.70		MODRES	35.50	CR		55.0	27M0G7W	RST-5	35	P	
RUS	RUS00401	110.00	128.73	54.30	4.25	2.02	156.81	R13TSS		35.11		MODRES	35.50	CL		58.9	27M0G7W	RUS-4	34	P	5, 7, 8
RUS	RUS00402	110.00	128.73	54.30	4.25	2.02	156.81	R13TSS		35.11		MODRES	35.50	CR		58.9	27M0G7W	RUS-4	34	P	5, 7, 8
S	S_13800	5.00	16.20	61.00	1.04	0.98	14.00	R13TSS		44.36		MODRES	35.50	CL		55.6	27M0G7W		04	P	
S	S_13900	5.00	17.00	61.50	2.00	1.00	10.00	R13TSS		41.44		MODRES	35.50	CL		61.1	27M0G7W		04	P	
SDN	SUDANBSS	−16.00	28.52	15.33	2.86	1.86	101.59	R123SS		37.19		MODRES	35.50	CR		59.0	27M0G7W			P	10
SEN	SEN22200	−37.00	−14.40	13.80	1.46	1.04	139.00	R13TSS		42.63		MODRES	35.50	CL		58.6	27M0G7W			P	5, 7
SEY	SEY00000	42.50	51.86	−7.23	2.43	1.04	27.51	R13TSS		40.44		MODRES	35.50	CR		58.9	27M0G7W			P	
SLM	SLM00000	128.00	159.27	−8.40	1.35	1.08	118.59	R13TSS		42.81		MODRES	35.50	CL		58.9	27M0G7W			P	
SMO	SMO05700	−178.00	−171.70	−13.87	0.60	0.60	90.00	R13TSS		48.88		MODRES	35.50	CR		58.6	27M0G7W			P	7
SMR	SMR31100	−36.80	12.60	43.70	0.60	0.60	0.00	R13TSS		48.88		MODRES	35.50	CR		57.4	27M0G7W			P	7
SNG	SNG15100	88.00	103.86	1.42	0.92	0.72	175.12	R13TSS		46.25		MODRES	35.50	CL		58.5	27M0G7W			P	
SOM	SOM001	−4.40	44.56	6.57	2.92	1.06	80.43	R123SS		39.54		MODRES	35.50	LE	0	59.0	27M0G7W			P	
SRB	SRB_BSS	−26.70	20.57	44.07	0.90	0.60	143.40	R123SS		47.12		MODRES	35.50	CR		59.3	27M0G7W			P	10
SRL	SRL25900	−33.50	−11.80	8.60	0.78	0.68	114.00	R13TSS		47.20		MODRES	35.50	CR		58.4	27M0G7W			P	6
SSD	SSUD_SAT	−23.90	30.25	8.06	1.73	1.18	110.06	R123SS		41.35		MODRES	35.50	CL		59.1	27M0G7W			P	10
STP	STP24100	−7.00	6.17	1.45	0.65	0.60	153.51	R13TSS		48.56		MODRES	35.50	CR		56.4	27M0G7W			P	
SUI	SUI14000	−18.80	10.31	49.47	1.82	0.92	151.78	MOD13FRTSS		42.19		MODRES	35.50	CL		59.1	27M0G7W			P	
SVK	SVK14401	−12.80	16.77	46.78	1.71	0.89	149.15	MOD13FRTSS		42.64		MODRES	35.50	CL		59.3	27M0G7W			P	
SVK	SVK14402	−12.80	16.77	46.78	1.71	0.89	149.15	MOD13FRTSS		42.64		MODRES	35.50	CR		59.3	27M0G7W			P	
SVK	SVK14403	−12.80	16.77	46.78	1.71	0.89	149.15	MOD13FRTSS		42.64		MODRES	35.50	CR		59.3	27M0G7W		37	P	
SVN	SVN14800	33.80	15.01	46.18	0.60	0.60	90.00	R13TSS		48.88		MODRES	35.50	CR		58.9	27M0G7W			P	
SWZ	SWZ_SAT	−23.90	31.51	−26.57	0.60	0.60	0.00	R123SS		48.88		MODRES	35.50	CR		59.3	27M0G7W			P	
SYR	SYR22900	11.00	37.55	34.02	1.47	0.91	73.16	MOD13FRTSS		43.19		MODRES	35.50	CL		55.5	27M0G7W		53	P	
SYR	SYR33900	11.00	37.60	34.20	1.32	0.88	74.00	MOD13FRTSS		43.80		MODRES	35.50	CL		56.4	27M0G7W		53	P	
TCD	TOUMAI	−34.00	17.20	15.50	3.10	1.15	104.19	R123SS		38.93		MODRES	35.50	CR		59.1	27M0G7W			P	10
TGO	TGO22600	−30.00	0.72	8.61	1.12	0.60	109.54	R13TSS		46.19		MODRES	35.50	CR		58.5	27M0G7W			P	5, 7
THA	THA14200	98.00	100.75	12.88	2.80	1.82	93.77	R13TSS		37.37		MODRES	35.50	CL		58.6	27M0G7W			P	
TJK	TJK06900	38.00	71.14	38.41	1.21	0.73	155.31	R13TSS		45.00		MODRES	35.50	CL		58.8	27M0G7W			P	5
TKM	TKM06800	50.00	59.24	38.83	2.26	1.02	166.64	R13TSS		40.81		MODRES	35.50	CR		58.9	27M0G7W			P	5
TLS	TLS00000	128.00	126.03	−8.72	0.66	0.60	13.92	R13TSS		48.50		MODRES	35.50	CR		58.9	27M0G7W			P	
TON	TON21500	170.75	−175.23	−18.19	1.59	0.60	71.33	R13TSS		44.64		MODRES	35.50	CR		58.3	27M0G7W			P	5
TUN	TUN_BSS	−37.30	9.01	33.79	1.31	0.60	121.24	R123SS		45.49		MODRES	35.50	CL		59.2	27M0G7W			P	10
TUN	TUN27200	−25.20	2.10	31.75	3.41	1.81	179.18	MOD13FRTSS		36.54		MODRES	35.50	CR		55.5	27M0G7W		55	P	4
TUR	TUR14500	42.00	34.95	39.09	3.18	0.99	0.79	R13TSS		39.47		MODRES	35.50	CL		58.8	27M0G7W		36	P	
TUV	TUV00000	176.00	177.61	−7.11	0.94	0.60	137.58	R13TSS		46.93		MODRES	35.50	CR		58.9	27M0G7W			P	
TZA	TANSAT1	−16.00	34.43	−5.95	2.13	1.13	96.91	R123SS		40.63		MODRES	35.50	CL		59.1	27M0G7W			P	10
UAE	UAE27400	52.50	53.85	24.34	1.19	0.85	3.72	R13TSS		44.39		MODRES	35.50	CR		58.2	27M0G7W			P	
UGA	UGASAT	−26.60	31.94	1.15	1.25	0.60	83.71	R123SS		45.70		MODRES	35.50	CR		59.2	27M0G7W			P	10
UKR	UKR06300	38.20	31.74	48.22	2.29	0.96	177.78	R13TSS		41.01		MODRES	35.50	CR		58.9	27M0G7W			P	
USA	GUM33100	122.00	144.50	13.10	0.60	0.60	0.00	R13TSS		48.88		MODRES	35.50	CL		58.3	27M0G7W			P	
USA	MRA33200	121.80	145.90	16.90	1.20	0.60	76.00	R13TSS		45.87		MODRES	35.50	CR		58.5	27M0G7W			P	
USA	PLM33200	170.00	−161.40	7.00	0.60	0.60	0.00	R13TSS		48.88		MODRES	35.50	CL		57.4	27M0G7W			P	
USA	USAA_100	170.00	−170.51	−12.72				CB_TSS_USAA		48.88		MODRES	35.50	CL		56.1	27M0G7W			P	
USA	WAK33400	140.00	166.50	19.20	0.60	0.60	0.00	R13TSS		48.88		MODRES	35.50	CR		58.6	27M0G7W			P	

1	2	3	4		5			6	7	8		9		10		11	12	13	14	15	16
Admin. symbol	Beam identification	Orbital position	Boresight		Space station antenna characteristics			Space station antenna code	Shaped beam	Space station antenna gain		Earth station antenna		Polarization		e.i.r.p.	Designation of emission	Identity of the space station	Group code	Status	Remarks
			Long.	Lat.	Major axis	Minor axis	Orien-tation			Co-polar	Cross-polar	Code	Gain	Type	Angle						
UZB	UZB07100	33.80	63.80	41.21	2.56	0.89	159.91	R13TSS		40.84		MODRES	35.50	CR		58.8	27M0G7W			P	
VTN	VTN32500	107.00	106.84	14.21	3.43	1.76	109.43	R13TSS		36.65		MODRES	35.50	CR		58.4	27M0G7W			P	
VUT	VUT12800	140.00	168.00	−16.40	1.52	0.68	87.00	R13TSS		44.30		MODRES	35.50	CL		57.8	27M0G7W			P	
YEM	YEM_100	11.00	48.05	14.64				CB_TSS_YEMA		47.63		MODRES	35.50	CL		54.9	27M0G7W			P	
ZMB	ZMB_2020	−23.90	27.29	−13.08	2.01	1.03	58.48	R123SS		41.29		MODRES	35.50	CR		59.1	27M0G7W			P	10
ZWE	ZWE_2020	−16.00	29.59	−18.92	1.32	1.05	60.86	R123SS		43.03		MODRES	35.50	CR		59.0	27M0G7W			P	

* Channel 1: 58.2 dBW, channels 3, 5, 7: 59.2 dBW, channels 9, 11, 13: 59.3 dBW, other channels: 59.4 dBW.

** Channels 2, 4, 6: 63.6 dBW, channels 8, 10, 12: 63.7 dBW.

*** Channels 2, 4, 6: 59.0 dBW, other channels: 59.1 dBW.

**** Channels 1, 3, 5, 7, 17: 0; channels 2, 4, 6, 8, 18: 90.

COLUMN HEADINGS IN TABLE 6B

Col. 1 *Nominal orbital position*, in degrees and hundredths of a degree from the Greenwich meridian (negative values indicate longitudes which are west of the Greenwich meridian; positive values indicate longitudes which are east of the Greenwich meridian).

Col. 2 *Notifying administration symbol*.

Col. 3 *Beam identification* (Column 2, normally, contains the symbol designating the administration or the geographical area taken from Table B1 of the Preface to the International Frequency Information Circular (BR IFIC), followed by the symbol designating the service area).

Col. 4 *Polarization* (CL – circular left, CR – circular right).

Col. 5 *Channel number/Indication of minimum equivalent protection margin (EPM) for a given assignment derived from the set of values for all test points belonging to the given beam* (dB).

TABLE 6B (REV.WRC-23)

Minimum equivalent protection margin of assignments in the Regions 1 and 3 Plan (sorted by orbital position)

1	2	3	4	5																																									
Orbital Position	Admin. symbol	Beam Identification	Polarization type	Channel number																																										
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
				Minimum EPM																																										
−178.00	FJI	FJI19300	CR	6.1		6.1		6.1		6.1		6.1		6.1		6.1		6.1		6.1		6.1		6.1		6.1																			
−178.00	SMO	SMO05700	CR	1.6		1.6		1.6		1.6		1.6		1.6		1.6		1.6		1.6		1.6		1.6		1.6																			
−160.00	F	OCE10100	CL		99.9		99.9		99.9		99.9		99.9		99.9		99.9		99.9		99.9		99.9		99.9		99.9																	
−37.20	GMB	GMB30200	CL	4.6		1.9		1.9		1.9		1.9		1.9		1.9		1.9		1.9		1.9																							
−37.20	IRL	IRL21100	CL	2.6		0.6		0.6		0.6		0.6		0.6		0.6		0.6		0.6		0.6																							
−37.20	NGR	NGR11500	CL		6.8		6.8		6.8		6.8		6.8		6.8		6.8		6.8		6.8		6.9																						
−37.00	AND	AND34100	CL		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.8																						
−37.00	GUI	GUI19200	CR		0.9		0.9		0.9		0.9		0.9		0.9		0.9		0.9		0.9		1.5																						
−37.00	POR	POR__100	CR	2.4		1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1																							
−37.00	SEN	SEN22200	CL																					−0.3		4.7		4.7		4.7		4.7		4.7		4.7		4.7		4.7		4.7	
−36.80	MTN	MTN__100	CR																						1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1		3.9
−36.80	SMR	SMR31100	CR	4.4		3.2		3.2		3.1		3.1		3.1		3.2		3.2		3.2		3.2																						
−33.50	CPV	CPV30100	CL		9.5		9.5		9.5		9.5		9.5		9.5		9.5		9.5		9.5		8.8																					
−33.50	DNK	DNK090XR	CR																													0.9				0.9								
−33.50	DNK	DNK091XR	CR																															−0.9				−0.9						
−33.50	G	G 02700	CR		−0.1		0.1		−0.1		−0.1		−0.1		−0.1		0.2		−0.1		0.1		0.3																					
−33.50	ISL	ISL04900	CL																					8.8		7.2		7.2		10.1		14.8		3.6		14.8		3.6		21.7		21.7	
−33.50	ISL	ISL05000	CR																						0.1		0.1		0.1														
−33.50	LBR	LBR24400	CR	3.3		0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4																						
−33.50	SRL	SRL25900	CR																					−0.4		1.0		1.0		1.0		1.0		0.9		1.0		0.9		1.0		1.0	
−30.00	BFA	BFA10700	CL																						1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		2.4
−30.00	E	E____100	CL																					8.3		5.9		5.9		5.9		5.9		5.9		5.6		5.9		5.6		5.9	
−30.00	E	HISP33D1	CL																							−0.4				−0.4				−0.4				−0.4				−0.4	
−30.00	E	HISP33D2	CL																							−1.0				−1.0				−1.0				−1.0				−1.0	
−30.00	E	HISPA27D	CL																							1.3				1.3				1.3				1.3				1.3	
−30.00	E	HISPASA4	CL																							1.3				1.3				1.3				1.3				1.3	
−30.00	GNB	GNB30400	CL																						0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.7
−30.00	TGO	TGO22600	CR	7.9		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5																						
−25.20	DNK	DNK__100	CL	−0.9		−1.5		−1.5		−1.5		−1.5		−1.5		−1.5		−1.5		−1.5		−1.5																						
−25.20	MRC	MRC20900	CR	0.1		−0.4		−0.4		−0.4		−0.4		−0.4		−0.3		−0.3		−0.4		−0.4																						
−25.20	TUN	TUN15000****	CR																					−1.0		−0.8		−0.8		−0.8		−0.8		−0.8		−0.8		−0.8		−0.8		−0.8	
−25.20	TUN	TUN27200	CR																																	−0.9				−0.9			
−25.00	GHA	GHA10800	CR																					7.1		5.2		5.2		5.2		5.2		5.2		4.7		5.2		4.7		5.2	
−24.80	AGL	AGL29500	CL	4.6		3.6		3.6		3.6		3.6		3.6		3.6		3.6		3.6		3.6																						

1	2	3	4	5																																											
Orbital Position	Admin. symbol	Beam Identification	Polarization type	Channel number																																											
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
				Minimum EPM																																											
–24.80	ALG	ALG__100	CL																						–0.7		–0.7		–0.7		–0.7		–0.7		–0.8		–0.8		–0.8		–0.8		2.2
–24.80	CTI	CTI23700	CL	3.4		2.9		2.9		2.9		2.9		2.9		2.9		2.9		2.9		2.9																							
–24.80	LBY	LBY__100	CL		2.4		2.4		2.4		2.4		2.4		2.4		2.4		2.4		2.4		2.7																						
–19.20	BEN	BEN23300****	CL	3.1		2.6		2.6		2.6		2.6		2.6		2.6		2.6		2.6		2.6																							
–19.20	COD	COD__100****	CR		4.7		4.7		4.7		4.7		4.7		4.7		4.7		4.7		4.7		5.9																						
–19.20	MLI	MLI__100****	CR	5.6		4.6		4.6		4.6		4.6		4.6		4.6		4.6		4.6		4.6																							
–19.20	NIG	NIG11900****	CR																						3.5		3.5		3.5		3.5		3.5		3.5		3.5		3.5		3.5		4.1
–18.80	AUT	AUT01600	CR																					0.9		–0.1		0.0		0.0		0.1		0.0		0.1		0.0		0.0		0.0	
–18.80	D	D 08700	CR	1.1		–0.2		–0.1		–0.2		–0.1		–0.1		–0.1		–0.1		–0.1		–0.2																						
–18.80	GNE	GNE30300	CL																					2.0		1.4		1.4		1.4		1.4		1.4		1.4		1.4		1.4		1.4	
–18.80	LIE	LIE25300	CL																						0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4		2.8
–18.80	NMB	NMB02500****	CL																					8.6		9.6		9.6		9.6		9.6		9.6		9.6		9.6		9.6		9.6	
–18.80	SUI	SUI14000	CL		0.2		0.7		0.2		0.7		0.3		0.7		0.3		0.7		0.2		0.8																					
–13.20	CAF	CAF25800	CL																						1.4		1.4		1.4		1.4		1.4		1.4		1.4		1.4		1.4		1.5
–13.20	COG	COG23500****	CL	0.8		0.7		0.7		0.7		0.7		0.7		0.7		0.7		0.7		0.7																						
–13.20	GAB	GAB26000****	CR	0.5		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0																						
–13.20	PSE	YYY00000	CL																					5.3		4.8		5.1		4.9		5.1		4.9		5.1		4.9		5.1		4.9	
–13.00	CME	CME30000	CR																						0.4		0.4		0.4		0.5		0.4		0.5		0.4		0.5		0.4		0.5
–12.80	CZE	CZE14401	CL	1.9								0.8								0.6								–0.9								–0.8							
–12.80	CZE	CZE14402	CR														0.1														–0.9								–0.9				
–12.80	CZE	CZE14403	CR		0.1*																				–0.9*		–0.9*																
–12.80	HNG	HNG10601	CL			1.1								1.2								1.1								–0.3							–0.3					
–12.80	HNG	HNG10602	CR						0.6																								–0.4								–0.4		
–12.80	HNG	HNG10603	CR		0.6*																				–0.4*		–0.4*																
–12.80	HRV	HRV14801	CL					0.6								0.8								0.3								–0.8								–0.8			
–12.80	HRV	HRV14802	CR										0.1																						–0.9								–0.2
–12.80	HRV	HRV14803	CR		0.1*																				–0.9*		–0.9*																
–12.80	SVK	SVK14401	CL							1.1								1.2								–0.4								–0.3								–0.3	
–12.80	SVK	SVK14402	CR																		0.6								–0.4								–0.4						
–12.80	SVK	SVK14403	CR		0.6*																				–0.4*		–0.4*																
–7.00	EGY	EGY02600	CL		10.9		10.9		10.9		10.9		10.9		10.9		10.9		10.9		10.9		5.9																					
–7.00	F	F 09300	CL																						5.4		4.3		5.6		4.3		5.6		4.8		5.6		4.8		5.6		5.5
–7.00	F	F____100	CR																					5.0		5.1		5.1		5.1		5.1		5.1		5.1		5.1		5.1		5.1	
–7.00	SRB	SRB14800****	CR																						–1.2		–1.1		–0.6		–0.9		–0.6		–0.9		–0.6		–0.9		–0.6		–0.5
–7.00	SDN	SDN__100****	CR																					5.4		8.0		8.0		8.0		8.0		8.0		8.0		8.0		8.0		8.0	

1	2	3	4	5																																											
Orbital Position	Admin. symbol	Beam Identification	Polarization type	Channel number																																											
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
				Minimum EPM																																											
–7.00	STP	STP24100	CR		6.1		5.6		5.6		5.6		5.6		5.6		5.6		5.6		5.6		4.9																					
–4.00	ISR	ISR11000	CR																					3.1		3.0		3.1		3.0		3.1		3.0		3.1		3.0		3.1		5.7
–1.20***	BUL	BUL02000	CL																					1.0		–0.4		1.6		–0.4		1.6		–0.4		1.6		–0.4		1.6		–0.3
–1.20	CVA	CVA08300****	CR	2.2		0.5		0.9		0.9		0.9		0.9																													
–1.20	CVA	CVA08500****	CR																					–0.8																			
–1.20	CYP	CYP08600	CR	1.4		0.0		0.5		0.5		0.5		0.5		2.2		2.2		2.2		1.5																					
–1.20	GRC	GRC10500	CL		–0.4		0.6		–0.1		0.8		–0.1		0.9		–0.1		0.9		–0.3		1.0																				
–1.00	MOZ	MOZ30700****	CL		2.8		3.8		2.8		3.8		2.8		3.8		2.8		3.8		2.8		3.6																				
–0.80	BOT	BOT29700****	CL																					1.5		0.9		1.5		0.9		1.5		0.9		1.5		0.9		1.5		2.2
–0.80	KEN	KEN24900****	CL																					3.8		2.8		3.9		2.8		3.9		2.8		3.9		2.8		3.9		3.3
–0.80	NOR	NOR12000	CL	4.4		2.0		–0.7		–0.7		–0.7		–0.7		–0.6		–0.6		–0.6		1.1																					
–0.80	NOR	NOR12100	CL																								–0.6				–0.6												
–0.80	ZMB	ZMB31400****	CR																					2.8		3.2		4.3		3.2		4.3		3.2		4.3		3.2		4.3		3.2
–0.80	ZWE	ZWE13500****	CR	5.5		2.6		2.6		2.6		2.6		2.6		2.6		2.6		2.6		2.6																					
4.80	AFS	AFS02100****	CL																					4.5		5.6		5.6		5.6		5.2		5.2		5.2		5.2		5.2		5.2
4.80	LSO	LSO30500****	CR	3.9		2.9		2.9		2.9		2.9		2.9		3.1		3.1		3.1		2.9																					
4.80	MWI	MWI30800****	CR		3.2		3.8		3.3		3.9		3.3		3.9		3.9		3.9		3.8		3.4																				
4.80	SWZ	SWZ31300****	CL	4.5		3.2		3.2		3.2		3.2		3.2		3.4		3.4		3.4		3.2																					
5.00	S	S 13800	CL																					4.7		–0.4		2.3		–0.4		2.3		0.6		4.5		0.6		4.5		0.6
5.00	S	S 13900	CL																														8.7										
9.00	I	I 08200	CR																						–3.6		–3.8		–3.6		–3.8		–3.8		–3.8		–3.8		–3.8		–3.8		–2.6
11.00	BDI	BDI27000****	CL																						3.0		3.0		3.0		3.0		3.0		3.0		3.0		3.0		3.0		5.6
11.00	JOR	JOR22400	CL		–1.0		–0.8		–0.7		–0.7		–0.7		–0.7		–0.7		–0.7		–0.8		0.0																				
11.00	KWT	KWT11300	CR																						5.4		5.4		5.4		5.4		5.4		5.4		5.4		5.4		5.4		6.3
11.00	LBN	LBN27900	CR	0.9		–0.6		–0.1		–0.1		–0.1		–0.1		–0.1		–0.1		–0.1		–0.6																					
11.00	RRW	RRW31000****	CL		10.2		10.2		10.2		10.2		10.2		10.2		10.2		10.2		10.2		5.7																				
11.00	SYR	SYR22900	CL																						–1.0		–1.0		–1.0		–1.0		–1.0		–1.0		–1.0		–1.0		–1.0		–0.5
11.00	SYR	SYR33900	CL																																								1.4**
11.00	TZA	TZA22500****	CR																					2.6		3.6		3.6		3.6		3.6		3.6		3.6		3.6		3.6		3.6	
11.00	YEM	YEM__100	CL	2.1		–0.3		–0.3		–0.3		–0.3		–0.3		–0.3		–0.3		–0.3		–0.3																					
16.80	DJI	DJI09900****	CL		8.2		8.2		8.1		8.1		8.1		8.1		8.1		8.1		8.1		6.7																				
17.00	ARS	ARS__100****	CL																						–0.4		–0.4		–0.4		–0.4		–0.4		–0.4		–0.4		–0.4		–0.4		0.0
17.00	ARS	ARS34000	CL																																								2.0
17.00	TCD	TCD14300****	CR	9.8		8.8		8.8		8.8		8.8		8.8		8.8		8.8		8.8		8.8																					
17.00	UGA	UGA05100****	CL																					3.6		4.0		4.0		4.0		4.0		4.0		4.0		4.0		4.0		4.0

1	2	3	4	5																																											
Orbital Position	Admin. symbol	Beam Identification	Polarization type	Channel number																																											
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
				Minimum EPM																																											
17.20	OMA	OMA12300	CR																						1.7		1.7		1.7		1.7		1.7		1.7		1.7		1.7		1.7		1.7		0.9
20.00	QAT	QAT24700	CL		5.9		5.9		5.9		5.9		5.9		5.9		5.9		5.8		5.8		6.2**																					
22.80	ARM	ARM06400	CR																						0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.4		0.5		2.7
22.80	ERI	ERI09200	CR																					2.3		2.8		2.8		2.8		2.8		2.8		2.8		2.8		2.8		2.8		
22.80	FIN	FIN10300	CL																						−0.5		1.2		1.9		2.0		1.8		2.1		1.7		2.2		1.6		4.9
22.80	FIN	FIN10400	CL																																				−0.4				1.1
22.80	MKD	MKD14800****	CR																					3.6		3.3		3.3		3.3		3.3		3.3		3.3		3.2		3.3		3.3	
22.80	MLT	MLT14700	CR																						1.7		1.8		1.7		1.8		1.7		1.8		1.7		1.7		1.8		3.4
23.20	AZE	AZE06400****	CL																					0.6		−0.1		−0.1		−0.1		−0.1		−0.1		−0.1		−0.1		−0.1		−0.1	
23.20	GEO	GEO06400****	CR	5.3		4.1		4.1		4.1		4.1		4.1		4.1		4.1		4.1		4.1																					
23.20	LTU	LTU06100	CL	1.4		0.1		0.0		0.0		−0.1		−0.1		−0.1		−0.2		−0.2		−0.2																					
23.20	LVA	LVA06100	CR		−0.8		−0.8		−0.8		−0.8		−0.9		−0.9		−0.9		−0.9		−0.9		−0.3																					
28.20	LUX	LUX11400	CL	3.1		2.9		2.8		2.8		2.8		2.8		2.8		2.8		2.8		2.8																					
29.00	COM	COM20700****	CR																					11.2		9.5		9.5		9.5		9.5		9.5		9.5		9.5		9.6		
29.00	MAU	MAU__100****	CL																						11.0		11.0		11.0		11.0		11.0		11.0		11.0		11.1		11.1		12.7
29.00	MDG	MDG23600****	CL	14.0		13.6		13.5		13.4		13.4		13.3		13.3		13.2		13.2		13.2																					
33.80	SVN	SVN14800	CR		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.4		1.6																					
33.80	UZB	UZB07100	CR	3.3		1.9		1.9		1.9		1.9		1.9		1.9		1.9		1.9		1.9																					
34.00	BHR	BHR25500	CR																					0.9		0.9		8.7		8.8		9.2		8.8		9.2		8.8		9.2		8.8	
34.00	IRN	IRN10900	CL	1.2		0.9		0.9		0.9		0.9		0.9		0.9		0.9		0.9		0.9		8.8		8.5																	
34.20	MCO	MCO11600	CL	0.7		−1.0		−1.0		−1.0		−1.0		−1.0		−1.0		−1.0		−1.0		−1.0																					
36.00	ETH	ETH09200	CL		11.8		11.8		11.8		11.8		11.8		11.8		11.8		11.8		11.8		12.1																					
36.00	RUS	RSTREA11	CL																											−3.6				−3.6				−3.6				−3.6	
36.00	RUS	RSTREA12	CR																												−4.3				−4.3				−4.3				−4.2
36.00	RUS	RSTRED11	CL																											−3.6				−3.6				−3.6				−3.6	
36.00	RUS	RSTRED12	CR																												−4.3				−4.3				−4.3				−4.2
36.00	RUS	RSTRSD11	CL																									4.5		4.9		4.9		4.9		4.9		4.9		4.9		4.9	
36.00	RUS	RSTRSD12	CR																										3.4		3.4		3.4		3.4		3.4		3.4		3.4		3.4
36.00	RUS	RSTRSD13	CL																									4.9		5.0		5.0		5.0		5.0		5.0		5.0		5.0	
36.00	RUS	RSTRSD14	CR																										3.5		3.5		3.5		3.5		3.5		3.5		3.5		3.6
37.80	BLR	BLR06200	CL	3.8		1.3		1.3		1.3		1.3		1.3		1.3		1.3		1.3		1.3																					
37.80	SOM	SOM31200****	CR																						3.3		3.3		11.7		10.2		11.7		10.2		11.7		10.2		11.7		10.4
38.00	TJK	TJK06900	CL																						0.6		1.2		7.9		7.8		7.9		7.8		7.9		7.8		7.9		7.9
38.20	BEL	BEL01800	CL																						2.5		2.2		2.0		1.7		2.0		1.7		2.0		1.7		2.0		3.4
38.20	HOL	HOL21300	CL		1.6		1.6		1.6		1.6		1.6		1.6		1.6		1.6		1.6		2.5																					
38.20	PAK	PAK12700	CR		3.5		3.5		3.5		3.5		3.5		3.5		3.5		3.5		3.5		4.6		2.0		2.1																	

1	2	3	4	5																																											
Orbital Position	Admin. symbol	Beam Identification	Polarization type	Channel number																																											
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
				Minimum EPM																																											
38.20	UKR	UKR06300	CR		0.6		0.6		0.6		0.6		0.6		0.6		0.6		0.6		0.6		1.5																					
42.00	TUR	TUR14500	CL		1.7		1.7		1.7		1.7		1.7		1.7		1.7		1.7		1.7		1.7																					
42.50	SEY	SEY00000	CR																						12.3		13.0		13.1		13.1		13.1		13.1		13.1		13.1		13.1		14.4
44.50	EST	EST06100	CR	6.6		5.6		5.6		5.6		5.6		5.6		5.6		5.6		5.6		5.6																					
50.00	AFG	AFG__100	CL	−0.3		−0.5		−0.5		−0.5		−0.5		−0.5		−0.5		−0.5		−0.5		−0.5		3.0		2.2																	
50.00	CLN	CLN21900	CL	0.8		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		1.5		1.6																	
50.00	IRQ	IRQ25600***	CL	4.2		3.6		3.6		3.6		3.6		3.6		3.6		3.6		3.6		3.6**																					
50.00	KGZ	KGZ07000	CR		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		1.0																					
50.00	MDA	MDA06300	CR																						0.7		0.7		1.4		1.4		1.4		1.4		1.4		1.4		1.4		1.4
50.00	MLD	MLD30600	CR	6.3		4.8		4.8		4.8		4.8		4.8		4.8		4.8		4.8		4.8		4.7		4.3																	
50.00	NPL	NPL12200	CR		3.1		3.1		3.1		3.1		3.1		3.1		3.1		3.1		3.1		3.2		2.2		3.4																	
50.00	POL	POL13200****	CL																						2.4		2.7		3.1		3.1		3.1		3.1		3.1		3.1		3.1		3.2
50.00	ROU	ROU13600****	CR	4.9		3.9		3.9		3.9		3.9		3.9		3.9		3.9		3.9		3.9																					
50.00	TKM	TKM06800	CR																						1.0		2.4		8.5		8.5		8.5		8.5		8.5		8.5		8.5		8.7
52.50	UAE	UAE27400	CR																				3.2			3.2		14.3		15.1		15.1		15.1		15.1		15.1		15.1		15.1**	
55.80	IND	INDA_100	CR		2.6		2.6		2.6		2.6		2.6		2.6		2.6		2.6		2.6		3.2		3.9		6.4																	
55.80	IND	INDB_100	CL	2.7		2.1		2.1		2.1		2.1		2.1		2.1		2.1		2.1		2.1		3.2		3.2																			
56.00	BIH	BIH14800***	CL	5.9		5.9		5.9		5.9		5.9		5.9		5.9		5.9		5.9		5.9																							
56.00	RUS	RSTRSD21	CL																									9.3		11.6		11.6		11.6		11.6		11.6		11.6		11.6	
56.00	RUS	RSTRSD22	CR																										3.5		3.5		3.5		3.5		3.5		3.5		3.5		3.6
56.40	KAZ	KAZ06600	CR	3.6		1.3		1.3		1.3		1.3		1.3		1.3		1.3		1.3		1.3																							
62.00	ALB	ALB29600****	CL																						8.6		10.9		33.5		33.5		33.5		33.5		33.5		33.5		33.5		34.4
62.00	CHN	CHN15500	CL	2.7		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5																			
62.00	CHN	CHNA_100	CR		1.9		1.9		1.9		1.9		1.9		1.9		1.9		1.9		1.9		2.1		2.3		5.3																	
68.00	IND	IND03700	CL		4.5		4.5		4.5		4.5		4.5		4.5		4.5		4.5		4.5		4.5		4.5		7.2																	
68.00	IND	IND04700	CR	5.4		5.0		5.0		5.0		5.0		5.0		5.0		5.0		5.0		5.0		5.0		5.0																			
68.00	IND	INDD_100	CR	6.0		4.6		4.6		4.6		4.6		4.6		4.6		4.6		4.6		4.6		4.6		4.6																			
74.00	BGD	BGD22000	CR	12.1		11.0		11.0		11.0		11.0		11.0		11.0		11.0		11.0		11.0		4.1		4.1																			
74.00	BRU	BRU33000	CR		5.1		5.1		5.1		5.1		5.1		5.1		5.1		5.1		5.1		4.8		4.5		6.9																	
74.00	MNG	MNG24800	CR																					6.6		6.6		26.4		99.9		99.9		99.9		99.9		99.9		99.9		99.9	
80.20	INS	INSA_100	CR	12.8		9.7		9.7		9.7		9.7		9.7		9.7		9.7		9.7		9.7		9.7		9.7																			
86.00	BTN	BTN03100	CR	11.8		8.9		8.9		8.9		8.9		8.9		8.9		8.9		8.9		8.9		8.9		8.9																			
86.00	CBG	CBG29900	CR		9.7		9.7		9.7		9.7		9.7		9.7		9.7		9.7		9.7		9.7		9.7		11.7																	
86.00	RUS	RSTRSD31	CL																									5.5		99.9		99.9		99.9		99.9		99.9		99.9		99.9	
86.00	RUS	RSTRSD32	CR																										99.9		99.9		99.9		99.9		99.9		99.9		99.9		99.9
88.00	SNG	SNG15100	CL	2.3		1.3		1.3		1.3		1.3		1.3		1.3		1.3		1.3		1.3		1.3		1.3																			

1	2	3	4	5																																										
Orbital Position	Admin. symbol	Beam Identification	Polarization type	Channel number																																										
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
				Minimum EPM																																										
91.50	MLA	MLA__100	CR		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		3.5**																	
92.20	CHN	CHNE_100	CL	4.4		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5																		
92.20	CHN	CHNF_100	CR		4.4		4.4		4.4		4.4		4.4		4.4		4.4		4.4		4.4		4.4		4.4		6.6																	
98.00	PHL	PHL28500	CL		2.3		2.3		2.3		2.3		2.3		2.3		2.3		2.3		2.3		2.3		2.3		4.7																	
98.00	THA	THA14200	CL	1.8		−0.2		−0.2		−0.2		−0.2		−0.2		−0.2		−0.2		−0.2		−0.2		−0.2		−0.2																	
104.00	BRM	BRM29800	CL	2.1		−0.1		−0.1		−0.1		−0.1		−0.1		−0.1		−0.1		−0.1		−0.1		−0.1		−0.1																	
104.00	INS	INSB_100	CL		4.1		4.1		4.1		4.1		4.1		4.1		4.1		4.1		4.1		4.1		4.1		4.9**																	
107.00	VTN	VTN32500	CR		0.2		0.2		0.2		0.2		0.2		0.2		0.2		0.2		0.2		0.2		0.2		3.1																	
109.85	J	000BS−3N	CR	6.3		4.3		4.3		4.3		4.2		4.1		6.5		12.6																									
109.85	J	J 10985	CR	6.2		4.2		4.2		4.2		4.2		4.0		6.6		13.9		13.9		13.9		13.9		13.9																	
110.00	J	J 11100	CR	5.5		3.5		3.5		3.4		3.4		3.3		5.9		13.8		13.8		13.8		13.8		13.8																	
110.00	J	J 1110E	CR	5.4		3.4		3.4		3.4		3.3		3.1		5.6		12.4																									
110.00	RUS	RUS00401	CL																									13.2		99.9		99.9		99.9		99.9		99.9		99.9		99.9	
110.00	RUS	RUS00402	CR																										99.9		99.9												
116.00	KOR	KO11201D	CL		5.6		5.7		5.6		5.2		5.0		5.3																												
116.00	KOR	KOR11200	CL		−0.8		−0.8		−0.8		−0.8		−1.2		−1.2		4.3		3.9		3.9		3.9		3.9		4.9																	
116.00	KOR	KOR11201	CL		5.6		5.7		5.6		5.2		5.0		5.3																												
121.80	USA	MRA33200	CR	5.3		3.5		3.5		3.5		3.5		3.5		3.5		3.5		3.5		3.5		3.5		3.5																	
122.00	CHN	CHN19000	CR	2.9		0.4		0.4		0.4		0.3		0.3		0.3		0.0		0.0		0.0		0.0		0.0																	
122.00	CHN	CHN20000	CL		1.4		1.4		1.4		1.3		1.3		1.4		0.9		0.7		0.7		0.7		0.7		2.4																	
122.00	USA	GUM33100	CL		6.0		6.0		6.0		6.0		6.0		6.0		6.0		6.0		6.0		6.0		6.0		8.6																	
122.20	LAO	LAO28400	CR		−1.8		−1.8		−1.8		−1.8		−1.8		−1.8		−1.8		−1.8		−1.8		−1.8		−1.8		−0.5																	
128.00	SLM	SLM00000	CL	13.3		11.9		11.9		11.9		11.9		11.9		11.9		11.7		11.7		11.7		11.7		11.7																	
128.00	TLS	TLS00000	CR		9.4		9.3		9.3		9.3		9.3		9.3		9.3		9.2		9.2		9.2		9.2		10.4																	
134.00	CHN	CHN15800	CR		−1.0		−1.0		−1.0		−1.0		−1.0		−1.0		−1.0		−1.0		−1.0		−1.0		−1.0		1.3																	
134.00	CHN	CHNC_100	CL	2.1		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4																	
134.00	NRU	NRU30900	CL	8.6		7.3		7.3		7.3		7.3		7.3		7.3		7.3		7.3		7.3		7.3		7.3																	
134.00	PNG	PNG13100	CR		6.4		6.4		6.4		6.4		6.4		6.4		6.4		6.4		6.4		6.4		6.4		7.5																	
140.00	F	NCL10000	CR		4.2		4.2		4.2		4.2		4.2		4.2		4.2		4.2		4.2		4.2		4.2		5.3																	
140.00	F	WAL10200	CR		7.8		7.8		7.8		7.8		7.8		7.8		7.8		7.8		7.8		7.8		7.8		7.9																	
140.00	KRE	KRE28600	CL	15.5		14.0		14.0		14.0		14.0		14.0		14.0		14.0		14.0		14.0		14.0		14.0																	
140.00	PLW	PLW00000	CR		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.4																	
140.00	RUS	RSTRSD51	CL																									15.8		99.9		99.9		99.9		99.9		99.9		99.9		99.9	
140.00	RUS	RSTRSD52	CR																										99.9		99.9		99.9		99.9		99.9		99.9		99.9		99.9
140.00	USA	WAK33400	CR	16.0		14.0		14.0		14.0		14.0		14.0		14.0		14.0		14.0		14.0		14.0		14.0																	
140.00	VUT	VUT12800	CL	7.1		4.3		4.3		4.3		4.3		4.3		4.3		4.3		4.3		4.3		4.3		4.3																	
146.00	MHL	MHL00000	CR		25.2		25.1		25.2		25.1		25.2		25.4		25.5		25.4		25.5		25.4		25.5		26.3																	
152.00	AUS	AUS00400	CR			5.7				5.7				5.7				5.7				5.7																					
152.00	AUS	AUS0040A	CR			16.9				16.9				16.9				16.9				16.9				16.9																	
152.00	AUS	AUS0040B	CR			16.3				16.3				16.3				16.3				16.3				16.3																	

1	2	3	4	5																																															
Orbital Position	Admin. symbol	Beam Identification	Polarization type	Channel number																																															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
				Minimum EPM																																															
152.00	AUS	AUS0040C	CR			17.4				17.4				17.4				17.4				17.4			17.4																								
152.00	AUS	AUS00500	CL				5.1				5.1				9.1				9.1				9.1				9.1																						
152.00	AUS	AUS00600	CL		4.3			4.3				4.3				8.7					8.7			8.7																								
152.00	AUS	AUSA_100	CR	9.2				7.5				7.5																																						
158.00	FSM	FSM00000	CR	14.9		23.5		14.6		23.5		14.6		23.5		23.8		24.9		25.3		24.9		25.3		24.9																						
158.00	NZL	NZL__100	CL		12.1		8.5		12.1		8.5		12.1		8.6		12.1		12.1		12.1		12.1		12.1		15.1																					
164.00	AUS	AUS00700	CR			4.8				4.8				4.8				9.4				9.4				9.4																						
164.00	AUS	AUS0070A	CR			7.7				7.7				7.7				15.8				15.8				15.8																						
164.00	AUS	AUS00800	CL		5.4				5.4				5.4				5.4				5.4				5.4																						
164.00	AUS	AUS00900	CR	7.8				3.6				3.6				3.6				7.2				7.2																								
164.00	AUS	AUS0090A	CR	13.0				7.1				7.1				7.1				13.0				13.0																								
164.00	AUS	AUS0090B	CR	16.2				7.7				7.7				7.7				15.7				15.7																								
164.00	AUS	AUSB_100	CL				4.6				4.6				4.6																																	
170.00	USA	PLM33200	CL		6.5		6.5		6.5		6.5		6.5		6.5		6.5		6.5		6.5		6.5		6.5		9.2																					
170.00	USA	USAA_100	CL	9.9		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4																						
170.75	TON	TON21500	CR		9.6		9.6		9.6		9.6		9.6		9.6		9.6		9.7		9.7		9.7		9.7		11.6																					
176.00	KIR	KIR__100	CL	13.4		10.5		10.5		10.5		10.5		10.5		10.5		10.5		10.5		10.5		10.5		10.5																						
176.00	TUV	TUV00000	CR		6.2		6.2		6.2		6.2		6.2		6.2		6.2		6.2		6.2		6.2		6.2		9.1																					

* This assignment shall only be used by the Administrations of Croatia, Czech Republic, Hungary and Slovakia on the basis of equal access subject to mutual agreement between them.

** See Note 1 of § 11.2.

*** The current entry is at 1.90° E (WRC-23)

**** This beam was replaced at WRC-23. The new beam is contained in Table 6A

11.3 (SUP - WRC-03)

ARTICLE 12 (REV.WRC-19)

Relationship to Resolution 507 (Rev.WRC-19)

12.1 The provisions and associated Plans for the broadcasting-satellite service in Regions 1 and 3 and in Region 2, of this Appendix, shall be regarded as including a world agreement and associated Plans for Regions 1, 2 and 3 in accordance with *resolves* 1 of Resolution **507 (Rev.WRC-19)**, which requires the stations in the broadcasting-satellite service to be established and operated in accordance with such agreements and associated Plans.

ARTICLE 13

Interference

13.1 The Member States of the Union shall endeavour to agree on the action required to reduce harmful interference which might be caused by the application of these provisions and the associated Plans.

ARTICLE 14

Period of validity of the provisions and associated Plans

14.1 For Regions 1 and 3, the provisions and associated Plan have been prepared in order to meet the requirements of the broadcasting-satellite service in the bands concerned for a period of at least fifteen years from 1 January 1979.

14.2 For Region 2, the provisions and associated Plan have been prepared in order to meet the requirements of the broadcasting-satellite service in the bands concerned for a period extending until at least 1 January 1994.

14.3 In any event, the provisions and associated Plans shall remain in force until their revision by a competent radiocommunication conference convened in accordance with the relevant provisions of the Constitution and Convention in force.

ANNEX 1 (REV.WRC-19)

Limits for determining whether a service of an administration is affected by a proposed modification to the Region 2 Plan or by a proposed new or modified assignment in the Regions 1 and 3 List or when it is necessary under this Appendix to seek the agreement of any other administration[25]

(See Article 4)

1 Limits for the interference into frequency assignments in conformity with the Regions 1 and 3 Plan or with the Regions 1 and 3 List or into new or modified assignments in the Regions 1 and 3 List

Under assumed free-space propagation conditions, the power flux-density of a proposed new or modified assignment in the List shall not exceed the value of −103.6 dB(W/(m^2 · 27 MHz)).

With respect to § 4.1.1 *a)* or *b)* of Article 4, an administration in Region 1 or 3 is considered by the Bureau as being affected if the minimum orbital spacing between the wanted and interfering space stations, under worst-case station-keeping conditions, is less than 9°.

However, an administration in Region 1 or 3 is considered as not being affected if either of the following two conditions is met:

a) under assumed free-space propagation conditions, the power flux-density at any test point within the service area associated with any of its frequency assignments in the Plan or in the List or for which the procedure of Article 4 has been initiated, does not exceed the following values:[26] (WRC-15)

-147 dB(W/(m^2 · 27 MHz))	for $0° \leq \theta < 0.23°$
$-135.7 + 17.74 \log \theta$ dB(W/(m^2 · 27 MHz))	for $0.23° \leq \theta < 2.0°$
$-136.7 + 1.66\, \theta^2$ dB(W/(m^2 · 27 MHz))	for $2.0° \leq \theta < 3.59°$
$-129.2 + 25 \log \theta$ dB(W/(m^2 · 27 MHz))	for $3.59° \leq \theta < 9°$

where θ is the minimum geocentric orbital separation in degrees between the wanted and interfering space stations, taking into account the respective East-West station-keeping accuracies;

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[25] With respect to this Annex, except for Section 2, the limits relate to the power flux-density which would be obtained assuming free-space propagation conditions.

With respect to Section 2 of this Annex, the limit specified relates to the overall equivalent protection margin calculated in accordance with § 2.2.4 of Annex 5.

[26] (SUP - WRC-15)

b) the effect of the proposed new or modified assignments in the List is that the equivalent downlink protection margin[27] corresponding to a test point of its assignment in the Regions 1 and 3 Plan or List, or for which the procedure of Article 4 has been initiated, including cumulative effect of any previous modification to the List or any previous agreement, does not fall more than 0.45 dB below 0 dB or, if already negative, more than 0.45 dB below the value resulting from:

– the Regions 1 and 3 Plan and List as established by WRC-2000; *or*

– a proposed new or modified assignment to the List in accordance with this Appendix; *or*

– a new entry in the Regions 1 and 3 List as a result of successful application of Article 4 procedures.

NOTE – In performing the calculation, the effect at the receiver input of all the co-channel and adjacent-channel signals is expressed in terms of one equivalent co-channel interfering signal. This value is usually expressed in decibels. (WRC-03)

2 Limits to the change in the overall equivalent protection margin for frequency assignments in conformity with the Region 2 Plan

With respect to § 4.2.3 *c)* of Article 4, an administration in Region 2 is considered as being affected if the overall equivalent protection margin[28] corresponding to a test point of its entry in the Region 2 Plan, including the cumulative effect of any previous modification to that Plan or any previous agreement, falls more than 0.25 dB below 0 dB, or, if already negative, more than 0.25 dB below the value resulting from:

– the Region 2 Plan as established by the 1983 Conference; *or*

– a modification of the assignment in accordance with this Appendix; *or*

– a new entry in the Region 2 Plan under Article 4; *or*

– any agreement reached in accordance with this Appendix. (WRC-03)

3 Limits to the change in the power flux-density to protect the broadcasting-satellite service in Regions 1 and 2 in the band 12.2-12.5 GHz and in Region 3 in the band 12.5-12.7 GHz

With respect to § 4.1.1 *c)* of Article 4, an administration in Region 2 is considered as being affected if the proposed new or modified assignment in the Regions 1 and 3 List would result in exceeding the following power flux-density values, at any test point in the service area of its overlapping frequency assignments:

-147 dB(W/(m^2 · 27 MHz))	for $0° \leq \theta < 0.23°$
$-135.7 + 17.74 \log \theta$ dB(W/(m^2 · 27 MHz))	for $0.23° \leq \theta < 1.8°$
$-134.0 + 0.89\, \theta^2$ dB(W/(m^2 · 27 MHz))	for $1.8° \leq \theta < 5.0°$

[27] For the definition of the equivalent protection margin, see § 3.4 of Annex 5.

[28] For the definition of the overall equivalent protection margin, see § 1.11 of Annex 5.

$-129.2 + 25 \log \theta$ dB(W/(m^2 · 27 MHz))	for $5.0° \leq \theta < 10.57°$
-103.6 dB(W/(m^2 · 27 MHz))	for $10.57° \leq \theta$

where θ is the minimum geocentric orbital separation in degrees between the wanted and interfering space stations, taking into account the respective East-West station-keeping accuracies.

With respect to § 4.2.3 *a)*, 4.2.3 *b)* or 4.2.3 *f)* of Article 4, as appropriate, an administration in Region 1 or 3 is considered as being affected if the proposed modification to the Region 2 Plan would result in exceeding the following power flux-density values, at any test point in the service area of its overlapping frequency assignments:

-147 dB(W/(m^2 · 27 MHz))	for $0° \leq \theta < 0.23°$
$-135.7 + 17.74 \log \theta$ dB(W/(m^2 · 27 MHz))	for $0.23° \leq \theta < 2.0°$
$-136.7 + 1.66\, \theta^2$ dB(W/(m^2 · 27 MHz))	for $2.0° \leq \theta < 3.59°$
$-129.2 + 25 \log \theta$ dB(W/(m^2 · 27 MHz))	for $3.59° \leq \theta < 10.57°$
-103.6 dB(W/(m^2 · 27 MHz))	for $10.57° \leq \theta$

where θ is the minimum geocentric orbital separation in degrees between the wanted and interfering space stations, taking into account the respective East-West station-keeping accuracies. (WRC-03)

4 Limits to the power flux-density to protect the terrestrial services of other administrations[29, 30, 31]

With respect to § 4.1.1 *d)* of Article 4, an administration in Region 1, 2 or 3 is considered as being affected if the consequence of the proposed modified assignment in the Regions 1 and 3 List is to increase the power flux-density arriving on any part of the territory of that administration by more than 0.25 dB over that resulting from that frequency assignment in the Plan or List for Regions 1 and 3 as established by WRC-2000. The same administration is considered as not being affected if the value of the power flux-density anywhere in its territory does not exceed the limits expressed below.

With respect to § 4.2.3 *d)* of Article 4, an administration in Region 1, 2 or 3 is considered as being affected if the consequence of the proposed modification to an existing assignment in the Region 2 Plan is to increase the power flux-density arriving on any part of the territory of that administration by more than 0.25 dB over that resulting from that frequency assignment in the Region 2 Plan at the time of entry into force of the Final Acts of the 1985 Conference. The same administration is considered as not being affected if the value of the power flux-density anywhere in its territory does not exceed the limits expressed below.

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[29] See § 3.18 of Annex 5.

[30] In the band 12.5-12.7 GHz in Region 1, these limits are applicable only to the territory of administrations mentioned in Nos. **5.494** and **5.496**.

[31] See Resolution **34 (Rev.WRC-19)**. (WRC-19)

With respect to § 4.1.1 *d)* or § 4.2.3 *d)* of Article 4, an administration in Region 1, 2 or 3 is considered as being affected if the proposed new assignment in the Regions 1 and 3 List, or if the proposed new frequency assignment in the Region 2 Plan, would result in exceeding a power flux-density, for any angle of arrival, at any point on its territory, of:

-148 dB(W/(m^2 · 4 kHz))	for $0° \leq \theta \leq 5°$
$-148 + 0.5\,(\theta - 5)$ dB(W/(m^2 · 4 kHz)	for $5° < \theta \leq 25°$
-138 dB(W/(m^2 · 4 kHz))	for $25° < \theta \leq 90°$

where θ represents the angle of arrival. (WRC-19)

5 (Not used.)

6 Limits to the change in the power flux-density of assignments in the Regions 1 and 3 Plan or List to protect the fixed-satellite service (space-to-Earth) in the frequency band 11.7-12.2 GHz[32] in Region 2 or in the frequency band 12.2-12.5 GHz in Region 3, and of assignments in the Region 2 Plan to protect the fixed-satellite service (space-to-Earth) in the frequency band 12.5-12.7 GHz in Region 1 and in the frequency band 12.2-12.7 GHz in Region 3

With respect to § 4.1.1 *e)* of Article 4, an administration is considered as being affected if the proposed new or modified assignment in the Regions 1 and 3 List would result in an increase in the power flux-density over any portion of the service area of its overlapping frequency assignments in the fixed-satellite service in Region 2 or Region 3 by more than 0.25 dB above that resulting from the frequency assignments in the Plan or List for Regions 1 and 3 as established by WRC-2000.

With respect to § 4.2.3 *e)*, an administration is considered as being affected if the proposed modification to the Region 2 Plan would result in an increase in the power flux-density over any portion of the service area of its overlapping frequency assignments in the fixed-satellite service in Region 1 or 3 by more than 0.25 dB above that resulting from the frequency assignments in the Region 2 Plan at the time of entry into force of the Final Acts of the 1985 Conference.

With respect to § 4.1.1 *e)* or 4.2.3 *e)* of Article 4, with the exception of cases covered by Note 1 below, an administration is considered as not being affected if the proposed new or modified assignment in the Regions 1 and 3 List, or if a proposed modification to the Region 2 Plan, gives a power flux-density anywhere over any portion of the service area of its overlapping frequency assignments in the fixed-satellite service in Region 1, 2 or 3 of less than or equal to:

-186.5 dB(W/(m^2 · 40 kHz))	for $0° \leq \theta < 0.054°$
$-164.0 + 17.74 \log \theta$ dB(W/(m^2 · 40 kHz))	for $0.054° \leq \theta < 2.0°$
$-165.0 + 1.66\,\theta^2$ dB(W/(m^2 · 40 kHz))	for $2.0° \leq \theta < 3.59°$

[32] Including assignments operating under No. **5.485**.

$-157.5 + 25 \log \theta$ dB(W/(m^2 · 40 kHz)) for $3.59° \leq \theta < 10.57°$

-131.9 dB(W/(m^2 · 40 kHz)) for $10.57° \leq \theta$

where θ is the minimum geocentric orbital separation in degrees between the wanted and interfering space stations, taking into account the respective East-West station-keeping accuracies.

NOTE 1 – With respect to § 4.1.1 *e)* of Article 4, an administration in Region 3 is considered as not being affected if the proposed new or modified assignment in the Regions 1 and 3 List in the orbital arc 105° E-129° E gives a power flux-density anywhere over any portion of the territory of the notifying administration within the service area of its overlapping frequency assignments in the fixed-satellite service in the orbital arc 110° E-124° E of less than or equal to:

-186.5 dB(W/(m^2 · 40 kHz)) for $0° \leq \theta < 0.054°$

$-164.0 + 17.74 \log \theta$ dB(W/(m^2 · 40 kHz)) for $0.054° \leq \theta < 1.8°$

$-162.3 + 0.89\, \theta^2$ dB(W/(m^2 · 40 kHz)) for $1.8° \leq \theta < 5.0°$

$-157.5 + 25 \log \theta$ dB(W/(m^2 · 40 kHz)) for $5.0° \leq \theta < 10.57°$

-131.9 dB(W/(m^2 · 40 kHz)) for $10.57° \leq \theta$

where θ is the minimum geocentric orbital separation in degrees between the wanted and interfering space stations, taking into account the respective East-West station-keeping accuracies.

The above set of formulas is only applied to networks:

– for which Appendix **4** information for coordination had been received by the Bureau prior to 30 March 2002; *and*

– which had been brought into use prior to 30 March 2002 and for which the date of bringing into use had been confirmed to the Bureau; *and*

– for which the complete due diligence information, in accordance with Annex 2 to Resolution **49 (Rev.WRC-19)***, had been received by the Bureau prior to 30 March 2002. (WRC-19)

7 Limits to the change in equivalent noise temperature to protect the fixed-satellite service (Earth-to-space) in Region 1 from modifications to the Region 2 Plan in the band 12.5-12.7 GHz

With respect to § 4.2.3 *e)* of Article 4, an administration is considered as being affected if the proposed modification to the Region 2 Plan would result in:

– the value of $\Delta T/T$ of its overlapping frequency assignments in the fixed-satellite service in Region 1 resulting from the proposed modification is greater than the value of $\Delta T/T$ resulting from the assignment in the Region 2 Plan as of the date of entry into force of the Final Acts of the 1985 Conference; *and*

– the value of $\Delta T/T$ of its overlapping frequency assignments in the fixed-satellite service in Region 1 resulting from the proposed modification exceeds 6%,

using the method of Appendix **8** (Case II). (WRC-07)

* *Note by the Secretariat*: This Resolution was revised by WRC-23.

ANNEX 2 (REV.WRC-03)

Basic characteristics to be furnished in notices relating to space stations in the broadcasting-satellite service

These data items are listed in Appendix **4**.

ANNEX 3 (WRC-03)

Method for determining the limiting interfering power flux-density at the edge of a broadcasting-satellite service area in the frequency bands 11.7-12.2 GHz (in Region 3), 11.7-12.5 GHz (in Region 1) and 12.2-12.7 GHz (in Region 2), and for calculating the power flux-density produced in these bands by a terrestrial station, or by a transmitting earth station in the fixed-satellite service in the band 12.5-12.7 GHz

1 General

1.1 This Annex describes a method of calculating the interference potential from terrestrial transmitters or transmitting earth stations in the fixed-satellite service (FSS) to receiving earth stations in the broadcasting-satellite service (BSS).

1.2 The method is in two parts:

a) the calculation of the maximum permissible interfering power flux-density at the edge of the BSS area concerned;

b) the calculation of the likely power flux-density produced at any point on the edge of the service area by the terrestrial transmitter or transmitting earth stations in the FSS of another administration.

1.3 The interference potential of the terrestrial transmitters or the transmitting earth stations in the FSS must be considered case by case; the power flux-density produced by each terrestrial transmitter or each transmitting earth station F_p is compared to the limiting power flux-density F at any point on the edge of the service area of a broadcasting-satellite station of another administration. If, for a given transmitter, the value of the power flux-density produced F_p is lower than the value of the limiting power flux-density F at any point on the edge of the service area, the interference caused to the BSS by this transmitter is considered to be lower than the permissible value and no coordination is required between administrations before the terrestrial service station or the transmitting earth station is brought into use. Where this is not the case, coordination and more precise calculations derived from a mutually agreed basis are necessary.

Section 2 calculates the limit of power flux-density F at the edge of the service area.

Section 3 calculates the power flux-density produced by a terrestrial station or a transmitting earth station, F_p.

1.4 It is emphasized that, should the calculation described in this Annex indicate that the maximum permissible power flux-density is exceeded, it does not necessarily preclude the introduction of the terrestrial or the FSS since the calculations are necessarily based on worst-case assumptions for:

a) the nature of the terrain of the interference path;

b) the off-beam discrimination on the broadcasting-satellite receiving installations;

c) the necessary protection ratios for the BSS;

d) the type of reception in the BSS, i.e., assuming individual reception, this being more critical than community reception for the angles of elevation concerned;

e) the value of power flux-density to be protected in the BSS;

f) the propagation conditions between the terrestrial station or the transmitting earth station in the FSS operating in the opposite direction of transmission, and the BSS area.

2 Limit of power flux-density

2.1 General

The limiting power flux-density not to be exceeded at the edge of the service area in order to protect the BSS of an administration is given by the formula:

$$F = F_0 - R + D + P \tag{1}$$

where:

F: the maximum permissible interfering power flux-density (dB(W/m^2)) within the necessary bandwidth of the broadcasting-satellite;

F_0: the wanted power flux-density (dB(W/m^2)) at the edge of the service area;

R: the protection ratio (dB) between the wanted and interfering signals;

D: angular antenna discrimination (dB) provided by the radiation pattern of the broadcasting-satellite receiver antenna;

P: polarization discrimination (dB) between the wanted and interfering signals.

2.2 Wanted power flux-density (F_0)

The value of F_0 is equal to:

For the Regions 1 and 3 Plan and List, Region 2 Plan and Article 4 submissions under § 4.1.3 and 4.2.6:

a) −108 dB(W/(m^2 · 27 MHz)) for service areas in Regions 1 and 3, *and*

b) −115 dB(W/(m^2 · 24 MHz)), as well as in dB(W/(m^2 · 27 MHz)) with respect to the cases mentioned in the footnote to § 3.8 of Annex 5 concerning necessary bandwidths in Region 2.

For the analogue BSS assignments in the Region 2 Plan:

−107 dB(W/(m^2 · 24 MHz)), as well as in dB(W/(m^2 · 27 MHz)) with respect to the cases mentioned in the footnote to § 3.8 of Annex 5 concerning necessary bandwidths in Region 2.

2.3 Protection ratio (*R*)

2.3.1 For digital BSS assignments, the single entry protection ratio is equal to 30 dB.

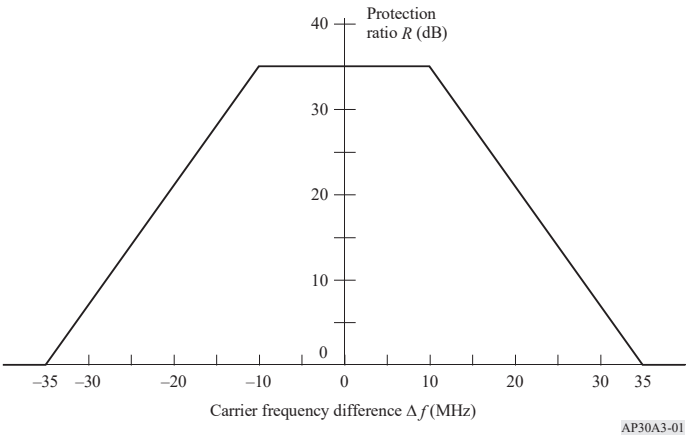
2.3.2 For the analogue BSS assignments in the Region 2 Plan and for notified BSS assignments in Regions 1 and 3 Plan and List which are in conformity with the Plans and List of Appendix **30** and which have been brought into use and for which the date of bringing into use has been confirmed to the Bureau before 9 June 2003, the single entry protection ratio against all types of terrestrial transmissions, with the exception of amplitude-modulation multichannel television systems, is 35 dB for carrier frequency differences between the wanted and interfering signals of up to ±10 MHz, decreasing linearly from 35 dB to 0 dB for carrier frequency differences between 10 MHz and 35 MHz, and is 0 dB for frequency differences in excess of 35 MHz (see Fig. 1). For amplitude-modulation multichannel television systems which produce high peaks of power flux-density spread over a wide range of their necessary bandwidth, the protection ratio *R* is 35 dB and is independent of the carrier frequency difference.

2.3.3 The carrier frequency difference should be determined by reference to the frequency assignments in the broadcasting-satellite Plan or, in the case of assignments not contained within a plan, by reference to the characteristics of the proposed or operational system.

2.3.4 A signal from a terrestrial station or a transmitting earth station in the FSS should be considered only if its necessary bandwidth overlaps the necessary bandwidth of the BSS assignment.

FIGURE 1

Protection ratio (*R*) (dB) for a broadcasting-satellite signal against a single entry of interference from a terrestrial service (except for AM multichannel TV system)



2.4 Angular antenna discrimination (*D*)

2.4.1 For all Regions (digital)

The value of D to be assumed in equation (1) is derived from the following equations, which are based on Recommendation ITU-R BO.1213 (also found in Annex 5):

$$
\begin{aligned}
D &= 0.0025((d/\lambda)\,\varphi)^2 && \text{dB} && \text{for } 0° \le \varphi < \varphi_m \\
D &= G_{max} - (29 - 25\log(\varphi_r)) && \text{dB} && \text{for } \varphi_m \le \varphi < \varphi_r \\
D &= G_{max} - (29 - 25\log(\varphi)) && \text{dB} && \text{for } \varphi_r \le \varphi \le 14.45° \\
D &= G_{max} && \text{dB} && \text{for } \varphi > 14.45°
\end{aligned}
\tag{2}
$$

where:

φ: elevation angle (degrees) for the proposed or operational broadcasting-satellite system for the BSS area concerned

φ_m: $(\lambda/d)((G_{max} - G_1)/(0.0025))^{0.5}$ (degrees)

G_1: $29 - 25\log(\varphi_r)$ (dB)

φ_r: $95(\lambda/d)$ (degrees)

G_{max}: maximum gain of the antenna (dBi)

d: diameter of the antenna (m)

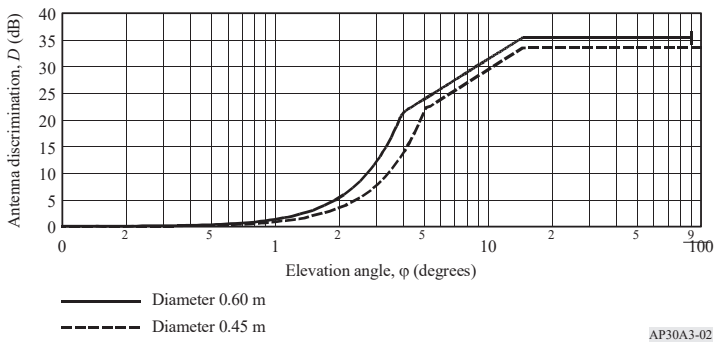
λ: the wavelength (m).

NOTE 1 – If more than one value of φ is specified for a particular service area, the appropriate value of φ should be used for each section of the edge of the service area under consideration.

For Regions 1 and 3, G_{max} = 35.5 dBi corresponding to a 0.6 m diameter antenna at 11.7 GHz and 65% efficiency. For Region 2, G_{max} = 33.3 dBi corresponding to a 0.45 m diameter antenna at 12.2 GHz and 65% efficiency. For a graphical depiction of this antenna discrimination see Fig. 2.

FIGURE 2

Discrimination *D* of a broadcasting-satellite receiving antenna as a function of elevation angle



2.4.2 For the analogue BSS assignments in the Region 2 Plan

The discrimination D should be derived from the expression (3) below where φ is the elevation angle for the proposed or operational broadcasting-satellite system for the BSS area concerned.

NOTE 1 – If more than one value of φ is specified for a particular service area, the appropriate value of φ should be used for each section of the edge of the service area under consideration.

$$\begin{aligned} D &= 0 && \text{dB} && \text{for } 0° \leq \varphi \leq 0.43° \\ D &= 4.15\,\varphi^2 && \text{dB} && \text{for } 0.43° < \varphi \leq 1.92° \\ D &= 8.24 + 25 \log \varphi && \text{dB} && \text{for } 1.92° < \varphi \leq 25° \\ D &= 43.2 && \text{dB} && \text{for } \varphi > 25° \end{aligned} \tag{3}$$

NOTE 2 – For the graphical determination of D see Fig. 3. The unit for φ is degrees.

2.5 Polarization discrimination (*P*)

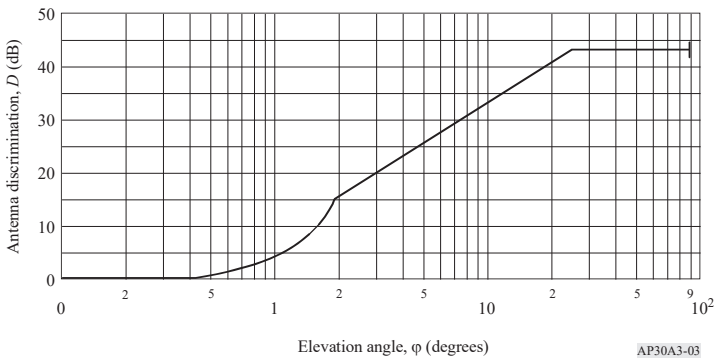
The value of P is equal to:

a) 3 dB when the interfering service uses linear polarization and the BSS uses circular polarization or vice versa;

b) 0 dB when the interfering service and the BSS both use circular or both use linear polarization.

FIGURE 3

Discrimination *D* of broadcasting-satellite receiving antenna as a function of elevation angle



3 Power flux-density produced by a terrestrial station or a transmitting earth station (F_p)

The power flux-density F_p (dB(W/m^2)) produced at any point on the edge of the service area by the terrestrial station or the transmitting earth station is determined from the following formula:

$$F_p = E - A + 10 \log (4\pi/\lambda^2) \tag{4}$$

where:

E: equivalent isotropically radiated power (dBW) of the terrestrial station or the transmitting earth station in the direction of the point concerned on the edge of the service area

A: total path loss (dB)

λ: wavelength (m).

3.1 Evaluation of path loss *A* for a terrestrial station or a transmitting earth station at the edge of the service area of the broadcasting satellite

The following propagation model is to be used for determining the minimum path loss between the interfering terrestrial transmitter or transmitting earth station and the edge of the BSS service area.

3.2 Propagation model

3.2.1 Distance limits

3.2.1.1 *Minimum distance limit*

The minimum coordination distance is given as:

$$d_{min}(f) = 100 + \frac{(\beta_p - f)}{2} \tag{5}$$

where:

f: frequency (GHz)

β_p: radiometeorological parameter, which reflects the relative incidence of clear-sky anomalous propagation conditions.

The value of β_p is latitude dependent. The latitude to be used in determining the correct value for β_p is given by:

$$\zeta_r = \begin{cases} |\zeta| - 1.8 & \text{for } |\zeta| > 1.8° \\ 0 & \text{for } |\zeta| \leq 1.8° \end{cases} \tag{6}$$

where ζ is the earth station latitude (degrees).

β_p is then determined using:

$$\beta_p = \begin{cases} 10^{(1.67 - 0.015\zeta_r)} & \text{for } \zeta_r \leq 70° \\ 4.17 & \text{for } \zeta_r > 70° \end{cases} \tag{7}$$

3.2.1.2 *Maximum distance limit*

The maximum distance, d_{max}, for paths comprising a single climatic zone must not exceed the value for that climatic zone given in the Table below. For mixed paths comprising multiple zones the overall maximum distance must not exceed the value in the Table below corresponding to the climatic zone in the mixed path having the largest value (e.g. for a mixed path comprising Zones A1 and A2, d_{max} is 500 km).

Climatic Zone[1]	Maximum distance, d_{max}[2]
A1	500
A2	375
B	900
C	1 200

[1] For the definition see Appendix **7**, § 1.5.1 and 1.5.3.2.

[2] As computed in § 2 of Appendix **7**.

3.2.2 Ducting model

3.2.2.1 *Distance-independent part of the loss (dB) for ducting*

For BSS earth stations, no additional protection due to the earth station horizon elevation angle can be assumed, i.e. A_h, the total terrain shielding attenuation, is 0 dB. However, if the detailed information for the transmitting station is known, including any site-shielding-based mitigation techniques that are used, all these factors need to be included in the determination of the coordination distance.

Reduction in attenuation arising from direct coupling into over-sea ducts (dB):

$$A_c = \frac{-6}{1 + d_c} \tag{8}$$

where d_c (km) is the distance from a land-based transmitting station to the coast in the direction being considered. d_c is zero in other circumstances.

Distance-independent part of the loss (dB) for ducting:

$$A_1 = 122.43 + 16.5 \log f + A_c \tag{9}$$

3.2.2.2 *Distance-dependent part of the loss (dB) for ducting*

a) The specific attenuation (dB/km) due to dry air is given as:

$$\gamma_0 = \left(7.19 \times 10^{-3} + \frac{6.09}{f^2 + 0.227} + \frac{4.81}{(f - 57)^2 + 1.50} \right) f^2 \times 10^{-3} \tag{10}$$

b) The specific attenuation due to water vapour is given as a function of ρ, the water vapour density in units of g/m^3, by the following equation:

$$\gamma_w(\rho) = \left(0.050 + 0.0021\rho + \frac{3.6}{(f - 22.2)^2 + 8.5} \right) f^2 \rho \times 10^{-4} \tag{11}$$

c) The specific attenuation (dB/km) due to water vapour for the ducting propagation model using a water vapour density of 7.5 g/m^3 for paths over land in Zones A1 and A2 is given as:

$$\gamma_{wdl} = \gamma_w (7.5) \tag{12}$$

d) The specific attenuation (dB/km) due to water vapour for the ducting propagation model using a water vapour density of 10.0 g/m^3 for paths over sea in Zones B and C is given as:

$$\gamma_{wds} = \gamma_w (10.0) \tag{13}$$

Note that the value of 10.0 g/m^3 is used for both Zones B and C in view of the lack of data on the variability of water vapour density on a global basis, particularly the minimum values.

e) Specific attenuation due to gaseous absorption (dB/km):

$$\gamma_g = \gamma_0 + \gamma_{wdl}\left(\frac{d_t}{d_i}\right) + \gamma_{wds}\left(1 - \frac{d_t}{d_i}\right) \tag{14}$$

where:

d_t (km): aggregate land distance (Zone A1 + Zone A2) along the path;

d_i (km): path length considered, which lies within the range between a minimum calculation distance and a maximum calculation distance.

f) Values for zone-dependent parameters:

$$\tau = 1 - \exp\left(-\left(4.12 \times 10^{-4}(d_{lm})^{2.41}\right)\right) \tag{15}$$

where:

d_{lm} (km): longest continuous inland distance (Zone A2) along the path considered.

$$\mu_1 = \left(10^{\frac{-d_{tm}}{16 - 6.6\tau}} + \left(10^{-(0.496 + 0.354\tau)}\right)^5\right)^{0.2} \tag{16}$$

where:

d_{tm} (km): longest continuous land (i.e. inland + coastal) distance (Zone A1 + Zone A2) along the path considered.

μ_1 is limited to $\mu_1 \leq 1$.

$$\sigma = -0.6 - 8.5 \times 10^{-9} d_i^{3.1} \tau \tag{17}$$

σ is limited to $\sigma \geq -3.4$.

$$\mu_2 = \left(2.48 \times 10^{-4} d_i^2\right)^{\sigma} \tag{18}$$

μ_2 is limited to $\mu_2 \leq 1$.

$$\mu_4 = \begin{cases} 10^{(-0.935 + 0.0176\,\zeta_r)\log \mu_1} & \text{for} \quad \zeta_r \leq 70° \\ 10^{0.3 \log \mu_1} & \text{for} \quad \zeta_r > 70° \end{cases} \tag{19}$$

g) Path-dependent incidence of ducting, β, and the related parameter, Γ_1, that are used to calculate time dependency of the path loss are given as:

$$\beta = \beta_e \cdot \mu_1 \cdot \mu_2 \cdot \mu_4 \tag{20}$$

$$\Gamma_1 = \frac{1.076}{(2.0058 - \log\ \beta)^{1.012}}\ \exp\left(-\left(9.51 - 4.8\ \log\ \beta + 0.198(\log \beta)^2\right) \times 10^{-6} d_i^{1.13}\right) \tag{21}$$

h) Distance-dependent part of the loss (dB) for ducting:

$$L_5(p) = (\gamma_d + \gamma_g) d_i + (1.2 + 3.7 \times 10^{-3} d_i) \log\left(\frac{p}{\beta}\right) + 12\left(\frac{p}{\beta}\right)^{\Gamma_1} + C_{2i} \tag{22}$$

where:

p: the maximum percentage of time for which the permissible interference power may be exceeded; $p = 0.3\%$

γ_d: the frequency-dependent ducting specific attenuation (dB/km).

$$\gamma_d = 0.05 f^{1/3} \tag{23}$$

NOTE 1 – For coordination of terrestrial mobile transmitting stations, fixed stations and transmitting earth stations, the mitigation factor C_{2i} was set equal to zero.

i) Attenuation due to ducting:

$$A_{duct} = A_1 + L_5(p) \tag{24}$$

3.2.3 For the tropospheric scatter model

3.2.3.1 *Distance-independent part of the loss (dB) for tropospheric scatter*

$$A_2 = 187.36 + 10\varepsilon_h + L_f - 0.15 N_0 - 10.1\left(-\log\left(\frac{p}{50}\right)\right)^{0.7} \tag{25}$$

where:

ε_h: earth station horizon elevation angle (degrees)

N_0: path centre sea level surface refractivity given as:

$$N_0 = 330 + 62.6\, e^{-\left(\frac{\zeta - 2}{32.7}\right)^2} \tag{26}$$

L_f: the frequency-dependent part of the loss (dB), given as:

$$L_f = 25 \log(f) - 2.5\left(\log\left(\frac{f}{2}\right)\right)^2 \tag{27}$$

3.2.3.2 *Distance-dependent part of the loss (dB) for tropospheric scatter*

$$L_6(p) = 20\ \log(d_i) + 5.73 \times 10^{-4}\left(112 - 15\cos(2\zeta)\right)d_i + (\gamma_0 + \gamma_{wt})d_i + C_{2i} \tag{28}$$

Total attenuation due to tropospheric scatter:

$$A_{trop} = A_2 + L_6(p) \tag{29}$$

3.2.3.3 *Minimum path loss*

The minimum path loss, A_{min}, between the site of the interfering transmitter and the edge of the BSS service area is given by:

$$A_{min} = \min\ (A_{duct}, A_{trop}) \tag{30}$$

ANNEX 4 (REV.WRC-19)

Need for coordination of a transmitting space station in the fixed-satellite service or in the broadcasting-satellite service where this service is not subject to a Plan: in Region 2 (11.7-12.2 GHz) with respect to the Plan, the List or proposed new or modified assignments in the List for Regions 1 and 3; in Region 1 (12.5-12.7 GHz) and in Region 3 (12.2-12.7 GHz) with respect to the Plan or proposed modifications to the Plan in Region 2; in Region 3 (12.2-12.5 GHz) with respect to the Plan, List or proposed new or modified assignments in the List for Region 1

(See Article 7)

With respect to § 7.1 and 7.2 of Article 7, coordination of a transmitting space station in the fixed-satellite service (FSS) (space-to-Earth) of Region 2 or Region 3 is required when, under assumed free-space propagation conditions, the power flux-density over any portion of the service area of the overlapping frequency assignments in the BSS of an administration in Region 1 or Region 3 exceeds the following values: (WRC-07)

-147 dB(W/(m^2 · 27 MHz))	for $0° \leq \theta < 0.23°$
$-135.7 + 17.74 \log \theta$ dB(W/(m^2 · 27 MHz))	for $0.23° \leq \theta < 2.0°$
$-136.7 + 1.66\ \theta^2$ dB(W/(m^2 · 27 MHz))	for $2.0° \leq \theta < 3.59°$
$-129.2 + 25 \log \theta$ dB(W/(m^2 · 27 MHz))	for $3.59° \leq \theta < 10.57°$
-103.6 dB(W/(m^2 · 27 MHz))	for $10.57° \leq \theta$

where θ is the minimum geocentric orbital separation in degrees between the wanted and interfering space stations, taking into account the respective East-West station-keeping accuracies.

In the case of an administration in Region 3 that has notified and brought into use its BSS Plan assignments before 9 June 2003, and whose notified assignments have been recorded in the Master Register with a favourable finding and for which the date of bringing into use has been confirmed to the Bureau, with respect to § 7.2.1 *a)* of Article 7, the conditions contained above are replaced by the following conditions:

– under assumed free-space propagation conditions, the power flux-density at any test point within the service area of the overlapping frequency assignments in the Plan exceeds the following values: (WRC-19)

-147 dB(W/(m^2 · 27 MHz))	for $0° \leq \theta < 0.23°$
$-135.7 + 17.74 \log \theta$ dB(W/(m^2 · 27 MHz))	for $0.23° \leq \theta < 1.8°$
$-134.0 + 0.89\, \theta^2$ dB(W/(m^2 · 27 MHz))	for $1.8° \leq \theta < 5.0°$
$-129.2 + 25 \log \theta$ dB(W/(m^2 · 27 MHz))	for $5.0° \leq \theta < 10.57°$
-103.6 dB(W/(m^2 · 27 MHz))	for $10.57° \leq \theta$

where θ is the minimum geocentric orbital separation in degrees between the wanted and interfering space stations, taking into account the respective East-West station-keeping accuracies.

With respect to § 7.1 and 7.2 of Article 7, coordination of a transmitting space station in the FSS (space-to-Earth) in Region 1 or 3 or BSS not subject to a Plan in Region 3 is required when, under assumed free-space propagation conditions, the power flux-density over any portion of the service area of the overlapping frequency assignments in the BSS of an administration in Region 2 exceeds the following values:

-147 dB(W/(m^2 · 27 MHz))	for $0° \leq \theta < 0.23°$
$-135.7 + 17.74 \log \theta$ dB(W/(m^2 · 27 MHz))	for $0.23° \leq \theta < 1.8°$
$-134.0 + 0.89\, \theta^2$ dB(W/(m^2 · 27 MHz))	for $1.8° \leq \theta < 5.0°$
$-129.2 + 25 \log \theta$ dB(W/(m^2 · 27 MHz))	for $5.0° \leq \theta < 10.57°$
-103.6 dB(W/(m^2 · 27 MHz))	for $10.57° \leq \theta$

where θ is the minimum geocentric orbital separation in degrees between the wanted and interfering space stations, taking into account the respective East-West station-keeping accuracies.

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33 (SUP - WRC-15)

ANNEX 5

Technical data used in establishing the provisions and associated Plans and the Regions 1 and 3 List, which should be used for their application[34] (Rev.WRC-03)

1 Definitions

1.1 Downlink service area

The area on the surface of the Earth in which the administration responsible for the service has the right to demand that the agreed protection conditions be provided.

NOTE – In the definition of service area, it is made clear that within the service area the agreed protection conditions can be demanded. This is the area where there should be at least the wanted power flux-density and protection against interference based on the agreed protection ratio for the agreed percentage of time.

1.2 Downlink coverage area

The area on the surface of the Earth delineated by a contour of a constant given value of power flux-density which would permit the wanted quality of reception in the absence of interference.

NOTE 1 – In accordance with the provisions of No. **23.13**, the coverage area must be the smallest area which encompasses the service area.

NOTE 2 – The coverage area, which will normally encompass the entire service area, will result from the intersection of the antenna beam (elliptical, circular, or shaped) with the surface of the Earth, and will be defined by a given value of power flux-density. For example, it would be the area delineated by the contour corresponding to the level specified in § 3.16 of this Annex. There will usually be an area outside the service area but within the coverage area in which the power flux-density will be at least equivalent to the minimum specified value; however, protection against interference will not be provided in this area.

NOTE 3 – If coverage is provided by a steerable beam, the contour delineating the coverage area will depend on the pointing capability of the beam and will not necessarily cover the entire service area.

1.3 Downlink beam area

The area delineated by the intersection of the half-power beam of the satellite transmitting antenna with the surface of the Earth. The downlink beam area concept was generally used for planning purposes in conjunction with elliptical beams.

NOTE – The beam area is simply that area on the Earth's surface corresponding to the −3 dB points on the satellite antenna radiation pattern. In many cases the beam area would almost coincide with the coverage area, the discrepancy being accounted for by the permanent difference in path lengths from the satellite throughout the beam area, and also by the permanent variations, if any, in propagation factors across the area. However, for a service area where the maximum dimension as seen from the satellite position is less than 0.6° in Regions 1 and 3, and less than 0.8° in Region 2 (the agreed minimum practicable satellite antenna half-power beamwidths), there could be a significant difference between the beam area and the coverage area.

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[34] In revising this Annex at WRC-97 and at WRC-2000, no changes have been made to the technical data applicable to the Region 2 Plan. However, for all three Regions, it should be noted that some of the parameters of networks proposed as modifications to the Region 2 Plan and the Regions 1 and 3 List may differ from the technical data presented herein. (WRC-2000)

1.4 Nominal orbital position

The longitude of a position in the geostationary-satellite orbit associated with a frequency assignment to a space station in a space radiocommunication service. The position is given in degrees from the Greenwich meridian.

NOTE – Definitions in § 1.6 to 1.11 are applicable to Region 2. (WRC-2000)

1.5 Adjacent channel

The RF channel in the broadcasting-satellite service frequency Plan, or in the associated feeder-link frequency Plan, which is situated immediately higher or lower in frequency with respect to the reference channel.

1.6 Second adjacent channel

The RF channel in the broadcasting-satellite service frequency Plan, or in the associated feeder-link frequency Plan, which is situated immediately beyond either of the adjacent channels, with respect to the reference channel.

1.7 Overall carrier-to-interference ratio

The overall carrier-to-interference ratio is the ratio of the wanted carrier power to the sum of all interfering RF powers in a given channel including both feeder links and downlinks. The overall carrier-to-interference ratio due to interference from the given channel is calculated as the reciprocal of the sum of the reciprocals of the feeder-link carrier-to-interference ratio and the down-link carrier-to-interference ratio referred to the satellite receiver input and earth station receiver input, respectively[35].

1.8 Overall co-channel protection margin

The overall co-channel protection margin in a given channel is the difference in decibels between the overall co-channel carrier-to-interference ratio and the co-channel protection ratio.

1.9 Overall adjacent channel protection margin

The overall adjacent channel protection margin is the difference in decibels between the overall adjacent channel carrier-to-interference ratio and the adjacent channel protection ratio.

1.10 Overall second adjacent channel protection margin

The overall second adjacent channel protection margin is the difference in decibels between the overall second adjacent channel carrier-to-interference ratio and the second adjacent channel protection ratio.

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[35] There are a total of five overall carrier-to-interference ratios used in the analysis of the Plan for the broadcasting-satellite service in Region 2, namely, co-channel, upper and lower adjacent channels, and upper and lower second adjacent channels. In Regions 1 and 3, three ratios are normally used, namely, co-channel and upper and lower adjacent channels. However, see the footnote to the definition of M_4 and M_5 in § 1.11 of this Annex.

1.11 Overall equivalent protection margin[36]

The overall equivalent protection margin, M, is given in decibels by the expression:

$$M = -10 \log \left(\sum_{i=1}^{5} 10^{\left(-M_i/10\right)} \right)$$

where:

M_1: overall co-channel protection margin (dB) (as defined in § 1.8);

M_2, M_3: overall adjacent channel protection margins for the upper and lower adjacent channels, respectively (dB) (as defined in § 1.9);

M_4, M_5: overall second adjacent channel protection margins for the upper and lower second adjacent channels, respectively (dB) (as defined in § 1.10)[37].

The adjective "equivalent" indicates that the protection margins for all interference sources from the adjacent and second adjacent channels as well as co-channel interference sources have been included. (WRC-2000)

2 Radio propagation factors

In Regions 1 and 3:

2.1 The propagation loss on the space-to-Earth path (used for computing downlink e.i.r.p. and as a guide in choosing orbital locations during the development of the Plan) is equal to the free-space path loss plus the atmospheric absorption and the rain attenuation exceeded for 1% of the worst month. Values of this attenuation can be calculated as a function of angle of elevation for the rain-climatic zones shown in Figs. 1 and 2 from Recommendation ITU-R P.837-1 by applying the method described in Recommendation ITU-R P.618-5.

---

[36] For calculation of overall equivalent protection margin for Regions 1 and 3, as defined at WARC Orb-88, see alternative formula in § 1.12 to Annex 3 of Appendix **30A**.

[37] M_4 and M_5 are applicable only for Region 2. (WRC-2000)

FIGURE 1

Rain-climatic zones for Regions 1 and 3 between longitudes 45° W and 105° E

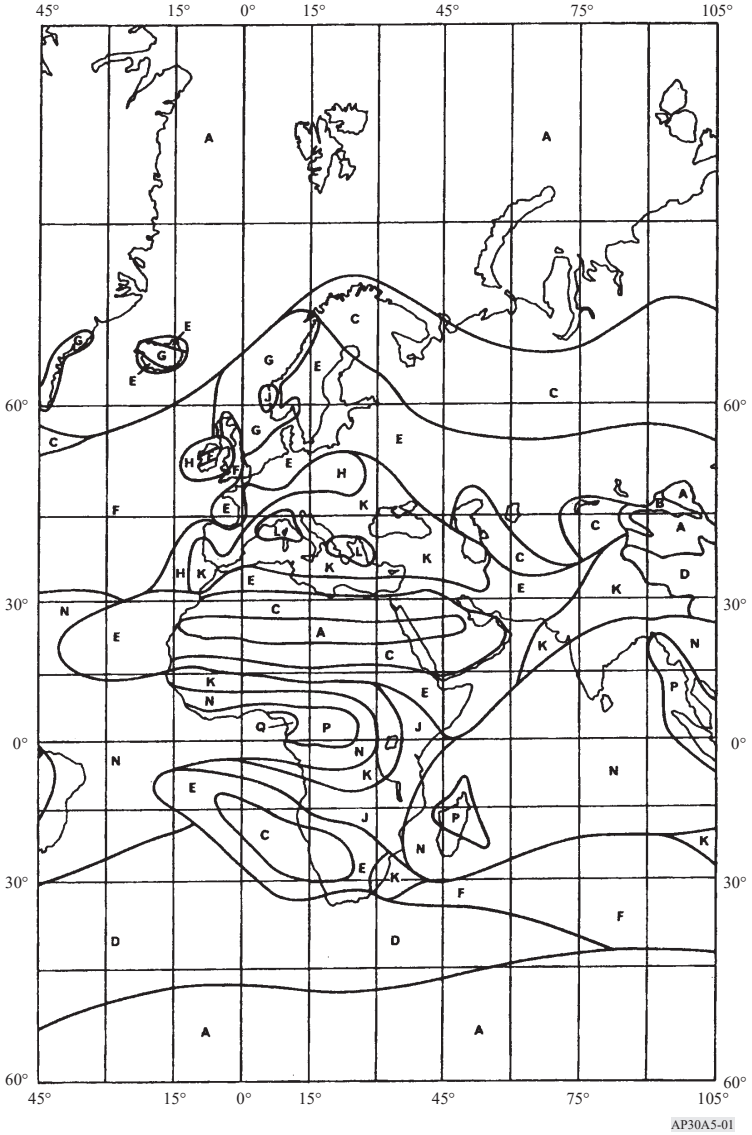
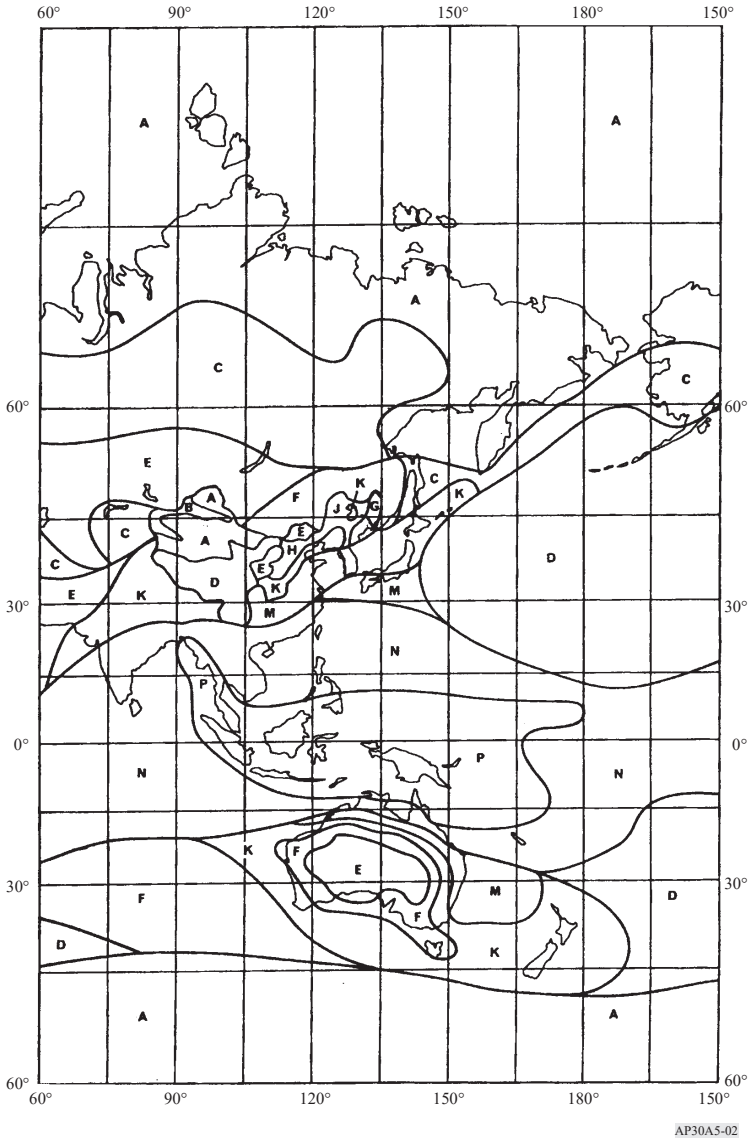


FIGURE 2

Rain-climatic zones for Regions 1 and 3 between longitudes 60° E and 150° W



In Region 2:

2.2 The propagation loss on a space-Earth path is equal to the free-space path loss plus the atmospheric absorption loss plus the rain attenuation exceeded for 1% of the worst month.

2.2.1 Atmospheric absorption

The loss due to atmospheric absorption (i.e. clear-sky attenuation) is given by:

$$A_a = \frac{92.20}{\cos\theta}\left[0.017F_o + 0.002\rho F_w\right] \quad \text{dB} \qquad \text{for } \theta < 5°$$

where:

$$F_o = \left[24.88 \tan\theta + 0.339\sqrt{1\,416.77 \tan^2\theta + 5.51}\right]^{-1}$$

$$F_w = \left[40.81 \tan\theta + 0.339\sqrt{3\,811.66 \tan^2\theta + 5.51}\right]^{-1}$$

and:

$$A_a = \frac{0.042 + 0.003\,\rho}{\sin\theta} \quad \text{dB} \qquad \text{for } \theta \geq 5°$$

where:

θ: elevation angle (degrees),

ρ: surface water vapour concentration (g/m^3), being

ρ = 10 g/m^3 for rain climatic zones A to K and

ρ = 20 g/m^3 for rain climatic zones M to P (see Fig. 3).

2.2.2 Rain attenuation

The rain attenuation A_p of circularly polarized signals exceeded for 1% of the worst month at 12.5 GHz is given by:

$$A_p = 0.21\,\gamma\,L\,r \quad \text{dB} \tag{31}$$

where:

L: slant path length through rain

$$= \frac{2\left(h_R - h_0\right)}{\left\{\sin^2\theta + 2\,\dfrac{h_R - h_0}{8\,500}\right\}^{1/2} + \sin\theta} \quad \text{km}$$

r: rain path length reduction factor

$$= \frac{90}{90 + 4L\cos\theta}$$

h_R: rain height (km)

$$= c \left\{ 5.1 - 2.15 \log \left(1 + 10^{(\zeta - 27)/25} \right) \right\} \quad \text{km}$$

where:

$c = 0.6$ for $|\zeta| \leq 20°$

$c = 0.6 + 0.02\,(|\zeta| - 20)$ for $20° < |\zeta| \leq 40°$

$c = 1.0$ for $|\zeta| > 40°$

h_0: height (km) above mean sea level of the earth station;

ζ: earth station latitude (degrees);

θ: elevation angle (degrees);

γ: specific rain attenuation = $0.0202\, R^{1.198}$ dB/km;

R: rain intensity (mm/h) obtained from the table below for the rain climatic zones identified in Fig. 3.

(NOTE – The method is based on R exceeded for 0.01% of an average year.)

Rainfall intensity (*R*) for the rain climatic zones (exceeded for 0.01% of an average year) (see Fig. 3)

Rain climatic zone	A	B	C	D	E	F	G	K	M	N	P
Rainfall intensity (mm/h)	8	12	15	19	22	28	30	42	63	95	145

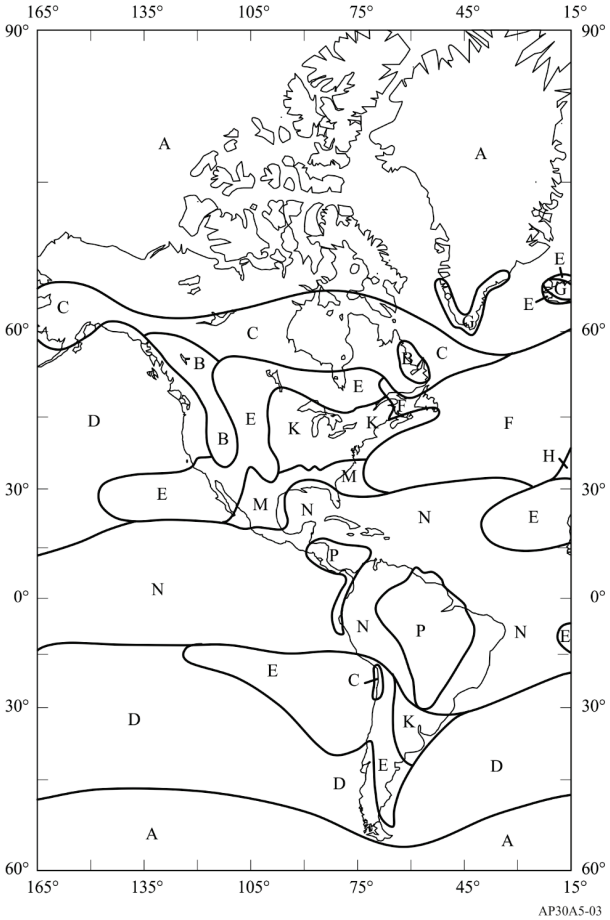
Figure 4 presents plots of rain attenuation, as calculated using equation (31), of circularly polarized signals exceeded for 1% of the worst month at 12.5 GHz, as a function of earth station latitude and elevation angle for each of the rain climatic zones shown in Fig. 3.

2.2.3 Rain attenuation limit

In the analysis of the Plan for the broadcasting-satellite service in Region 2, a maximum downlink attenuation of 9 dB was agreed in order to limit the inhomogeneity of broadcasting-satellite power flux-density and to facilitate sharing during clear-sky conditions.

FIGURE 3

Rain-climatic zones (Region 2)



2.2.4 Procedure for calculating the carrier-to-interference ratio at a test point

The calculation of the down-link carrier-to-interference ratio (exceeded for 99% of the worst month) used to obtain the overall equivalent protection margin at a test point is the minimum value of the carrier-to-interference ratio obtained assuming:

i) clear-sky conditions (i.e. including atmospheric absorption); *or*

ii) rain-faded conditions corresponding to an attenuation value exceeded for 1% of the worst month.

2.3 Depolarization

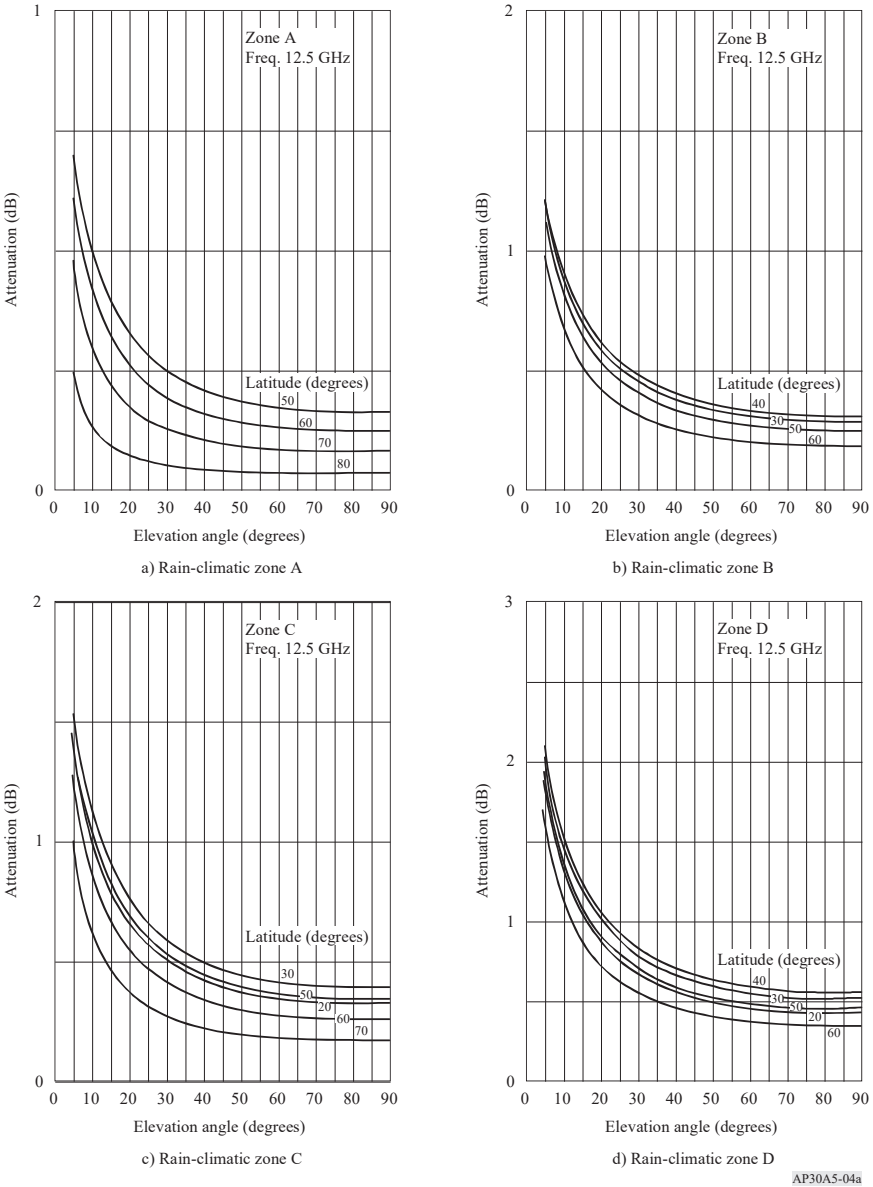
Rain and ice can cause depolarization of radio frequency signals. The level of the co-polar component relative to the depolarized component is given by the cross-polarization discrimination (XPD) ratio. For circularly polarized emissions, the XPD ratio (dB) exceeded for 99% of the worst month is obtained from:

$$XPD = 30 \log f - 40 \log (\cos \theta) - 20 \log A_p \qquad \text{for } 5° \leq \theta \leq 60° \qquad (32)$$

where A_p (dB) is the co-polar rain attenuation exceeded for 1% of the worst month (calculated in § 2.2), f is the frequency in GHz and θ is the elevation angle. For angles of θ greater than 60°, use $\theta = 60°$ in equation (32).

FIGURE 4

Rain attenuation values exceeded for 1% of the worst month (sea level) for Region 2 rain-climatic zones



a) Rain-climatic zone A

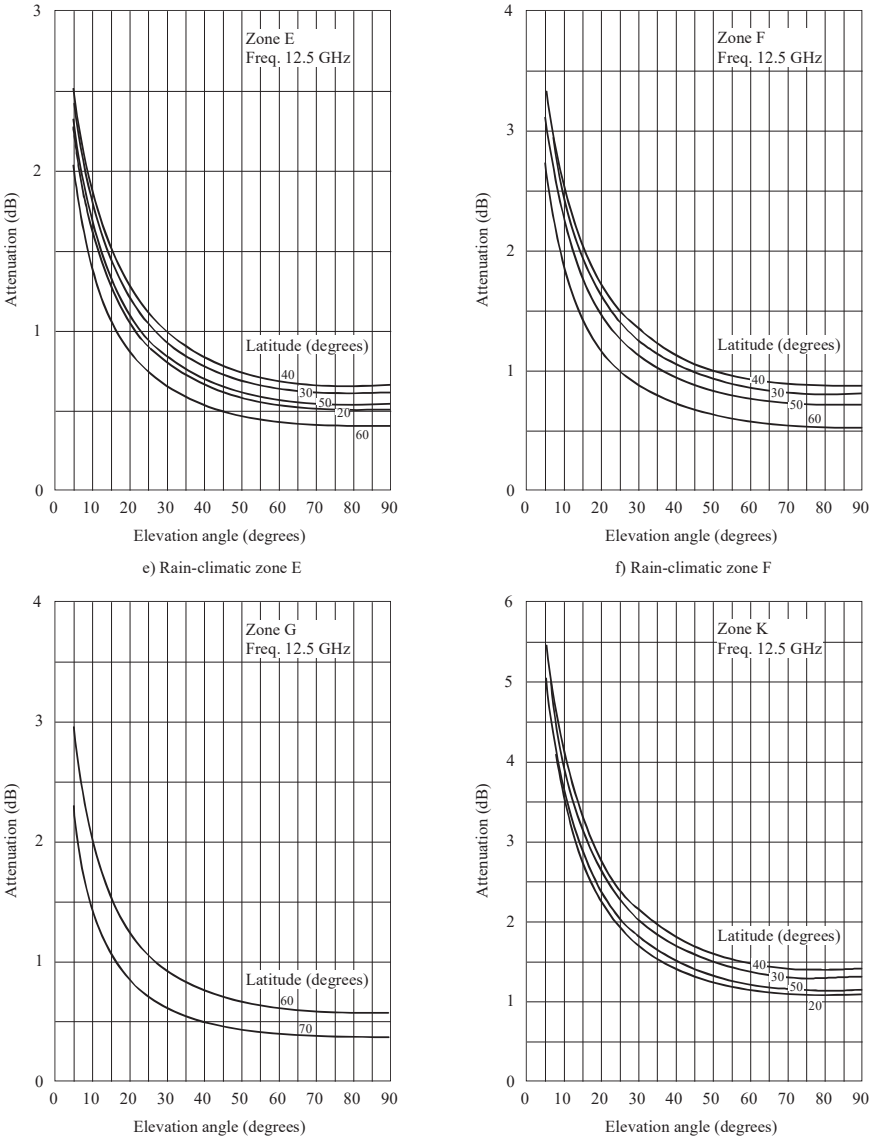
b) Rain-climatic zone B

c) Rain-climatic zone C

d) Rain-climatic zone D

FIGURE 4 (*continued*)

Rain attenuation values exceeded for 1% of the worst month (sea level) for Region 2 rain-climatic zones



e) Rain-climatic zone E

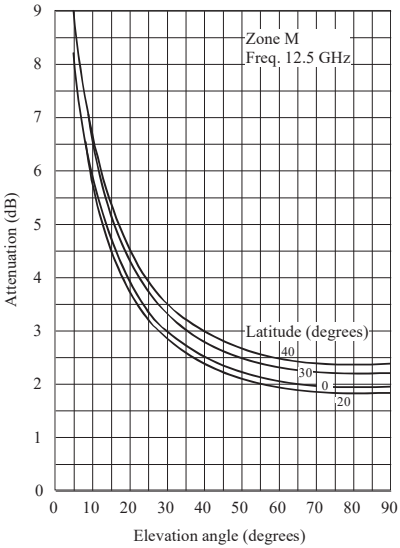
f) Rain-climatic zone F

g) Rain-climatic zone G

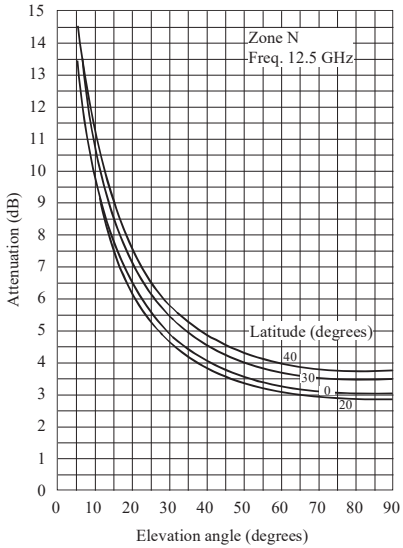
h) Rain-climatic zone K

FIGURE 4 (*continued*)

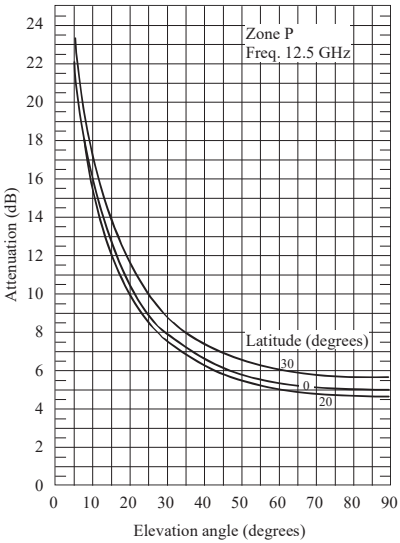
Rain attenuation values exceeded for 1% of the worst month (sea level) for Region 2 rain-climatic zones



j) Rain-climatic zone M



k) Rain-climatic zone N



l) Rain-climatic zone P

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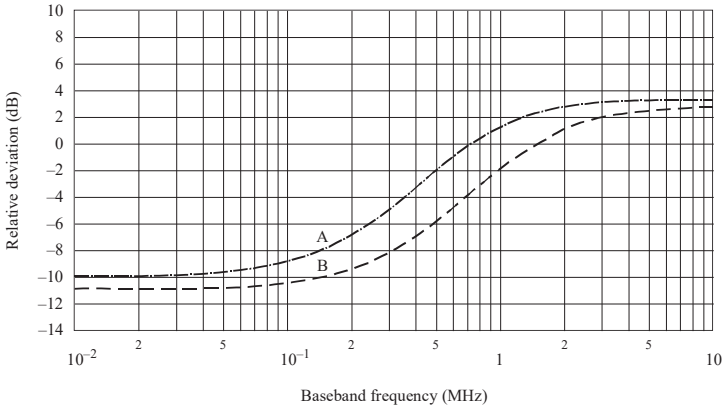
3 Basic technical characteristics

3.1 Type of modulation

3.1.1 At WARC-77 and during revision of the Regions 1 and 3 Plan at WRC-97, planning of the broadcasting-satellite service was based on the use of a signal consisting of a video signal with an associated carrier, frequency-modulated by a sound signal, both frequency-modulating a carrier in the 12 GHz band, with a pre-emphasis characteristic in accordance with Fig. 5 (from Recommendation ITU-R F.405-1*). The WRC-2000 Regions 1 and 3 Plan and the List are generally based on digital modulation of sound and television signals. (WRC-2000)

FIGURE 5

Pre-emphasis characteristic for television on 525- and 625-line systems



Curves A: 525-line system
B: 625-line system

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3.1.2 In Region 2, planning is based on the use of a frequency-modulated composite-coded colour television signal with two sound sub-carriers. However, in recognition of the need to provide for the use of new, enhanced television coding and modulation formats (e.g. time-compressed, multiplexed analogue video component signals and digitally-coded sound and data signals), values of the important technical characteristics have been chosen to take into consideration the implementation of these new formats within the provisions of the Plan.

* *Note by the Secretariat*: This Recommendation was suppressed by the Radiocommunication Assembly (Geneva, 2003).

3.1.3 Nevertheless, other modulating signals having different characteristics (e.g. modulation with sound channels frequency-multiplexed within the bandwidth of a television channel, digital modulation of sound and television signals, or other pre-emphasis characteristics) are not precluded, provided that appropriate protection masks and calculation methods[38] are applied or if the use of such characteristics complies with the provisions of § 3.2 of Article 3.

3.2 Polarization

3.2.1 For the planning of the broadcasting-satellite service, circular polarization is generally used. However, for implementation of assignments in the Plan, linear polarization may also be used, subject to the successful application of the modification procedure of Article 4.

3.2.2 In Regions 1 and 3, the polarization of different beams intended to serve the same area should, if possible, be the same.

3.2.3 The terms "direct" and "indirect" used in the Plans to indicate the direction of rotation of circularly-polarized waves correspond to right-hand (clockwise) and left-hand (anti-clockwise) polarization respectively according to the following definitions:

Direct polarization (right-hand or clockwise polarization):

An elliptically or circularly-polarized electromagnetic wave, in which the electric field-intensity vector, observed in any *fixed plane*, normal to the direction of propagation, whilst looking in (i.e., not against) the direction of propagation, rotates *with time* in a *right-hand* or clockwise direction.

NOTE – For right-hand circularly-polarized plane waves, the ends of the electric vectors drawn from any points along a straight line normal to the plane of the wave front form, *at any instant*, a *left-hand* helix.

Indirect polarization (left-hand or anti-clockwise polarization):

An elliptically or circularly-polarized electromagnetic wave, in which the electric field-intensity vector, observed in any *fixed plane*, normal to the direction of propagation, whilst looking in (i.e., not against) the direction of propagation, rotates *with time* in a *left-hand* or anti-clockwise direction.

NOTE – For left-hand circularly-polarized plane waves, the ends of the electric vectors drawn from any points along a straight line normal to the plane of the wave front form, *at any instant*, a *right-hand* helix.

3.2.4 Linear polarization is defined in Recommendation ITU-R BO.1212. This Recommendation should be used when analysing linearly polarized signals.

3.3 Carrier-to-noise ratio

For the purpose of planning the broadcasting-satellite service, the carrier-to-noise ratio is equal to or exceeds 14 dB for 99% of the worst month.

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[38] Protection masks for verifying that this provision is met are not yet fully defined in existing ITU-R Recommendations. Recommendations for interference between analogue and digital signals are still under development. In absence of criteria to evaluate interference, the Bureau will use the worst-case approach as adopted by the Radio Regulations Board.

In Regions 1 and 3, the reduction in quality in the down-link due to thermal noise in the feeder-link is taken as equivalent to a degradation in the down-link carrier-to-noise ratio not exceeding 0.5 dB for 99% of the worst month. In Region 2, as a guide for planning, the reduction in quality in the down-link due to thermal noise in the feeder link is taken as equivalent to a degradation in the down-link carrier-to-noise ratio of approximately 0.5 dB not exceeded for 99% of the worst month, but the feeder-link and down-link Plans are evaluated on the basis of the overall carrier-to-noise ratio of 14 dB for the combined down-link and feeder-link contributions.

3.4 Protection ratio between television signals

For developing the original 1977 broadcasting-satellite service Plan for Regions 1 and 3, the following protection ratios were used[39, 40]:

– 31 dB for co-channel signals;

– 15 dB for adjacent channel signals.

For revising this Plan at WRC-97, the following aggregate downlink protection ratios were specified in Recommendation ITU-R BO.1297 for the purpose of calculating downlink equivalent protection margins[40, 41, 42]:

– 24 dB for co-channel signals;

– 16 dB for adjacent channel signals.

---

39 These protection ratio values were used for the assignments notified, which are in conformity with this Appendix, brought into use, and for which the date of bringing into use has been confirmed to the Bureau before 27 October 1997.

40 The equivalent protection margin M is given in dB by the formula:

$$M = -10 \log (10^{-M_1/10} + 10^{-M_2/10} + 10^{-M_3/10})$$

where M_1 is the value (dB) of the protection margin for the same channel. This is defined in the following expression where the powers are evaluated at the receiver input:

$$\frac{\text{wanted power}}{\text{sum of the co-channel interfering powers}} \text{ (dB)} - \text{co-channel protection ratio (dB)}$$

M_2 and M_3 are the values (dB) of the upper and lower adjacent-channel protection margins respectively.

The definition of the adjacent-channel protection margin is similar to that for the co-channel case except that the adjacent-channel protection ratio and the sum of the interfering powers due to emissions in the adjacent channel are considered.

41 These protection ratio values were used for the assignments notified, which are in conformity with this Appendix, brought into use, and for which the date of bringing into use has been confirmed to the Bureau between 27 October 1997 and 12 May 2000. (WRC-2000)

42 These protection ratio values were used for protection of digital and analogue assignments from analogue emissions. (WRC-2000)

In revising the Regions 1 and 3 Plan at WRC-97, the following aggregate overall protection ratio values were used for calculating the overall co-channel and adjacent-channel protection margins as defined in § 1.8 and 1.9:

– 23 dB for co-channel signals;

– 15 dB for adjacent channel signals.

It was also specified that for the revision of the Regions 1 and 3 Plan, no overall co-channel single entry *C*/*I* should be lower than 28 dB.

However, for the assignments notified, which are in conformity with this Appendix, brought into use, and for which the date of bringing into use has been confirmed to the Bureau before 27 October 1997, the overall equivalent protection margins were calculated using a co-channel overall protection ratio of 30 dB and lower and upper overall adjacent channel protection ratios of 14 dB[43].

WRC-2000 adopted, for the protection of digital assignments from digital emissions, the following protection ratio values to be applied for calculation of downlink equivalent protection margins of the WRC-2000 Regions 1 and 3 Plan:

– 21 dB for co-channel signals;

– 16 dB for adjacent channel signals.

During planning at WRC-2000, these values were used for all assignments of the Regions 1 and 3 Plan and List except those for which WRC-2000 adopted different values used in the planning process[44].

Revision of the Regions 1 and 3 Plan at WRC-97 and planning at WRC-2000 were generally based on a set of reference parameters such as the average e.i.r.p., the reference earth station receiving antenna, all test points placed within the −3 dB contour, a bandwidth of 27 MHz and the predetermined value of *C*/*N*. The Regions 1 and 3 Plan as established by WRC-2000 is generally based on the use of digital modulation.

Protection masks and associated calculation methods for interference into broadcasting satellite systems involving digital emissions shall be in accordance with Recommendation ITU-R BO.1293-2 (Annexes 1 and 2[45]).

In Region 2, the following protection ratios have been adopted for the purpose of calculating the overall equivalent protection margin[46]:

– 28 dB for co-channel signals;

– 13.6 dB for adjacent-channel signals;

– −9.9 dB for second adjacent-channel signals.

---

[43] The overall protection margin calculation method used is based on the first formula in § 1.12 of Annex 3 to Appendix **30A**.

[44] For analogue assignments, the protection ratios adopted by WRC-97 were used (24 dB co-channel and 16 dB adjacent channel). (WRC-2000)

[45] Annex 3 of this Recommendation may be applied only in compatibility analysis for bilateral coordination between administrations. (WRC-03)

[46] The definitions in § 1.7, 1.8, 1.9, 1.10 and 1.11 of this Annex apply to these calculations. (WRC-03)

In Region 2, as a guide for planning, the reduction in the overall *C*/*I* ratio due to co-channel interference in the feeder link is taken as equivalent to a degradation in the downlink co-channel *C*/*I* ratio of approximately 0.5 dB not exceeded for 99% of the worst month; however, the feeder-link and downlink Plans are evaluated on the basis of the overall equivalent protection margin, which includes the combined downlink and feeder-link contributions.

In Region 2, an overall equivalent protection margin of 0 dB, or greater, indicates that the individual protection ratios have been met for the co-channel, the adjacent channels and the second adjacent channels. (WRC-03)

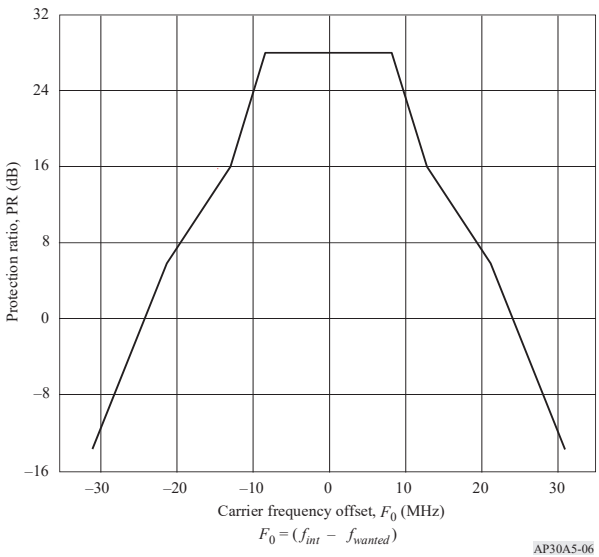
3.4.1 Adjacent channel protection ratio template for Region 2[47] (FMTV into FMTV)

The protection ratios for adjacent channels are derived from the template given in Fig. 6. The template is symmetrical and is given in terms of absolute levels for the *C*/*I* ratios.

The template is obtained by joining the segment for adjacent channels to the horizontal extension of the co-channel protection ratio value. The adjacent channel protection ratio cannot be adjusted relative to the co-channel value.

FIGURE 6

Protection ratio template (FMTV/FMTV), for planning of broadcasting-satellite systems in Region 2



47 See Annex 6 for the protection ratio template for interference between TV/FM signals in Regions 1 and 3.

The template is given by the following expressions:

$$PR = \begin{cases} 28 & \text{dB} \quad \text{for} \quad |F_0| \le 8.36 \text{ MHz} \\ -2.762 \; |F_0| + 51.09 & \text{dB} \quad \text{for} \quad 8.36 < |F_0| \le 12.87 \text{ MHz} \\ -1.154 \; |F_0| + 30.4 & \text{dB} \quad \text{for} \quad 12.87 < |F_0| \le 21.25 \text{ MHz} \\ -2.00 \; |F_0| + 48.38 & \text{dB} \quad \text{for} \quad |F_0| > 21.25 \text{ MHz} \end{cases}$$

where PR is the protection ratio (dB) and $|F_0|$ is the carrier spacing between the interfering and wanted signals (MHz).

3.5 Channel spacing

3.5.1 Channel spacing in the Plans

In Regions 1 and 3, the spacing between the assigned frequencies of two adjacent channels is 19.18 MHz.

In Region 2, the spacing between the assigned frequencies of two adjacent channels is 14.58 MHz, which corresponds to 32 channels in the 500 MHz bandwidth allocated to the broadcasting-satellite service.

The Plans give the assigned frequencies for each channel.

However, in the Regions 1 and 3 Plan, for the implementation of assignments different frequency spacing may be used subject to the successful application of the modification procedure of Article 4, ITU-R Recommendations for protection masks should be used if available. In the absence of such Recommendations, the Bureau should apply the worst-case approach as adopted by the Radio Regulations Board.

3.5.2 Arrangement of channels in the same beam

Planning in Region 1 at the 1977 Conference was carried out by trying to restrict all the channels radiated within a single antenna beam within a frequency range of 400 MHz, in order to simplify receiver construction. Such a restriction was considered unnecessary for the revision of the Regions 1 and 3 Plan at WRC-97.

3.5.3 Spacing between assigned channel frequencies feeding a common antenna

In the 1977 Plan for Regions 1 and 3, owing to technical difficulties in the output circuit of a satellite transmitter, spacing between the assigned frequencies of two channels feeding a common antenna was required to be greater than 40 MHz. This restriction was not imposed in the revision of the Plan.

3.6 Figure of merit (*G*/*T*) of a receiving station in the broadcasting-satellite service

In planning the broadcasting-satellite service, the value of the figure of merit *G*/*T* for clear-sky conditions is:

for Regions 1 and 3:

The original 1977 broadcasting-satellite service Plan used values[48] of:

6 dB(K^{-1}) for individual reception

14 dB(K^{-1}) for community reception, *and*

for Region 2:

10 dB(K^{-1}) for individual reception.

The 1997 revision of the Regions 1 and 3 Plan is based on a uniform value of the figure of merit *G*/*T* equal to 11 dB(K^{-1}).

These values were calculated from a formula which allows for pointing error, polarization effects and equipment ageing.

See also Report ITU-R BO.473-3 (Annex 1).

3.7 Receiving antennas

3.7.1 Half-power beamwidth of receiving antennas

In the development of the original 1977 broadcasting-satellite service Plan for Regions 1 and 3, the minimum receiving antenna diameter was such that the half-power beamwidth was 2° for individual reception and 1° for community reception.

In revising this Plan at WRC-97, the minimum receiving antenna diameter was such that the half-power beamwidth was 2.86°. (WRC-07)

For planning the broadcasting-satellite service in Region 2, the minimum receiving antenna diameter must be such that the half-power beamwidth φ_0 is 1.7°.

3.7.2 Receiving antenna reference patterns

The co-polar and cross-polar receiving antenna reference patterns are given in Figs. 7, 7*bis* and 8.

a) For Regions 1 and 3, the original 1977 Conference Plan was based on the antenna pattern[49] shown in Fig. 7 where the relative antenna gain (dB) is given by the curves for:

– individual reception, for which use should be made of:

  – Curve A for the co-polar component;

  – Curve B for the cross-polar component;

---

[48] These values are still used for assignments notified, which are in conformity with this Appendix, brought into use, and for which the date of bringing into use has been confirmed to the Bureau before 27 October 1997.

[49] This antenna pattern is used in the broadcasting-satellite service Plan for Regions 1 and 3 for assignments notified, which are in conformity with this Appendix, brought into use, and for which the date of bringing into use has been confirmed to the Bureau before 27 October 1997.

– community reception, for which use should be made of:

  – Curve A′ up to the intersection with Curve C, then Curve C, for the co-polar component;

  – Curve B for the cross-polar component.

The WRC-97 revision of the Regions 1 and 3 broadcasting-satellite service Plan was based on the absolute gain (dBi) patterns for a 60 cm antenna given in Recommendation ITU-R BO.1213 as shown in Fig. 7*bis*.

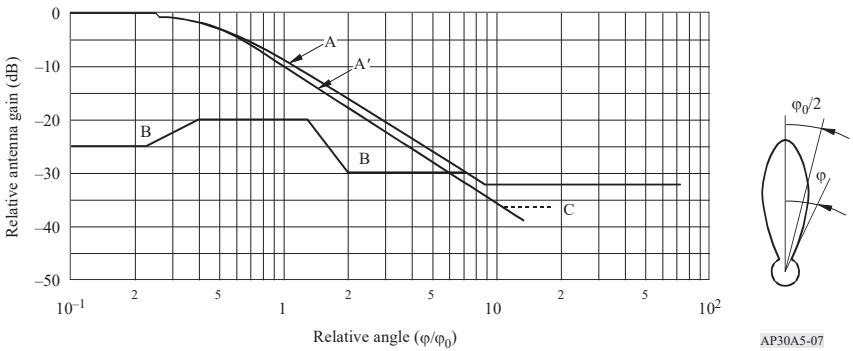
b) For Region 2, the relative antenna gain (dB) is given by the curves in Fig. 8 for individual reception, for which use should be made of:

  – Curve A for the co-polar component;

  – Curve B for the cross-polar component.

FIGURE 7

Co-polar and cross-polar receiving antenna reference patterns in Regions 1 and 3



Curve A: co-polar component for individual reception without side-lobe suppression (dB relative to main beam gain)

0	for	0	$\leq$	$\varphi \leq 0.25\ \varphi_0$
$-12\left(\frac{\varphi}{\varphi_0}\right)^2$	for	$0.25\ \varphi_0$	$<$	$\varphi \leq 0.707\ \varphi_0$
$-\left[9.0 + 20 \log\left(\frac{\varphi}{\varphi_0}\right)\right]$	for	$0.707\ \varphi_0$	$<$	$\varphi \leq 1.26\ \varphi_0$
$-\left[8.5 + 25 \log\left(\frac{\varphi}{\varphi_0}\right)\right]$	for	$1.26\ \varphi_0$	$<$	$\varphi \leq 9.55\ \varphi_0$
-33	for			$\varphi < 9.55\ \varphi_0$

Curve A': co-polar component for community reception without side-lobe suppression (dB relative to main beam gain)

0	for	$0 \leq \varphi \leq 0.25\,\varphi_0$		
$-12\left(\frac{\varphi}{\varphi_0}\right)^2$	for	$0.25\,\varphi_0 < \varphi \leq 0.86\,\varphi_0$		
$-\left[10.5 + 25 \log\left(\frac{\varphi}{\varphi_0}\right)\right]$	for	$\varphi > 0.86\,\varphi_0$	up to intersection with Curve C (then Curve C)	

Curve B: cross-polar component for both types of reception (dB relative to main beam gain)

-25	for	$0 \leq \varphi \leq 0.25\,\varphi_0$
$-\left(30 + 40 \log\left\lvert\frac{\varphi}{\varphi_0} - 1\right\rvert\right)$	for	$0.25\,\varphi_0 < \varphi \leq 0.44\,\varphi_0$
-20	for	$0.44\,\varphi_0 < \varphi \leq 1.4\,\varphi_0$
$-\left(30 + 25 \log\left\lvert\frac{\varphi}{\varphi_0} - 1\right\rvert\right)$	for	$1.4\,\varphi_0 < \varphi \leq 2\,\varphi_0$

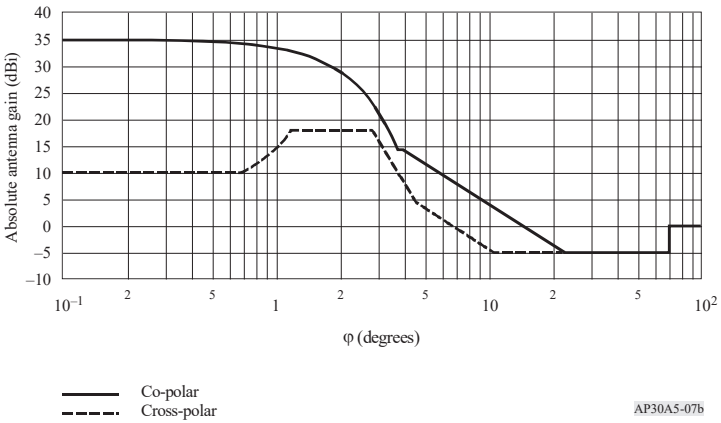
-30 until intersection with co-polar component curve; then co-polar component curve.

Curve C: minus the on-axis gain (Curve C in this figure illustrates the particular case of an antenna with an on-axis gain of 37 dBi).

NOTE – For values of φ_0 see § 3.7.1.

FIGURE 7*bis* (WRC-03)

Reference receiving earth station antenna patterns used at WRC-97 for revising the Regions 1 and 3 broadcasting-satellite service Plan



Co-polar pattern:

$$G_{co}(\varphi) = G_{max} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda} \varphi \right)^2 \qquad \text{for } 0 \le \varphi < \varphi_m$$

where:

$$\varphi_m = \frac{\lambda}{D} \sqrt{\frac{G_{max} - G_1}{0.0025}}$$

$$G_{co}(\varphi) = G_1 = 29 - 25 \log \varphi_r \qquad \text{for } \varphi_m \le \varphi < \varphi_r$$

where:

$$\varphi_r = 95 \frac{\lambda}{D}$$

$$G_{co}(\varphi) = 29 - 25 \log \varphi \qquad \text{for } \varphi_r \le \varphi < \varphi_b$$

where:

$$\varphi_b = 10^{(34/25)}$$

$$G_{co}(\varphi) = -5 \text{ dBi} \qquad \text{for } \varphi_b \le \varphi < 70°$$

$$G_{co}(\varphi) = 0 \text{ dBi} \qquad \text{for } 70° \le \varphi < 180°$$

Cross-polar pattern:

$$G_{cross}(\varphi) = G_{max} - 25 \qquad \text{for } 0 \le \varphi < 0.25\, \varphi_0$$

where:

$$\varphi_0 = 2 \frac{\lambda}{D} \sqrt{\frac{3}{0.0025}} = 3 \text{ dB beamwidth}$$

$$G_{cross}(\varphi) = G_{max} - 25 + 8 \left(\frac{\varphi - 0.25\, \varphi_0}{0.19\, \varphi_0} \right) \qquad \text{for } 0.25\, \varphi_0 \le \varphi < 0.44\, \varphi_0$$

$$G_{cross}(\varphi) = G_{max} - 17 \qquad \text{for } 0.44\, \varphi_0 \le \varphi < \varphi_0$$

$$G_{cross}(\varphi) = G_{max} - 17 + C \left| \frac{\varphi - \varphi_0}{\varphi_1 - \varphi_0} \right| \qquad \text{for } \varphi_0 \le \varphi < \varphi_1 \qquad \text{(WRC-07)}$$

where:

λ: wavelength corresponding to 12.1 GHz (m)

$C = 21 - 25 \log \varphi_1 - (G_{max} - 17)$

$$\varphi_1 = \frac{\varphi_0}{2} \sqrt{10.1875}$$

$$G_{cross}(\varphi) = 21 - 25 \log \varphi \qquad \text{for } \varphi_1 \le \varphi < \varphi_2$$

where:

$$\varphi_2 = 10^{(26/25)}$$

$$G_{cross}(\varphi) = -5 \text{ dBi} \qquad \text{for } \varphi_2 \le \varphi < 70°$$

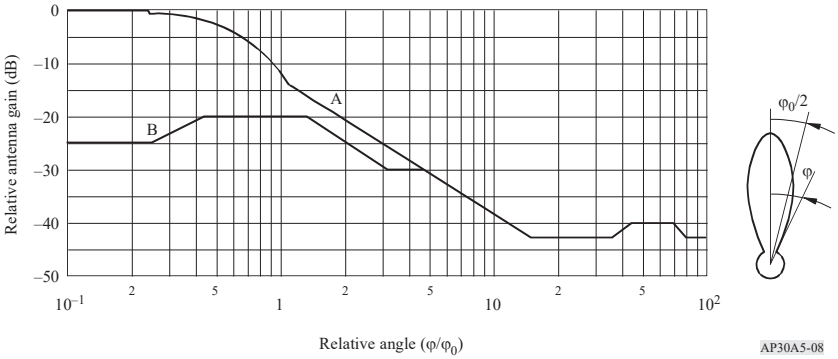
$$G_{cross}(\varphi) = 0 \text{ dBi} \qquad \text{for } 70° \le \varphi < 180°$$

The reference frequency used in calculations for this antenna pattern = 12.1 GHz.

For the 0.60 m antenna pattern, which was used as a reference receiving antenna in replanning the absolute gain of 35.5 dBi was applied. (WRC-03)

FIGURE 8

Reference patterns for co-polar and cross-polar components for receiving earth station antennas in Region 2



Curve A: co-polar component without side-lobe suppression (dB relative to main beam gain)

0	for	$0 \leq \varphi \leq 0.25\ \varphi_0$
$-12\ (\varphi/\varphi_0)^2$	for	$0.25\ \varphi_0 < \varphi \leq 1.13\ \varphi_0$
$-\{14 + 25 \log (\varphi/\varphi_0)\}$	for	$1.13\ \varphi_0 < \varphi \leq 14.7\ \varphi_0$
−43.2	for	$14.7\ \varphi_0 < \varphi \leq 35\ \varphi_0$
$-\{85.2 - 27.2 \log (\varphi/\varphi_0)\}$	for	$35\ \varphi_0 < \varphi \leq 45.1\ \varphi_0$
−40.2	for	$45.1\ \varphi_0 < \varphi \leq 70\ \varphi_0$
$-\{-55.2 + 51.7 \log (\varphi/\varphi_0)\}$	for	$70\ \varphi_0 < \varphi \leq 80\ \varphi_0$
−43.2	for	$80\ \varphi_0 < \varphi \leq 180°$

Curve B: cross-polar component (dB relative to main beam gain)

−25	for	$0 \leq \varphi \leq 0.25\ \varphi_0$
$-\left(30 + 40 \log \left\lvert \frac{\varphi}{\varphi_0} - 1 \right\rvert\right)$	for	$0.25\ \varphi_0 < \varphi \leq 0.44\ \varphi_0$
−20	for	$0.44\ \varphi_0 < \varphi \leq 1.28\ \varphi_0$
$-\left(17.3 + 25 \log \left\lvert \frac{\varphi}{\varphi_0} \right\rvert\right)$	for	$1.28\ \varphi_0 < \varphi \leq 3.22\ \varphi_0$
−30	until intersection with co-polar component curve; then co-polar component curve.	

NOTE 1 – For values of φ_0 see § 3.7.1.

NOTE 2 – In the angular range between 0.1 φ_0 and 1.13 φ_0 the co-polar and cross-polar gains must not exceed the reference patterns.

NOTE 3 – At off-axis angles larger than 1.13 φ_0 and for 90% of all sidelobe peaks in each of the reference angular windows, the gain must not exceed the reference patterns. The reference angular windows are 1.13 φ_0 to 3 φ_0, 3 φ_0 to 6 φ_0, 6 φ_0 to 10 φ_0, 10 φ_0 to 20 φ_0, 20 φ_0 to 40 φ_0, 40 φ_0 to 75 φ_0 and 75 φ_0 to 180°.

3.8 Necessary bandwidth

WARC-77 Regions 1 and 3 Plan and the WRC-97 revision of the Regions 1 and 3 Plan used the following:

– 625-line systems in Regions 1 and 3: 27 MHz;

– 525-line systems in Region 3: 27 MHz. (WRC-2000)

The planning at WRC-2000 was generally based on a necessary bandwidth of 27 MHz. (WRC-2000)

In Region 2, the Plan is based on a channel bandwidth of 24 MHz[50], but different bandwidths may be implemented in accordance with the provisions of this Appendix, provided that applicable ITU-R Recommendations are available. In the absence of such Recommendations, the Bureau will use the worst-case approach. (WRC-2000)

If different bandwidths and/or channel spacing are submitted, they will be treated in accordance with applicable ITU-R Recommendations for protection masks when available. In the absence of such Recommendations, the Bureau will use the worst-case approach. (WRC-2000)

3.9 Guardbands

3.9.1 A guardband is defined as the portion of the frequency spectrum between the edge of the allocated band and the edge of the necessary bandwidth of the emission in the nearest channel.

3.9.2 For the planning of the broadcasting-satellite service, the guardbands chosen at the 1977 Conference to protect the services in adjacent frequency bands are shown in the Table below.

Regions	Guardband at the lower edge of the band (MHz)	Guardband at the upper edge of the band (MHz)
1	14	11
2	12	12
3	14	11

For Regions 1 and 3 at WARC-77, the guardbands were derived on the assumption of analogue emissions and a maximum beam centre e.i.r.p. of 67 dBW (value relating to individual reception), and a filter roll-off of 2 dB/MHz. If smaller e.i.r.p. values are assumed, the guardbands can be reduced in width by 0.5 MHz for each decibel decrease in e.i.r.p. The degree of possible reduction also depends on improvements in technology and on the type of modulation. (WRC-2000)

3.9.3 (SUP - WRC-97)

[50] For France, Denmark and some of the United Kingdom requirements which use 625-line standards with greater video bandwidth, the channels shown in the Plan have a necessary bandwidth of 27 MHz. This is indicated by an appropriate symbol in the Plan.

3.9.4 The guardbands at both the lower and upper edges may be used to provide space operation functions in accordance with No. **1.23** in support of the operation of geostationary-satellite networks in the broadcasting-satellite service. (WRC-03)

3.10 Orbital spacing

The Plan for Regions 1 and 3 has been based generally on nominal orbital positions spaced uniformly at intervals of 6°. The Plan for Region 2 has been based on a non-uniform spacing.

3.11 Satellite station-keeping

Space stations in the broadcasting-satellite service must be maintained in position with an accuracy equal to or better than ±0.1° in the E-W directions. For such space stations, the maintenance of the tolerance ±0.1° in the N-S direction is recommended but is not a requirement.

3.12 Elevation angle of receiving antennas

The Plans have been based on the desirability of a minimum angle of elevation of 20° to minimize the required e.i.r.p. of the satellite and to reduce the effects of shadowing and the possibility of interference from terrestrial services. However, for areas situated in latitudes above about 60°, the angle of elevation is of necessity less than 20°. Attention is also drawn to § 2.1 for the Regions 1 and 3 Plan and to § 2.2.3 for the Region 2 Plan.

For mountainous areas where an elevation angle of 20° may not suffice, an angle of at least 30° has been provided, where possible, to provide an acceptable service. An angle of elevation of at least 40° has been considered for service areas subject to high precipitation, but exceptions were made in some cases in Region 2.

Some dry, non-mountainous areas may be given an acceptable service at angles of elevation less than 20°.

In areas with small elevation angles, the shadowing effect of tall buildings may have to be taken into account.

In choosing a satellite position designed to give the maximum angle of elevation at the ground, the influence of such a position on the eclipse period was taken into account at the 1977 Conference. In the revision of the Regions 1 and 3 Plan at WRC-97, this influence was not considered to be a significant constraint on the choice of orbital position.

3.13 Transmitting antennas

3.13.1 Cross-section of transmitted beam

Planning in Regions 1, 2 and 3 has been generally based on the use of satellite transmitting antennas with beams of elliptical cross-section.

If the cross-section of the emitted beam is elliptical, the effective beamwidth φ_0 is a function of the angle of rotation between the plane containing the satellite and the major axis of the beam cross-section and the plane in which the beamwidth is required.

The relationship between the maximum gain of an antenna and the half-power beamwidth can be derived from the expression:

$$G_m = \frac{27\ 843}{ab}$$

where:

a and *b* are the angles (degrees) subtended at the satellite by the major and minor axes of the elliptical cross-section of the beam; an antenna efficiency of 55% was assumed.

However, in implementing their assignments, administrations can choose beams other than elliptical, as described in Annex 2 to this Appendix, subject to successful application of the modification procedure of this Appendix.

3.13.2 Minimum beamwidth of transmitting antenna

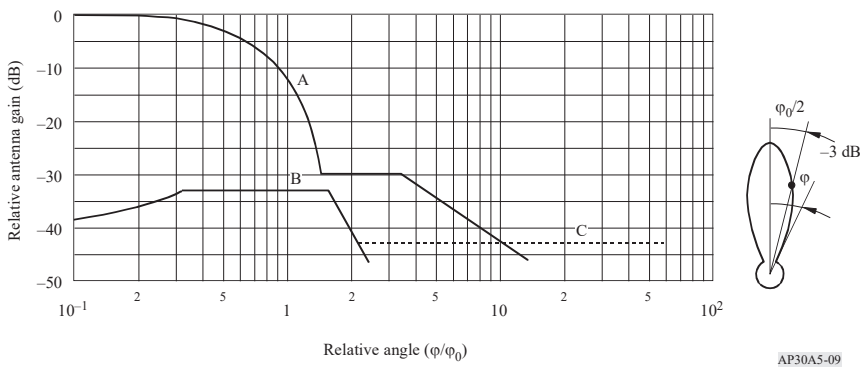
A minimum value of 0.6° for the half-power beamwidth of a transmitting antenna has been adopted for planning for Regions 1 and 3, and 0.8° for Region 2.

3.13.3 Transmitting antenna reference patterns

The reference patterns for the co-polar and cross-polar components of satellite transmitting antennas used in preparing the Plans are given in Fig. 9 for Regions 1 and 3, and in Fig. 10 for Region 2.

FIGURE 9

Reference patterns for co-polar and cross-polar components for satellite transmitting antennas in Regions 1 and 3



Curve A: co-polar component (dB relative to main beam gain)

$-12\left(\frac{\varphi}{\varphi_0}\right)^2$	for	$0 \leq \varphi \leq 1.58\ \varphi_0$
-30	for	$1.58\ \varphi_0 < \varphi \leq 3.16\ \varphi_0$
$-\left[17.5 = 25 \log\left(\frac{\varphi}{\varphi_0}\right)\right]$	for	$\varphi > 3.16\ \varphi_0$

after intersection with Curve C: as Curve C

Curve B: cross-polar component (dB relative to main beam gain)

$$-\left(40 + 40 \log \left|\frac{\varphi}{\varphi_0} - 1\right|\right) \qquad \text{for } 0 \leq \varphi \leq 0.33\ \varphi_0$$

$$-33 \qquad \text{for } 0.33\ \varphi_0 < \varphi \leq 1.67\ \varphi_0$$

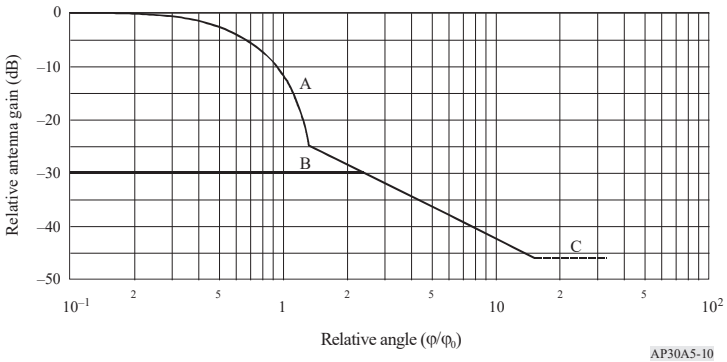
$$-\left(40 + 40 \log \left|\frac{\varphi}{\varphi_0} - 1\right|\right) \qquad \text{for } \varphi > 1.67\ \varphi_0$$

after intersection with Curve C: as Curve C

Curve C: minus the on-axis gain (Curve C in this figure illustrates the particular case of an antenna with an on-axis gain of 43 dBi).

FIGURE 10

Reference patterns for co-polar and cross-polar components for satellite transmitting antennas in Region 2



Curve A: co-polar component (dB relative to main beam gain)

$$-12\left(\frac{\varphi}{\varphi_0}\right)^2 \qquad \text{for } 0 \leq (\varphi/\varphi_0) \leq 1.45$$

$$-\left(22 + 20 \log \left(\frac{\varphi}{\varphi_0}\right)\right) \qquad \text{for } (\varphi/\varphi_0) > 1.45$$

after intersection with Curve C: Curve C

Curve B: cross-polar component (dB relative to main beam gain)

$$-30 \qquad \text{for } 0 \leq (\varphi/\varphi_0) \leq 2.51$$

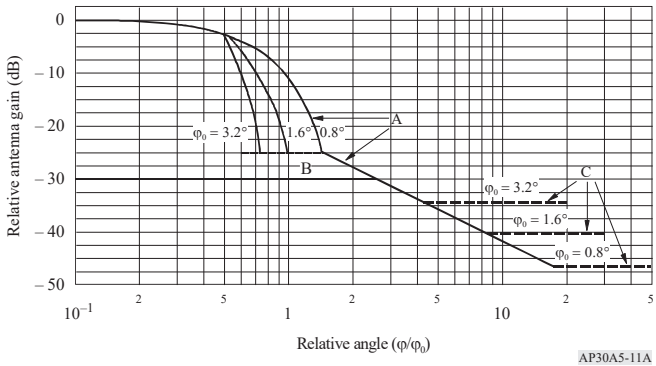
after intersection with co-polar pattern: co-polar pattern

Curve C: minus the on-axis gain (Curve C in this figure illustrates the particular case of an antenna with an on-axis gain of 46 dBi).

In Region 2, when it was necessary to reduce interference, the pattern shown in Fig. 11A was used; this use is indicated in the Plan by an appropriate symbol. This pattern is derived from an antenna producing an elliptical beam with fast roll-off in the main lobe assuming a "beamlet" half-power beamwidth of 0.8°. For Regions 1 and 3, the pattern shown in Fig. 11B, based on a "beamlet" beamwidth of 0.6° was used. Curves for three different values of φ_0 are shown as examples in Fig. 11A and in Fig. 11B.

FIGURE 11A

Reference patterns for co-polar and cross-polar components for satellite transmitting antennas with roll-off in the main beam for Region 2



Curve A: co-polar component (dB relative to main beam gain)

$$-12\left(\frac{\varphi}{\varphi_0}\right)^2 \qquad \text{for } 0 \le (\varphi/\varphi_0) \le 0.5$$

$$-12\left(\frac{\frac{\varphi}{\varphi_0} - x}{\frac{B_{min}}{\varphi_0}}\right)^2 \qquad \text{for } 0.5 < (\varphi/\varphi_0) \le \left(\frac{1.45}{\varphi_0} B_{min} + x\right)$$

$$-25.23 \qquad \text{for } \left(\frac{1.45}{\varphi_0} B_{min} + x\right) < (\varphi/\varphi_0) \le 1.45$$

$$-\left(22 + 20 \log\left(\frac{\varphi}{\varphi_0}\right)\right) \qquad \text{for } (\varphi/\varphi_0) > 1.45$$

after intersection with Curve C: Curve C

Curve B: cross-polar component (dB relative to main beam gain)

$$-30 \qquad \text{for } 0 \le (\varphi/\varphi_0) < 2.51$$

after intersection with co-polar pattern: co-polar pattern

Curve C: minus the on-axis gain (Curves A and C represent examples of three antennas having different values of φ_0 as labelled in Fig. 11A. The on-axis gains of these antennas are approximately 34, 40 and 46 dBi, respectively).

where:

φ : off-axis angle (degrees)

φ_0 : dimension of the minimum ellipse fitted around the downlink service area in the direction of interest (degrees)

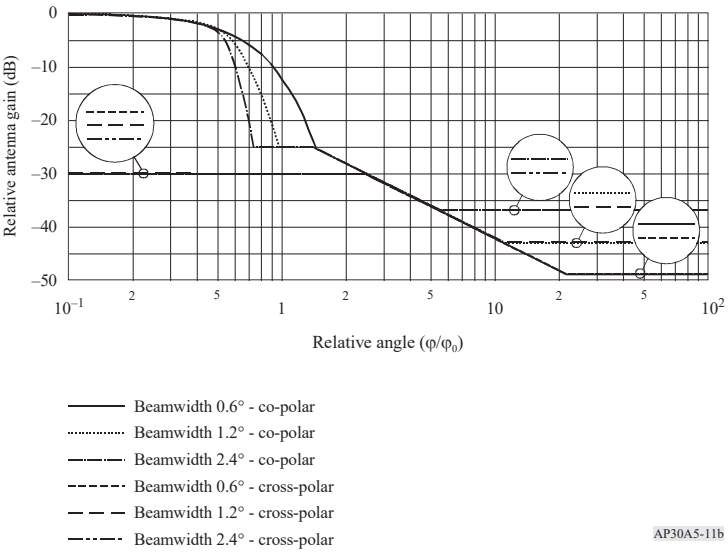
B_{min} = 0.8° for Region 2 and B_{min} = 0.6° for Regions 1 and 3

$$x = 0.5\left(1 - \frac{0.8}{\varphi_0}\right) \quad \text{in Region 2}$$

$$x = 0.5\left(1 - \frac{0.6}{\varphi_0}\right) \quad \text{in Regions 1 and 3}$$

FIGURE 11B

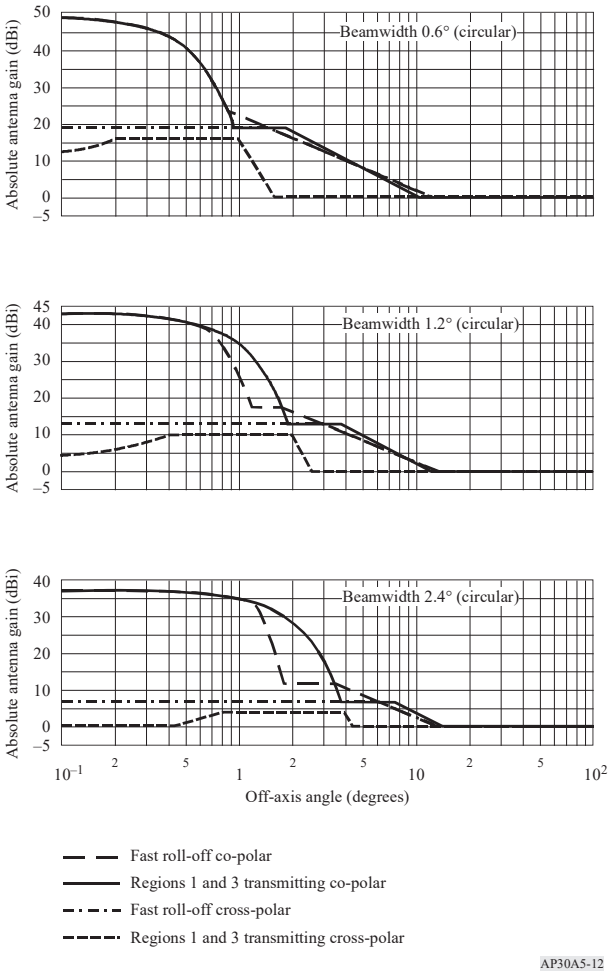
Fast roll-off antenna for Regions 1 and 3 Plan revision (beamlet beamwidth of 0.6°)



The difference in performance between the fast roll-off satellite transmitting antenna and the reference satellite transmitting antenna for Regions 1 and 3 is shown in Fig. 12.

FIGURE 12

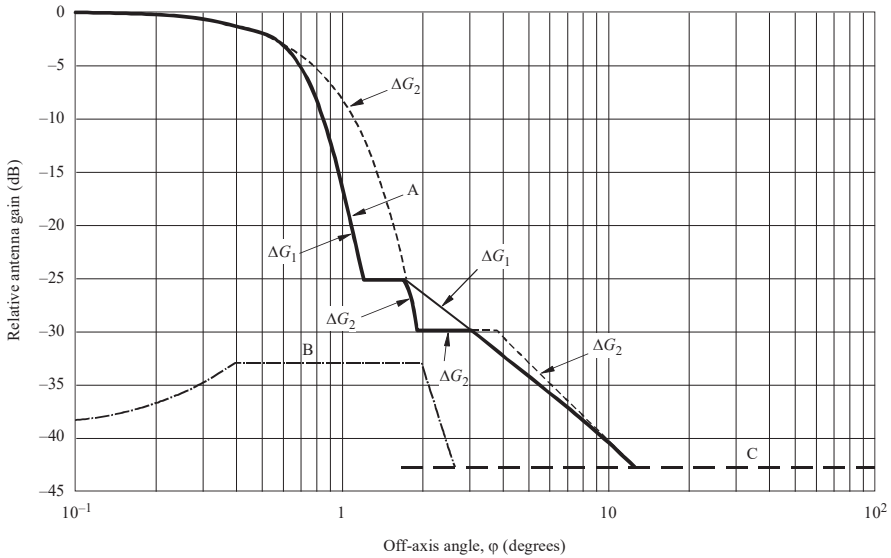
Comparison between fast roll-off and Regions 1 and 3 reference satellite transmitting antennas



The improved fast roll-off satellite transmitting antenna pattern described in Recommendation ITU-R BO.1445 (see Fig. 13) has been used in the planning at WRC-2000. (WRC-2000)

FIGURE 13 (Rev.WRC-03)

Improved fast roll-off satellite transmitting antenna pattern for Regions 1 and 3



Regions 1 and 3 transmitting fast roll-off co-polar (Curve ΔG_1)

Improved fast roll-off co-polar (Curve A defined as ΔG below)

Regions 1 and 3 transmitting co-polar (Curve ΔG_2)

Improved fast roll-off cross-polar (Regions 1 and 3 transmitting cross-polar) (Curve B)

Curve C (minus the on-axis gain)

Note 1 – The diagram gives the example curves in the case of a satellite antenna beamwidth of $\varphi_0 = 1.2°$ (circular).

AP30A5-13

Curve A: co-polar relative gain (dB relative to main beam gain):

$$\Delta G = \min(\Delta G_1, \Delta G_2)$$

where:

$$\Delta G_1 = -12(\varphi/\varphi_0)^2 \qquad \text{for } 0 \le (\varphi/\varphi_0) \le 0.5$$

$$\Delta G_1 = -12\left(\frac{\frac{\varphi}{\varphi_0} - x}{\frac{B_{min}}{\varphi_0}}\right)^2 \qquad \text{for } 0.5 < (\varphi/\varphi_0) \le \left(\frac{1.45}{\varphi_0} B_{min} + x\right) \qquad \text{(WRC-2000)}$$

$$\Delta G_1 = -25.23 \qquad \text{for } \left(\frac{1.45}{\varphi_0} B_{min} + x\right) < (\varphi/\varphi_0) \le 1.45 \qquad \text{(WRC-03)}$$

$\Delta G_1 = -\left(22 + 20 \log\left(\varphi/\varphi_0\right)\right)$ for $(\varphi/\varphi_0) > 1.45$

$\Delta G_1 = -\left(G_{on\text{-}axis}\right)$ after intersection with Curve C

$\Delta G_2 = -12\left(\varphi/\varphi_0\right)^2$ for $0 \leq \varphi \leq 1.58\ \varphi_0$

$\Delta G_2 = -30$ for $1.58\ \varphi_0 < \varphi \leq 3.16\ \varphi_0$

$\Delta G_2 = -\left(17.5 + 25 \log\left(\varphi/\varphi_0\right)\right)$ for $\varphi > 3.16\ \varphi_0$

$\Delta G_2 = -\left(G_{on\text{-}axis}\right)$ after intersection with Curve C

Curve B: cross-polar relative gain (dB):

$-\left(40 + 40 \log\left|\frac{\varphi}{\varphi_0} - 1\right|\right)$ for $0 \leq \varphi \leq 0.33\ \varphi_0$

-33 for $0.33\ \varphi_0 < \varphi \leq 1.67\ \varphi_0$

$-\left(40 + 40 \log\left|\frac{\varphi}{\varphi_0} - 1\right|\right)$ for $\varphi > 1.67\ \varphi_0$

$-\left(G_{on\text{-}axis}\right)$ after intersection with Curve C

Curve C: minus the on-axis gain (Curve C in this Figure illustrates the particular case of an antenna with an on-axis gain of 42.8 dBi)

where:

φ: off-axis angle (degrees)

φ_0: cross-sectional half-power beamwidth in the direction of interest (degrees)

B_{min}: 0.6° for Regions 1 and 3

$$x = 0.5\left(1 - \frac{B_{min}}{\varphi_0}\right) \qquad \text{(WRC-2000)}$$

3.13.4 Composite beam

A composite beam represents a single beam (i.e. "simulated shaped beam") and is formed by combining two or more elliptical beams at a given orbital position. In general, composite beams were used at WRC-2000 for administrations which had more than one beam at a given orbital position in the WRC-97 Regions 1 and 3 Plan. (WRC-2000)

3.14 Satellite antenna pointing accuracy

3.14.1 The deviation of the antenna beam from its nominal pointing direction must not exceed a limit of 0.1° in any direction. Moreover, the angular rotation of a transmitting beam about its axis must not exceed a limit of ±1°; the limit on rotation is not necessary for beams of circular cross-section using circular polarization[51].

[51] In the original 1977 broadcasting-satellite service Plan for Regions 1 and 3, the angular rotation of a transmitting beam about its axis must not exceed a limit of ±2°. This limit is still applied for assignments notified, which are in conformity with this Appendix, brought into use, and for which the date of bringing into use has been confirmed to the Bureau before 27 October 1997.

3.14.2 The following factors contribute to the total variation in the area on the surface of the Earth illuminated by the satellite beam:

– variations in satellite station-keeping;

– the variations caused by the pointing tolerances, which become more significant for coverage areas with low angles of elevation;

– the effect of the yaw error, which increases as the beam ellipse lengthens.

3.14.3 The effect of these possible variations should be assessed on a case-by-case basis, since their total effect on the area covered will vary with the geometry of the satellite beam, and it would not be reasonable to indicate a single value of shift in the area covered for all situations.

3.14.4 If linear polarization is used for an emission, yaw error makes a significant contribution to increasing the transmitted cross-polarized component; this increases the interference with other carriers which were originally cross-polarized with the emission in question.

3.15 Limitation of output power in the satellite transmitter

The output power of a space station transmitter in the broadcasting-satellite service must not rise by more than 0.25 dB relative to its nominal value throughout the life of the satellite.

3.16 Power flux-density at edge of coverage area

The original 1977 broadcasting-satellite service Plan used the following values[52] of the power flux-density at the edge of the coverage area exceeded for 99% of the worst month:

−103 dB(W/m^2) for individual reception in Regions 1 and 3;

−107 dB(W/m^2) for individual reception in Region 2 for 24 MHz, as well as for 27 MHz with respect to the cases mentioned in the footnote to § 3.8.

−111 dB(W/m^2) for community reception in Regions 1 and 3.

The 1997 revision of the Regions 1 and 3 Plan was generally based on a uniform value of the power flux-density at the edge of coverage area equal to −108 dB(W/m^2). This corresponds to the general reduction in e.i.r.p. of 5 dB referenced to the average e.i.r.p. of 63.9 dBW in the 1977 broadcasting-satellite service Plan.

3.17 Difference between the e.i.r.p. directed towards the edge of the coverage area and that on the axis of the beam

For planning, the absolute value of the difference between the e.i.r.p. directed towards the edge of the coverage area and that on the axis of the beam should preferably be 3 dB.

If the beam area is larger than the coverage area, the value will be less than 3 dB.

---

[52] These values are still used for assignments notified, which are in conformity with this Appendix, brought into use, and for which the date of bringing into use has been confirmed to the Bureau before 27 October 1997.

3.18 Use of energy dispersal

For planning, an energy dispersal value has been adopted which reduces by 22 dB the spectral power flux-density measured in a 4 kHz bandwidth in relation to that measured in the entire bandwidth: For frequency-modulated television signals, this reduction corresponds to a peak-to-peak deviation of 600 kHz. Digital modulation can achieve appropriate energy dispersal by proper implementation of digital modulation (e.g. by applying spectrum scrambling and/or interleaving).

3.19 Orbital separation limit for interference calculation

WRC-2000 has adopted the use of an orbital separation limit for interference calculation in Regions 1 and 3. Beyond this limit no interference was taken into account.

Initially, the values used for the orbital separation limit were 15° for co-polar and 9° for cross-polar emissions. At a later stage, the unique value of the orbital separation limit of 9° was adopted by WRC-2000. (WRC-2000)

ANNEX 6[53] (WRC-03)

Criteria for sharing between services

Part A – Technical bases for the criteria for interregional sharing between space services in Annexes 1 and 4

The revised interregional sharing criteria in the bands governed by Appendix **30** are based nominally on the following assumptions.

1 Reference assumptions regarding earth station antenna patterns

1.1 For earth station antennas with diameters between 0.45 m and 2.40 m, the gain of the side lobes given by Recommendation ITU-R BO.1213 were used.

For the patterns of earth station antennas with diameters greater than 2.40 m, the gain of the side lobes given by Recommendation ITU-R S.580-5, with a $(29 - 25 \log \theta)$ side-lobe envelope, complemented by the main-lobe given in Annex 3 to Appendix **8**, were used. θ is the off-axis angle in degrees.

1.2 For the broadcasting-satellite service and fixed-satellite service earth stations, an antenna efficiency of 65% was used at a frequency of 11.7 GHz.

[53] Sections 1 and 2 are applicable when the services of Regions 1 or 3 are involved. Section 3 is applicable to all Regions.

2 Antenna diameters and noise temperatures

The range of antenna diameters and associated noise temperatures considered for the protection of the fixed-satellite service and the broadcasting-satellite service on an interregional basis are given in the following table:

Receive earth station antenna diameter (m)	0.45 [1]	0.60	0.80	1.20	2.40	5 [2]	8 [2]	11 [2]
Receive earth station noise temperature (K)	110	110	125	150	150	200	250	250
Total link noise temperature (K)	174	174	198	238	238	317	396	396

[1] This antenna diameter applies in certain cases (see Annexes 1, 3 and 4).

[2] This antenna diameter does not apply for broadcasting-satellite service.

The total link noise temperature was calculated from the receive earth station noise temperature (which includes the antenna temperature, the receive amplifier temperature and the noise increase resulting from feeder losses), and adding 2 dB to take account of all other sources of noise (uplink noise, geostationary-satellite orbit interference, cross polarization isolation and frequency reuse interference).

3 Protection criteria

The power flux-density masks developed in sections 1, 3 and 6 of Annex 1 and in Annex 4 have been determined by setting at 6% the allowable relative noise increase ($\Delta T/T$), for the earth station antenna characteristics given in the above Table.

The allowable interfering power flux-density was calculated by the following expression:

$$PFD_{all}(\theta) = 10 \log(\Delta T / T) + 10 \log(k\ T\ b_{rf}) + G_m - G_a(\varphi)$$

where:

$PFD_{all}(\theta)$: allowable level of interfering power flux-density for an orbital separation of θ°

$\Delta T/T$: allowable relative increase in receive link noise = 6%

k: Boltzmann's constant (1.38×10^{-23} J/K)

T: receive link noise temperature (K) (see Table in section 2 above)

b_{rf}: reference bandwidth (27 MHz in Regions 1 and 3; 24 MHz in Region 2)

G_m: gain for a 1 m^2 effective aperture (dBi/m^2)

$G_a(\varphi)$: receive antenna gain for topocentric angle of φ (dBi)

φ: topocentric angle (degrees) between the interfering and the wanted satellite, as defined in Annex 1 of Appendix **8**.

4 Power flux-density levels for fixed-satellite service and broadcasting-satellite service with specific antenna diameters

The table below contains power flux-density levels derived for fixed-satellite service and broadcasting-satellite service earth stations with specific antenna diameters for the characteristics defined in sections 1, 2 and 3 above. These levels were used to develop the power flux-density masks in sections 1, 3 and 6 of Annex 1 and in Annex 4 by taking the envelope of the individual pfd masks for the relevant antenna diameters.

Orbital separation between wanted and interfering space stations (degrees)	**Power flux-density level in dB(W/(m^2 · 27 MHz)) corresponding to different antenna diameters**							
	0.45 m [1]	**0.60 m**	**0.80 m**	**1.20 m**	**2.40 cm**	**5 m** [2]	**8 m** [2]	**11 m** [2]
0°	−134.2	−136.7	−138.7	−141.4	−147.4	−152.5	−155.7	−158.4
θ > 0°	For any value of the orbital separation θ between the wanted and interfering space stations, the applicable power flux-density should be relaxed from the value corresponding to 0° orbital separation by adding the off-axis antenna discrimination, as calculated under the assumptions in section 1 above							

[1] This antenna diameter applies to certain cases (see Annexes 1, 3 and 4).

[2] This antenna diameter does not apply for broadcasting satellite service.

Part B – Sharing criteria used in establishing the WARC SAT-77 Plan

1 Protection requirements for sharing between services in the 12 GHz band

1.1 The establishment of sharing criteria for the different services using the 12 GHz band should be based on the protection requirements listed in the table below.

1.2 The values given as “total acceptable” are those necessary to protect the wanted signal. The “single entry” values are those which should be used as a guide for determining sharing criteria. The total interference from all sources must be calculated, since satisfying the “single entry” criteria for each source may not guarantee that the total interference meets the above protection requirements. A “single entry” is defined as the aggregate of emissions from any one station entering any receiver in the wanted service within the channel to be protected.

1.3 The carrier-to-interference ratio (C/I) refers to the ratio of the wanted-to-interfering power at the affected ground station. The value given shall be exceeded for 80% of the worst month for the fixed-satellite service, and for 99% of the worst month for the broadcasting service and the broadcasting-satellite service.

1.4 The term N refers to the post-demodulation noise power at a point of 0 dBm0 relative test tone level in any voice channel of an FDM/FM telephony system. The value given shall not be exceeded for 80% of the worst month.

1.5 The specified values of protection ratio (i.e., the carrier-to-interference power ratio corresponding to a specified picture quality) are applicable, for planning purposes, to television signals of any of the several television standards.

Wanted service[1]	Wanted signal[1]	Interfering service[1]	Interfering signal[1]	Protection requirements[2]	
				Total acceptable[3]	Single entry
BSS	TV/FM	BSS, FSS, FS, BS	TV/FM	C/I = 30 dB [4, 7]	C/I = 35 dB [4]
FSS	FDM/FM	BSS	TV/FM	N = 500 pW0p [8]	N = 300 pW0p
FSS	TV/FM	BSS, FSS	TV/FM	C/I = 32 dB [5]	C/I = 37 dB [5]
FSS	4φ-PSK	BSS, FSS	TV/FM	C/I = 30 dB	C/I = 35 dB
FSS	FDM/FM	FSS	FDM/FM	N = 1 000 pW0p	N = 400 pW0p
FS	FDM/FM	BSS	TV/FM	N = 1 000 pW0p	−125 dB(W/(m^2 · 4 kHz)) [6]
BS	TV/VSB	BSS	TV/FM	C/I = 50 dB	Not applicable

1 BSS: broadcasting-satellite service FM: frequency modulation
FSS: fixed-satellite service FDM: frequency division multiplex
BS: broadcasting service 4φ-PSK: quadraphase shift keying
FS: fixed service VSB: vestigial sideband.
TV: television

2 These limits include both up-link and down-link contributions.

3 Values (dB) are protection ratios for the sum of interfering signals. Values (pW0p) represent interference noise in the worst telephone channels caused by the sum of interfering signals.

4 For BSS satellites located at the interfaces of the Regions 1 and 3 Plan and the Region 2 Plan, the C/I ratios should be 1 dB higher.

5 See Recommendation ITU-R S.483-3.

6 This value may be suitably modified for tropical regions to take account of rain attenuation. Allowance may also be made for polarization discrimination.

7 C/I: ratio of carrier-to-interfering signal.

8 N: noise power.

1.6 For broadcasting-satellite service systems with FM/TV as the wanted signal, the protection ratios are given for particular reference conditions, the most important of which are:

a) frequency deviation of the wanted signal (12 MHz peak-to-peak);

b) quality of the wanted service (grade 4.5)[54];

c) co-channel carriers (no carrier-frequency offset).

1.7 If system design is based on conditions other than those of § *a)* and *b)* above, the FM/TV protection ratio is given by:

$$R = 12.5 - 20 \log\left(D_v/12\right) - Q + 1.1\, Q^2 \qquad \text{dB}$$

54 Impairment grade on a 5-point scale as defined in Recommendation ITU-R BT.500-7.

where:

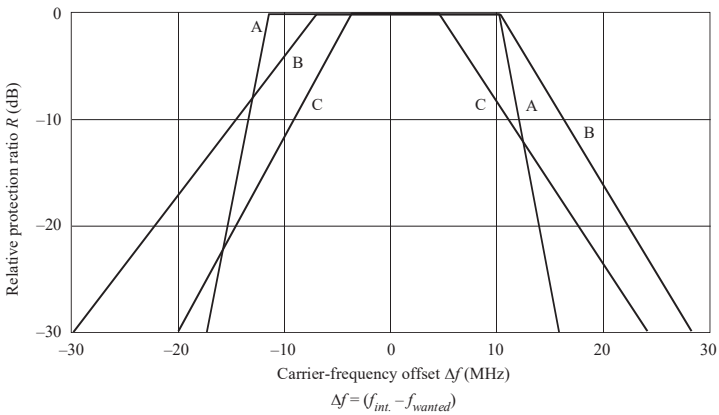
D_V: nominal peak-to-peak frequency deviation (MHz);

Q: the impairment grade, concerning the interference only.

1.8 When carriers are offset in frequency, condition of § *c)* does not apply and the adjacent channel protection ratios should be adjusted according to the frequency offset as shown in Fig. 1. For example, at a frequency offset of 20 MHz, the total acceptable ratio of protection against interference to an FM/TV signal from another FM/TV signal is 13 dB. The corresponding "single entry" value is 18 dB.

FIGURE 1

Reference case protection ratios relative to co-channel values



Curves A : TV/VSB-wanted, TV/FM interfering
B : TV/FM-wanted, TV/FM interfering
C : TV/FM-wanted, TV/VSB interfering

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2 Reference antenna diameter for a fixed-satellite earth station to be used in calculating interference from space stations in the broadcasting-satellite service

2.1 For antennas larger than 100 λ (2.5 m) in the fixed-satellite service, the gain of the side-lobes is given by the expression $32 - 25 \log \theta$, where θ is the angle from the boresight (Recommendation ITU-R S.465-5). The side-lobe gain is independent of antenna diameter.

2.2 However, in the case of transmitting earth stations, the level of interference radiated into the up-link of other satellite systems would be inversely proportional to the square of the antenna diameter. In this case, the interference decreases with increasing antenna diameter. Since the 11.7-12.2 GHz band is only assigned in the space-to-Earth direction in the fixed-satellite service, this point is not of direct concern to the broadcasting-satellite service.

2.3 Hence it does not appear appropriate, for antenna diameters greater than 100 λ, to specify a minimum antenna diameter for receiving earth stations in the fixed-satellite service sharing the band 11.7-12.2 GHz. It may be useful to consider a 4.5 m antenna having an efficiency of 60% and an on-axis gain of 53 dB as typical for the purpose of planning the sharing of this band.

3 Use of energy dispersal in the broadcasting-satellite service

3.1 Artificial energy dispersal is useful in promoting sharing between the broadcasting-satellite service and the other services to which the band is also allocated.

3.2 Such energy dispersal is achieved by the addition at baseband of a triangular waveform to the video signal to form a composite baseband which, in turn, is used to frequency-modulate the up-link carrier. The frequency of the triangular waveform is usually synchronized at a sub-multiple of the television frame frequency. Typical frequencies range from 12.5 Hz to 30 Hz.

3.3 The Table below gives the relative reduction in spectral power flux-density in a 4 kHz bandwidth as a function of the peak-to-peak deviation due to the energy dispersal signal. This Table is based on the following equation:

$$\text{Relative reduction (dB) in a 4 kHz band} = 10 \log \frac{\Delta F_{pp} + \delta f_{rms}}{4}$$

where:

ΔF_{pp}: peak-to-peak deviation due to the energy dispersal signal (kHz);

δf_{rms}: rms deviation due to "natural" energy dispersal (kHz).

In compiling the table below, a value of 40 kHz has been assumed for δf_{rms}, on the basis of the value of 10 dB for "natural" dispersion given in Table IV of ex-CCIR Report 631* (Rev.76).

Reduction of spectral power flux-density relative to a 4 kHz bandwidth

Peak-to-peak deviation (kHz)	Relative reduction (dB)
0	10
100	15.44
200	17.78
300	19.29
400	20.41
500	21.30
600	22.04
700	22.67
800	23.22
900	23.71
1 000	24.15

* *Note by the Secretariat*: See Report ITU-R BO.631.

3.4 The value of energy dispersal for the broadcasting-satellite service has been determined such that the spectral power flux-density measured in a 4 kHz bandwidth is reduced by 22 dB relative to that measured in the entire bandwidth; this reduction corresponds to a peak-to-peak deviation of 600 kHz.

ANNEX 7 (REV.WRC-19)

Orbital position limitations[55, 56]

A In applying the procedure of Article 4 for proposed modifications to the Region 2 Plan or for proposed new or modified assignments in the Regions 1 and 3 List, administrations should observe the following criteria:

1) No broadcasting satellite serving an area in Region 1 and using a frequency in the frequency band 11.7-12.2 GHz shall occupy a nominal orbital position further east than 146° E.

2) No broadcasting satellite serving an area in Region 2 and using a frequency in the frequency band 12.2-12.7 GHz that involves an orbital position different from that contained in the Region 2 Plan shall occupy a nominal orbital position further west than 175.2° W.

However, modifications necessary to resolve possible incompatibilities during the incorporation of the Regions 1 and 3 feeder-link Plan into the Radio Regulations shall be permitted.

3) (SUP WRC-19)

B The Region 2 Plan is based on the grouping of the space stations in nominal orbital positions of ±0.2° from the centre of the cluster of satellites. Administrations may locate those satellites within a cluster at any orbital position within that cluster, provided they obtain the agreement of administrations having assignments to space stations in the same cluster. (See § 4.13.1 of Annex 3 to Appendix **30A**.)

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[55] See Resolution **558 (WRC-19)**. (WRC-19)

[56] Resolution **768 (WRC-19)** applies to broadcasting satellites serving areas in Region 1 in the frequency band 11.7-12.2 GHz from nominal orbital positions further west than 37.2° W and broadcasting satellites serving areas in Region 2 in the frequency band 12.5-12.7 GHz from nominal orbital positions further east than 54° W and not within its clusters in the Region 2 Plan of Appendix **30**. (WRC-19)

APPENDIX 30A (REV.WRC-23)*

Provisions and associated Plans and List[1] for feeder links for the broadcasting-satellite service (11.7-12.5 GHz in Region 1, 12.2-12.7 GHz in Region 2 and 11.7-12.2 GHz in Region 3) in the frequency bands 14.5-14.8 GHz[2] and 17.3-18.1 GHz in Regions 1 and 3, and 17.3-17.8 GHz in Region 2 (WRC-07)

(See Articles **9** and **11**) (WRC-03)

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* The expression "frequency assignment to a space station", wherever it appears in this Appendix, shall be understood to refer to a frequency assignment associated with a given orbital position. (WRC-03)

[1] The Regions 1 and 3 feeder-link List of additional uses is annexed to the Master International Frequency Register. (WRC-23)

[2] This use of the band 14.5-14.8 GHz is reserved for countries outside Europe.

Note by the Secretariat: Reference to an Article with the number in roman is referring to an Article in this Appendix.

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Article 7	Coordination, notification and recording in the Master International Frequency Register of frequency assignments to stations in the fixed-satellite service (space-to-Earth) in Regions 1 and 2 in the frequency band 17.3-18.1 GHz and in Region 3 in the frequency band 17.7-18.1 GHz, to stations in the fixed-satellite service (Earth-to-space) in Region 2 in the frequency bands 14.5-14.8 GHz and 17.8-18.1 GHz, to stations in the fixed-satellite service (Earth-to-space) in countries listed in Resolution 163 (WRC-15) in the frequency band 14.5-14.75 GHz and in countries listed in Resolution 164 (WRC-15) in the frequency band 14.5-14.8 GHz where those stations are not for feeder links for the broadcasting-satellite service, and to stations in the broadcasting-satellite service in Region 2 in the frequency band 17.3-17.8 GHz when frequency assignments to feeder links for broadcasting-satellite stations in the frequency bands 14.5-14.8 GHz and 17.3-18.1 GHz in Regions 1 and 3 or in the frequency band 17.3-17.8 GHz in Region 2 are involved	29
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ARTICLE 1 (REV.WRC-03)

General definitions

1 For the purposes of this Appendix, the following terms shall have the meanings defined below:

1.1 *Regions 1 and 3 feeder-link Plan*: The Plan for feeder links in the frequency bands 14.5-14.8 GHz[3] and 17.3-18.1 GHz for the broadcasting-satellite service in Regions 1 and 3 contained in this Appendix.

1.2 *Region 2 feeder-link Plan*: The Plan for feeder links in the frequency band 17.3-17.8 GHz for the broadcasting-satellite service in Region 2 contained in this Appendix, together with any modifications resulting from the successful application of the procedure of Article 4.

1.3 *Frequency assignment in conformity with the Plan*:

– any frequency assignment for a receiving space station or transmitting earth station which appears in the Regions 1 and 3 feeder-link Plan; *or*

– any frequency assignment for a receiving space station or transmitting earth station which appears in the Region 2 feeder-link Plan or for which the procedure of Article 4 has been successfully applied.

1.4 *1983 Conference*: Regional Administrative Radio Conference for the Planning in Region 2 of the Broadcasting-Satellite Service in the Frequency Band 12.2-12.7 GHz and Associated Feeder-links in the Frequency Band 17.3-17.8 GHz, called in short Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2 (Geneva, 1983) (RARC Sat-R2).

1.5 *1985 Conference*: First Session of the World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It (Geneva, 1985), called in short WARC Orb-85.

1.6 *1988 Conference*: Second Session of the World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It (Geneva, 1988), called in short WARC Orb-88.

1.7 *1997 Conference*: World Radiocommunication Conference (Geneva, 1997), called in short WRC-97.

1.8 *2000 Conference*: World Radiocommunication Conference (Istanbul, 2000), called in short WRC-2000.

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[3] This use of the band 14.5-14.8 GHz is reserved for countries outside Europe.

1.9 *Additional use in Regions 1 and 3*: For the application of the provisions of this Appendix, additional uses in Regions 1 and 3 are:

a) use of assignments with characteristics different from those appearing in the Regions 1 and 3 feeder-link Plan and which are capable of causing more interference than the corresponding entries in that Plan;

b) use of assignments in addition to those appearing in the Regions 1 and 3 feeder-link Plan.

1.10 *Regions 1 and 3 feeder-link List of additional uses (hereafter called in short the "feeder-link List")*: The list of assignments for additional uses in Regions 1 and 3 as established by WRC-2000, as updated following the successful application of the procedure of § 4.1 of Article 4. (WRC-23)

1.11 *Frequency assignment in conformity with the feeder-link List*: Any frequency assignment which appears in the feeder-link List as updated following successful application of § 4.1 of Article 4. (WRC-03)

1.12 *Broadcasting-satellite service (BSS) feeder link subject to one of the Plans*: The BSS feeder-link subject to one of the Plans referred to in this Appendix is the BSS feeder link in the frequency bands 14.5-14.8 GHz and 17.3-18.1 GHz in Regions 1 and 3 and 17.3-17.8 GHz in Region 2. (WRC-03)

ARTICLE 2 (WRC-03)

Frequency bands

2.1 The provisions of this Appendix apply to the feeder-links in the fixed-satellite service (Earth-to-space) in the frequency bands 14.5-14.8 GHz and 17.3-18.1 GHz for the broadcasting-satellite service in Regions 1 and 3, and 17.3-17.8 GHz for the broadcasting-satellite service in Region 2 and to other services to which these bands are allocated in Regions 1, 2 and 3 so far as their relationship to the fixed-satellite service (Earth-to-space) in these bands is concerned.

2.2 (SUP - WRC-03)

ARTICLE 2A (REV.WRC-19)

Use of the guardbands[3*bis*]

2A.1 The use of the guardbands defined in § 3.1 and 4.1 of Annex 3 to provide space operation functions in accordance with No. **1.23** in support of the operation of geostationary-satellite networks for the broadcasting-satellite service (BSS) feeder link is not subject to the application of Section I of Article **9**.

2A.1.1 Coordination between assignments intended to provide the space operation functions and assignments of the BSS feeder link subject to a Plan shall be effected using the provisions of Article 7.

[3*bis*] The provisions of Resolution **49 (Rev.WRC-19)*** do not apply. (WRC-19)

* *Note by the Secretariat*: This Resolution was revised by WRC-23.

2A.1.2 Coordination among assignments intended to provide the space operation functions and services not subject to a Plan shall be effected using the provisions of Nos. **9.7**, **9.17, 9.17A**, **9.18**, and the associated provisions of Section II of Article **9**, as appropriate.

2A.1.3 Coordination of modifications to the Region 2 feeder-link Plan or assignments to be included in the Regions 1 and 3 feeder-link List, with assignments intended to provide these functions shall be effected using § 4.1.1 *d)* of Article 4.

2A.1.4 Requests for the coordination referred to in § 2A.1.1, 2A.1.2 and 2A.1.3 shall be sent by the requesting administration to the Bureau, together with the appropriate information listed in Appendix **4**.

2A.2 Any assignment intended to provide these functions in support of a geostationary-satellite network for the BSS feeder link shall be notified under Article **11** and brought into use within the following time-limits[3*ter*]. (WRC-15)

2A.2.1 *a)* for the case where the associated BSS feeder-link assignments are contained in one of the initial Plans (Region 2 Plans incorporated in the Radio Regulations at WARC Orb-85 and Regions 1 and 3 Plan adopted at WRC-2000), within the regulatory time-limit referred to in § 4.1.3 or 4.2.6 of Article 4 from the date of receipt by the Bureau of the complete Appendix **4** data for those assignments intended to provide the space operation functions;

2A.2.2 *b)* for the case where the associated BSS feeder-link assignments have been submitted under § 4.1.3 or § 4.2.6 of Article 4 for entry in the Regions 1 and 3 List or a modification to the Region 2 Plan, within the regulatory time-limit referred to in § 4.1.3 or § 4.2.6 of Article 4 for those associated BSS feeder-link assignments;

2A.2.3 *c)* for the case where the associated BSS feeder-link assignments have already been brought into use in accordance with the Radio Regulations, within the regulatory time-limit referred to in § 4.1.3 and § 4.2.6 of Article 4 from the date of receipt by the Bureau of the complete Appendix **4** data for those assignments intended to provide these space operation functions.

ARTICLE 3 (REV.WRC-19)

Execution of the provisions and associated Plans

3.1 The Member States in Regions 1, 2 and 3 shall adopt, for their feeder-link space and earth stations in the fixed-satellite service (Earth-to-space) in the frequency bands referred to in this Appendix, the characteristics specified in the appropriate Regional Plan and the associated provisions.

[3*ter*] The time-limit is established at the time when the request is received under § 2A.1.4. (WRC-15)

3.2 The Member States shall not change the characteristics specified in the Region 1 and 3 feeder-link Plan or in the Region 2 feeder-link Plan, or bring into use assignments to receiving space stations or transmitting earth stations in the fixed-satellite service or to stations of the other services to which these frequency bands are allocated, except as provided for in the Radio Regulations and the appropriate Articles and Annexes of this Appendix.

3.3 The procedures for the use of interim systems in Region 2 for feeder links in the fixed-satellite service for the frequency bands covered by this Appendix are given in Resolution **42 (Rev.WRC-19)**. (WRC-19)

3.4 The Regions 1 and 3 feeder-link Plan is based on national coverage from the geostationary-satellite orbit. The associated procedures contained in this Appendix are intended to promote long-term flexibility of the Plan and to avoid monopolization of the planned bands and orbit by a country or a group of countries.

ARTICLE 4 (REV.WRC-23)

Procedures for modifications to the Region 2 feeder-link Plan or for additional uses in Regions 1 and 3

4.1 Provisions applicable to Regions 1 and 3

4.1.1 An administration proposing to include a new or modified assignment in the feeder-link List shall seek the agreement of those administrations whose services are considered to be affected, i.e. administrations[4, 5]:

a) of Regions 1 and 3 having a feeder-link frequency assignment in the fixed-satellite service (Earth-to-space) to a space station in the broadcasting-satellite service which is included in the Regions 1 and 3 feeder-link Plan with a necessary bandwidth, any portion of which falls within the necessary bandwidth of the proposed assignment; *or*

b) of Regions 1 and 3 having a feeder-link frequency assignment included in the feeder-link List or for which complete Appendix **4** information has been received by the Radiocommunication Bureau in accordance with the provisions of § 4.1.3, and any portion of which falls within the necessary bandwidth of the proposed assignment; *or*

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[4] Agreement with administrations having a frequency assignment in the bands 14.5-14.8 GHz or 17.7-18.1 GHz to a terrestrial station, or having a frequency assignment in the band 17.7-18.1 GHz to an earth station in the fixed-satellite service (space-to-Earth), or having a frequency assignment in the band 17.3-17.8 GHz in the broadcasting-satellite service shall be sought under No. **9.17**, No. **9.17A** or No. **9.19**, respectively.

[5] Coordination under Nos. **9.17** or **9.17A** is not required for an earth station of an administration on the territory of which this earth station is located and for which the procedures of former § 4.2.1.2 and 4.2.1.3 of Appendix **30A (WRC-97)** have been successfully applied by that administration before 3 June 2000 in respect of terrestrial stations or earth stations operating in the opposite direction of transmission. (WRC-03)

c) of Region 2 having a feeder-link frequency assignment in the fixed-satellite service (Earth-to-space) to a space station in the broadcasting-satellite service which is in conformity with the Region 2 feeder-link Plan, or in respect of which proposed modifications to that Plan have already been received by the Bureau in accordance with the provisions of § 4.2.6 with a necessary bandwidth, any portion of which falls within the necessary bandwidth of the proposed assignment; *or*

d) having a feeder-link frequency assignment in the frequency bands 14.5-14.8 GHz or 17.8-18.1 GHz in Region 2 in the fixed-satellite service (Earth-to-space) to a space station in the broadcasting-satellite service, or a frequency assignment in the frequency band 14.5-14.75 GHz in countries listed in Resolution **163 (WRC-15)** and in the frequency band 14.5-14.8 GHz in countries listed in Resolution **164 (WRC-15)**, in the fixed-satellite service (Earth-to-space) not subject to a Plan, which is recorded in the Master Register or which has been coordinated or is being coordinated under the provisions of No. **9.7**, or under § 7.1 of Article **7**, with a necessary bandwidth, any portion of which falls within the necessary bandwidth of the proposed assignment. (WRC-19)

4.1.2 The services of an administration are considered to be affected when the limits shown in Annex 1 are exceeded.

4.1.3 An administration, or one[6] acting on behalf of a group of named administrations, intending to include a new or modified assignment in the feeder-link List shall send to the Bureau, not earlier than eight years but preferably not later than two years before the date on which the assignment is to be brought into use, the relevant information listed in Appendix **4**. An assignment in the feeder-link List shall lapse if it is not brought into use within eight years after the date of receipt by the Bureau of the relevant complete information. A proposed new or modified assignment not included in the List within eight years after the date of receipt by the Bureau of the relevant complete information shall also lapse. (WRC-23)

4.1.3*bis* The regulatory time-limit for bringing into use an assignment in the List may be extended once by not more than three years due to launch failure in the following cases:

– the destruction of the satellite intended to bring the assignment into use; *or*

– the destruction of the satellite launched to replace an already operating satellite which is intended to be relocated to bring another assignment into use; *or*

– the satellite is launched, but fails to reach its assigned orbital location.

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6 Whenever, under this provision, an administration acts on behalf of a group of named administrations, all members of that group retain the right to respond in respect of their own networks or systems. (WRC-03)

7 (SUP – WRC-23)

For this extension to be granted, the launch failure must have occurred at least five years after the date of receipt of the complete Appendix **4** data. In no case shall the period of the extension of the regulatory time-limit exceed the difference in time between the three-year period and the period remaining from the date of the launch failure to the end of the regulatory time-limit[8]. In order to take advantage of this extension, the administration shall have, within one month of the launch failure or one month after 5 July 2003, whichever comes later, notified the Bureau in writing of such failure, and shall also provide the following information to the Bureau before the end of the regulatory time-limit of § 4.1.3:

– date of launch failure;

– due diligence information as required in Resolution **49 (Rev.WRC-15)**[*] for the assignment with respect to the satellite that suffered the launch failure, if that information has not already been provided.

If, 11 months after the request for extension, the administration has not provided to the Bureau updated Resolution **49 (Rev.WRC-15)**[*] information, the Bureau shall promptly send a reminder to the notifying administration. If, within one year of the request for extension, the administration has not provided to the Bureau updated Resolution **49 (Rev.WRC-15)**[*] information for the new satellite under procurement, the related frequency assignments shall lapse. (WRC-15)

4.1.4 If the information received by the Bureau under § 4.1.3 is found to be incomplete, the Bureau shall immediately seek from the administration concerned any clarification required and information not provided.

4.1.5 The Bureau shall determine, on the basis of Annex 1, the administrations whose frequency assignments are considered to be affected. The Bureau shall publish[8*bis*], in a Special Section of its International Frequency Information Circular (BR IFIC), the complete information received under § 4.1.3, together with the names of the affected administrations, the corresponding fixed-satellite service networks, and the corresponding feeder-links to broadcasting-satellite service assignments, as appropriate. The Bureau shall immediately send a telegram/fax to the administration proposing the assignment, drawing its attention to the information contained in the relevant BR IFIC. (WRC-07)

4.1.6 The Bureau shall send a telegram/fax to the administrations listed in the Special Section of the BR IFIC, drawing their attention to the information it contains. (WRC-07)

4.1.7 An administration which considers that it should have been identified in the publication referred to under § 4.1.5 above shall, within four months of the date of publication of its relevant BR IFIC, and giving the technical reasons for so doing, request the Bureau to include its name in the publication. The Bureau shall study this information on the basis of Annex 1 and shall inform both administrations of its conclusions. Should the Bureau agree to the administration's request, it shall publish an addendum to the publication under § 4.1.5.

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[8] For a launch failure which occurred before 5 July 2003, the maximum extension of three years shall apply as from 5 July 2003. (WRC-03)

[*] *Note by the Secretariat*: This Resolution was revised by WRC-19 and WRC-23.

[8*bis*] If the payments are not received in accordance with the provisions of Council Decision 482, as amended, on the implementation of cost recovery for satellite network filings, the Bureau shall cancel the publication, after informing the administration concerned. The Bureau shall inform all administrations of such action and that the network specified in the publication in question no longer has to be taken into consideration by the Bureau and other administrations. The Bureau shall send a reminder to the notifying administration not later than two months prior to the deadline for the payment in accordance with the above-mentioned Council Decision 482 unless the payment has already been received. (WRC-07)

4.1.7*bis* Except as provided under § 4.1.18 to 4.1.20, any inclusion of a new or modified frequency assignment in the Regions 1 and 3 List which would have the effect of exceeding the limits specified in Annex 1 shall be subject to the agreement of all administrations whose services are considered to be affected. (WRC-03)

4.1.8 The administration seeking agreement or the administration with which agreement is sought may request any additional technical information it considers necessary. The administrations shall inform the Bureau of such requests.

4.1.9 Comments from administrations identified in the publication referred to under § 4.1.5 above shall be sent to the Bureau and to the administration proposing the modification. (WRC-15)

4.1.10 An administration that has not notified its agreement either to the administration seeking agreement or to the Bureau within a period of four months following the date of the BR IFIC referred to in § 4.1.5 shall be deemed to have not agreed to the proposed assignment unless the provisions of § 4.1.10a to 4.1.10d and § 4.1.21 are applied. This time-limit may be extended:

– for an administration that has requested additional information under § 4.1.8, by up to three months, *or*

– for an administration that has requested the assistance of the Bureau under § 4.1.21, by up to three months following the date at which the Bureau communicated the result of its action. (WRC-15)

4.1.10*bis* Thirty days prior to the expiry of the same four-month period, the Bureau shall dispatch a reminder telegram or fax to an administration which has not made its comments under § 4.1.10, bringing the matter to its attention. (WRC-03)

4.1.10*ter* (SUP - WRC-15)

4.1.10a After the same time period as specified in § 4.1.10, the notifying administration may, pursuant to § 4.1.21, request the Bureau to assist in respect of an administration which has not replied within this time period. (WRC-15)

4.1.10b The Bureau, acting under § 4.1.10a, shall send a reminder to the administration which has not replied, together with the results of its previously published compatibility analysis, containing the change in the values referred to in paragraph 4 of Annex 1 to Appendix **30A**, requesting a decision. (WRC-15)

4.1.10c Fifteen days before the expiry of the 30-day period referred to in § 4.1.10d, the Bureau shall send a reminder to the above-mentioned administration drawing its attention to the consequence of no reply. (WRC-15)

4.1.10d If no decision is communicated to the Bureau within 30 days after the date of dispatch of the reminder under § 4.1.10b and the identification is for:

– an assignment in the Regions 1 and 3 Plan, it shall be deemed that the administration which has not given a decision has no objection to the proposed assignment and an agreement under § 4.1.13*bis* is considered as concluded between the administration for the affected assignment in the Regions 1 and 3 Plan and the notifying administration for the proposed assignment; or

– an assignment not in the Regions 1 and 3 Plan, it shall be deemed that the administration which has not given a decision has agreed to the proposed assignment. (WRC-23)

4.1.10e An administration may at any time during or after the above-mentioned four-month period inform the Bureau of its objection to being included in the service area of any assignment, even if this assignment has been entered in the List. The Bureau shall then inform the administration responsible for the assignment and exclude the territory and test points[9] that are within the territory of the objecting administration from the service area. The Bureau shall update the reference situation without reviewing the previous examinations. (WRC-23)

4.1.11 If, in seeking agreement, an administration modifies its initial proposal, it shall again apply the provisions of § 4.1 and the subsequent procedure in cases where:

– the assignments of any other administration received by the Bureau in accordance with § 4.1.3 or § 4.2.6, or § 2A.1.4 of Article 2A, or § 7.1 of Article 7, or No. **9.7** before this modified proposal is received under § 4.1.12; *or*

– the assignments of any other administration contained in the Plans or the Lists,

are considered as being affected and receive more interference as a result of the modifications than that produced by the initial proposal. (WRC-15)

4.1.12[9*bis*] If agreement has been reached with the administrations identified in the publication referred to under § 4.1.5 above, the administration proposing the new or modified assignment may continue with the appropriate procedure in Article 5 and shall inform the Bureau, indicating the final characteristics of the frequency assignment together with the names of the administrations with which agreement has been reached. (WRC-19)

4.1.12*bis* In application of § 4.1.12, an administration may indicate the changes to the information communicated to the Bureau under § 4.1.3 and published under § 4.1.5. In submitting such information, noting the requirements of § 5.1.6, the administration may also request the Bureau to examine the submission in respect of notification under § 5.1.2. (WRC-19)

4.1.13 The agreement of the administrations affected may also be obtained in accordance with this Article, for a specified period. When this specific period of agreement expires for an assignment in the List, the assignment in question shall be maintained in the List until the end of the period referred to in § 4.1.3 above. After that date this assignment shall lapse unless the agreement of the administrations affected is renewed[9*ter*]. (WRC-19)

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[9] The administration responsible for the assignment may request to relocate the feeder-link test points from the excluded territory to a new location within the remaining part of its service area, provided that the relocation shall not cause more interference. (WRC-23)

[9*bis*] For any remaining affected networks whose assignments were entered in the List before the notice received under § 4.1.12, the Bureau shall use the method in Annex 1 to further examine if the remaining corresponding assignments in the List are still considered as being affected. The examination in respect of those remaining affected networks is conducted independently using the Appendices **30** and **30A** master database corresponding to the Part B Special Section that was published under § 4.1.15. Resolution **548 (Rev.WRC-12)** applies. (WRC-19)

[9*ter*] Unless the Bureau has been informed by the notifying administration of the renewal of the agreement, it shall, no later than six months before the end of the specified period, send a reminder to the notifying administration. (WRC-19)

4.1.13*bis* When an agreement under this provision is concluded with the administration of an affected assignment in the Regions 1 and 3 Plan, the notifying administration shall provide a firm, objective, measurable and enforceable commitment to respect a power flux-density of −197.0 − GRx[9*quat*] dB(W/(m^2 · Hz)) arriving at the receiving space station of the administration whose assignment was the basis of the disagreement at the date on which the frequency assignment in the Regions 1 and 3 Plan is to be brought into use, communicated under § 5.1.10*bis* or within 12 months of the date of dispatch of the telefax sent under § 5.1.10*bis*, whichever comes later. (WRC-23)

4.1.13*ter* Upon the conclusion of agreements under § 4.1.13*bis*, when entering the assignment in the List, the Bureau shall indicate those administrations whose assignments in the Regions 1 and 3 Plan were the basis of the agreement. (WRC-23)

4.1.14 Where the proposed assignment involves developing countries, administrations shall seek all practicable solutions conducive to the economical development of the broadcasting-satellite systems of these countries.

4.1.15 The Bureau shall publish[10] in a Special Section of its BR IFIC the information received under § 4.1.12, together with the names of any administrations with which the provisions of this Article have been successfully applied. The frequency assignment concerned shall be included in the feeder-link List. (WRC-03)

4.1.16 In case of disagreement on the part of an administration whose agreement has been sought, the requesting administration shall first endeavour to solve the problem by exploring all possible means of meeting its requirement. If the problem still cannot be solved by such means, the administration whose agreement has been sought should endeavour to overcome the difficulties as far as possible, and shall state the technical reasons for any disagreement if the administration seeking the agreement requests it to do so. (WRC-19)

4.1.17 If no agreement is reached between the administrations concerned, the Bureau shall carry out any study that may be requested by either one of these administrations; the Bureau shall inform them of the result of the study and shall make such recommendations as it may be able to offer for the solution of the problem.

[9*quat*] GRx is the relative receive antenna gain of the space station of the affected assignment in the Regions 1 and 3 Plan of the administration with which an agreement under § 4.1.13*bis* was concluded in the direction of the location of the feeder-link earth station of the notifying administration. (WRC-23)

[10] If the payments are not received in accordance with the provisions of Council Decision 482, as amended, on the implementation of cost recovery for satellite network filings, the Bureau shall cancel the publication, after informing the administration concerned. The Bureau shall inform all administrations of such action and that the network specified in the publication in question no longer has to be taken into consideration by the Bureau and other administrations. The Bureau shall send a reminder to the notifying administration not later than two months prior to the deadline for the payment in accordance with the above-mentioned Council Decision 482 unless the payment has already been received. (WRC-07)

4.1.18 If, in spite of the application of § 4.1.16 and 4.1.17, there is still continuing disagreement and the assignment which was the basis of the disagreement is not an assignment in the Regions 1 and 3 Plan, or in the Region 2 Plan or for which the procedure of § 4.2 has been initiated, and if the notifying administration insists that the proposed assignment be included in the Regions 1 and 3 feeder-link List, the Bureau shall provisionally enter the assignment in the Regions 1 and 3 feeder-link List with an indication of those administrations whose assignments were the basis of the disagreement; however, the entry shall be changed from provisional to definitive recording in the feeder-link List only if the Bureau is informed that the new assignment in the Regions 1 and 3 feeder-link List has been in use, together with the assignment which was the basis for the disagreement, for at least four months without any complaint of harmful interference being made. (WRC-03)

4.1.18*bis* When requesting the application of § 4.1.18, the notifying administration shall undertake to meet the requirements of § 4.1.20 and provide to the administration in respect of which § 4.1.18 is applied, with a copy to the Bureau, a description of the steps by which it undertakes to meet these requirements. Once an assignment is entered in the feeder-link List provisionally under the provisions of § 4.1.18, the calculation of the equivalent protection margin (EPM)[11] of an assignment in the Regions 1 and 3 feeder-link List or for which the procedure of Article 4 has been initiated and which was the basis for the disagreement shall not take into account interference produced by the assignment for which the provisions of § 4.1.18 have been applied. When the recording of an assignment entered into the List is changed from provisional to definitive in accordance with § 4.1.18, but there is still continuing disagreement between the administrations, the Bureau shall consult with the administration responsible for the assignments which were the basis for the disagreement in determining the appropriate course of action as regards any update to the EPM for the assignments which were the basis for the disagreement. (WRC-19)

4.1.19 Should the assignments that were the basis of the disagreement not be brought into use within the period specified in No. **11.44** (for non-planned services), or in § 4.1 (for assignments in the feeder-link List or having initiated the procedure under § 4.1), as appropriate, then the status of the assignment in the feeder-link List shall be reviewed accordingly. (WRC-03)

4.1.20 Should harmful interference be caused by an assignment included in the feeder-link List under § 4.1.18 to any recorded assignment in the Master Register which was the basis of the disagreement, the administration using the frequency assignment included in the feeder-link List under § 4.1.18 shall, upon receipt of advice thereof, immediately eliminate this harmful interference. (WRC-03)

4.1.21 An administration may, at any stage in the procedure described, or before applying it, request the assistance of the Bureau.

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[11] For the definition of the EPM, see § 1.7 of Annex 3. (WRC-03)

4.1.22 The relevant provisions of Article 5 shall be applied when frequency assignments are notified to the Bureau.

4.1.23 When a frequency assignment included in the feeder-link List is no longer required, the administration concerned shall immediately so inform the Bureau. The Bureau shall publish this information in a Special Section of its BR IFIC and delete the assignment from the feeder-link List. (WRC-03)

4.1.24 No assignment in the feeder-link List shall have a period of operation exceeding 15 years, counted from the date of bringing into use, or 2 June 2000, whichever is later. Upon request by the responsible administration received by the Bureau at the latest three years before the expiry of this period, this period may be extended by up to 15 years, on condition that all the characteristics of the assignment remain unchanged[11*bis*]. (WRC-19)

4.1.25 Where an administration already having included in the feeder-link List two assignments (not including those systems notified on behalf of a group of named administrations and included in the feeder-link List by WRC-2000) in the same channel and covering the same service area, proposes to include in the feeder-link List a new assignment in the same channel over this same service area, it shall apply the following in respect of another administration which has no assignment in the feeder-link List in the same channel and which proposes to include in the feeder-link List a new assignment:

a) if the agreement of the former administration is required following the application of § 4.1 by the latter administration, in order to protect the new assignment proposed by the former administration from interference caused by the assignment proposed by the latter administration, both administrations shall make every possible effort to resolve the difficulties by means of mutually acceptable adjustments to their networks;

b) in case of continuing disagreement, and if the former administration has not communicated to the Bureau the information specified in Annex 2 to Resolution **49 (Rev.WRC-15)***, this administration shall be deemed to have given its agreement to inclusion in the feeder-link List of the assignment of the latter administration. (WRC-15)

4.1.26 The procedure of this Article may be applied by the administration of a new ITU Member State in order to include new assignments in the feeder-link List. Upon completion of the procedure, the next world radiocommunication conference may be requested to consider, among the assignments included in the feeder-link List after the successful completion of this procedure, the inclusion in the Regions 1 and 3 feeder-link Plan of up to 10 channels (for Region 1) and up to 12 channels (for Region 3), over the national territory of the new Member State. (WRC-03)

4.1.27 When an administration has successfully applied this procedure and received all the agreements[12] required to include in the feeder-link List assignments over its national territory, at an orbital location and/or in channels different from those appearing in the Regions 1 and 3 feeder-link Plan for its country, it may request the next world radiocommunication conference to consider the inclusion in this Plan of up to 10 (for Region 1) and up to 12 (for Region 3) of these assignments, in replacement of its assignments appearing in this Plan. (WRC-03)

[11*bis*] Unless the request has been received by the Bureau, it shall, no later than 90 days before the deadline of such a request, send a reminder to the notifying administration. (WRC-19)

* *Note by the Secretariat*: This Resolution was revised by WRC-19 and WRC-23.

[12] In such a case, § 4.1.18 does not apply.

4.1.27*bis* Should the assignments mentioned in § 4.1.26 and 4.1.27 over the national territory of the administration not be brought into use within the regulatory time-limit mentioned in § 4.1.3, they would be retained in the List until the end of the World Radiocommunication Conference following immediately after the successful completion of procedure referred to in § 4.1.26 and 4.1.27, respectively and thereafter they shall be removed from the List. (WRC-03)

4.1.28 The feeder-link List, as updated, shall be published periodically by the Bureau. (WRC-03)

4.1.29 New or modified assignments in the feeder-link List shall be limited to digital modulation. (WRC-03)

4.1.30 An administration, or an administration acting on behalf of a group of named administrations, responsible for a notice with:

– a service area limited to the national territory of an administration or to the national territories of a group of named administrations responsible for that assignment; and

– a coverage area that shall be the smallest area which encompasses the associated service area,

may request the Bureau to be entitled under this Article to apply the procedure described in §§ 4.1.32 to 4.1.33 with respect to an assignment identified as potentially affected under § 4.1.1*b)* of this Appendix, when none of those administrations have a frequency assignment included in the Region 1 and 3 feeder-link List and for which complete Appendix **4** information has been received by the Bureau in accordance with the provisions of § 4.1.3 and published in accordance with § 4.1.5. The administration may seek the assistance of the Bureau in selecting an orbital position. (WRC-23)

4.1.30*bis* Before applying the procedure described in §§ 4.1.32 to 4.1.33, an administration or a group of named administrations requesting to be entitled under § 4.1.32 is requested to take all practical steps in accordance with the Radio Regulations to reach a coordination agreement with the administrations identified under § 4.1.1*b)* of this Appendix. The Bureau will inform these identified administrations and request them to make the utmost effort to coordinate with the administration applying § 4.1.30. The responsible administration may at any time seek the assistance of the Bureau and its support in the coordination process. (WRC-23)

4.1.31 If, in spite of the application of § 4.1.30*bis*, there is still continuing disagreement between the administration, or the group of named administrations, applying § 4.1.30 and the administrations identified under § 4.1.1*b)* of this Appendix, administrations may seek the assistance of the Bureau, which shall take into account the actual operational parameters of the affected networks under § 4.1.1.*b)* as provided by the administration, to the extent possible, in its compatibility analysis. (WRC-23)

4.1.31*bis* If, in spite of the application of § 4.1.31, there is still continuing disagreement, the Bureau shall, upon receipt of a request from the administration, or the group of named administrations, applying § 4.1.30, submit the case, together with additional supporting materials from administrations, to the subsequent meeting of the Radio Regulations Board for review and the necessary actions. If the case relates to an assignment having global coverage with limited service area in the Earth-to-space direction, the necessary actions of the Board shall also include consideration of whether to instruct the Bureau to apply the procedure described in §§ 4.1.32 to 4.1.33 with respect to the administrations identified under § 4.1.1*b)* at the time of the examination, under § 4.1.12, of the frequency assignments of the administration applying § 4.1.30. (WRC-23)

4.1.32 For examination of a proposed new or modified assignment to the feeder-link List subject to § 4.1.30, and following instruction from the Radio Regulations Board under § 4.1.31*bis* against an assignment identified under § 4.1.1*b)* of this Appendix, the Bureau will generate coverage diagrams that shall be the smallest area which encompasses the associated service area of the satellite network[12*bis*], using the Bureau's relevant software applications and following the procedure below:

Individual minimum ellipses will be created for each country/territory included in the service area of the incumbent network contained in Part A or the initial Part B, as appropriate:

– if the −10 dB contours of individual minimum ellipses overlap with each other, the beam contains only one coverage area formed by the contours stemming from the elliptical coverage generated by the Bureau that encompasses these countries/territories;

– if the −10 dB contours of individual minimum ellipses do not overlap with each other, the beam consists of multiple spots stemming from the non-overlapping ellipses, and each spot is formed by the contours stemming from the minimum ellipses generated for countries/territories as described in the bullet above. (WRC-23)

4.1.33 When an assignment subject to § 4.1.30 is entered in the List, the Bureau shall not update the reference situation for the latter assignment referred to in § 4.1.30 if the latter assignment is still affected based on its submitted feeder-link coverage area. (WRC-23)

4.1.34 When an assignment is entered in the List referred to in § 4.1.13*ter*, that assignment shall not be taken into account in updating the reference situation for those assignments in the Regions 1 and 3 Plan with which an agreement under § 4.1.13*bis* has been concluded. (WRC-23)

4.1.35 If the Bureau is informed that a commitment under § 4.1.13*bis* is not being respected by an assignment in the List, the Bureau shall immediately consult the administration responsible for the assignment, requesting immediate respect for the conditions specified in § 4.1.13*bis*. (WRC-23)

[12*bis*] For satellite networks whose assignments were received by the Bureau under § 4.1.12 of this Appendix on or before 1 January 2025, the Bureau will use the coverage diagram contained in the List. In addition, administrations responsible for such satellite networks shall notify the Bureau when all the assignments associated with such networks are used by a space station launched after 1 January 2028. In such cases, the coverage area will be established as defined in § 4.1.32. (WRC-23)

4.1.36 If, in spite of the application of § 4.1.35, the conditions specified in § 4.1.13*bis* are still not respected by an assignment in the List, the Bureau shall submit the case, together with additional supporting materials from administrations, to the subsequent meeting of the Radio Regulations Board for review and the necessary actions. (WRC-23)

4.2 Provisions applicable to Region 2

4.2.1 When an administration intends to make a modification to the Region 2 feeder-link Plan, i.e.:

a) to modify the characteristics of any of its frequency assignments in the fixed-satellite service which are shown in the Region 2 feeder-link Plan, or for which the procedure in this Article has been successfully applied, whether or not the station has been brought into use; *or*

b) to include in the Region 2 feeder-link Plan a new frequency assignment in the fixed-satellite service; *or*

c) to cancel a frequency assignment in the fixed-satellite service,

the following procedure shall be applied before any notification of the frequency assignment is made to the Bureau (see Article 5 and Resolution **42 (Rev.WRC-19)**). (WRC-19)

4.2.2 An administration proposing a modification to the characteristics of a frequency assignment in conformity with the Region 2 feeder-link Plan, or the inclusion of a new frequency assignment in that Plan, shall seek the agreement of those administrations[13, 14, 15]:

a) having an assignment for feeder-links in the fixed-satellite service (Earth-to-space) which is in conformity with the Regions 1 and 3 feeder-link Plan with the necessary bandwidth, any portion of which falls within the necessary bandwidth of the proposed assignment; *or*

b) of Regions 1 and 3 having a feeder-link frequency assignment included in the feeder-link List or for which complete Appendix **4** information has been received by the Bureau in accordance with the provisions of § 4.1.3, and any portion of which falls within the necessary bandwidth of the proposed assignment; *or*

c) of Region 2 having a feeder-link frequency assignment in the fixed-satellite service (Earth-to-space) in the same channel or an adjacent channel, which appears in the Region 2 feeder-link Plan or in respect of which proposed modifications to this Plan have been received by the Bureau in accordance with the provisions of § 4.2.6;

d) which are considered affected. (WRC-03)

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[13] Agreement with administrations having a frequency assignment in the bands 17.7-17.8 GHz to a terrestrial station or to an earth station in the fixed-satellite service (space-to-Earth) shall be sought under No. **9.17** or No. **9.17A**, respectively.

[14] Coordination under No. **9.17** or **9.17A** is not required for an earth station of an administration on the territory of which this earth station is located and for which the procedures of former § 4.2.3.2 and 4.2.3.3 of Appendix **30A (WRC-97)** have been successfully applied by that administration before 3 June 2000 in respect of terrestrial stations or earth stations operating in the opposite direction of transmission. (WRC-03)

[15] Agreement with administrations having a frequency assignment in the band 17.3-17.8 GHz to an earth station in the broadcasting-satellite service shall be sought under No. **9.19**.

4.2.3 (Not used.)

4.2.4 The services of an administration are considered to be affected when the limits shown in Annex 1 are exceeded.

4.2.5 The agreement referred to in § 4.2.2 is not required when an administration proposes to bring into use, with characteristics appearing in the Region 2 feeder-link Plan, a fixed feeder-link earth station in the band 17.3-17.8 GHz or a transportable feeder-link earth station in the band 17.3-17.7 GHz. Administrations may communicate to the Bureau the characteristics of such earth stations for inclusion in this Plan.

4.2.6 An administration, or one[16] acting on behalf of a group of named administrations, intending to make a modification to the Region 2 feeder-link Plan shall send to the Bureau, not earlier than eight years but preferably not later than two years before the date on which the assignment is to be brought into use, the relevant information listed in Appendix **4**. Modifications to that Plan shall lapse if the assignment is not brought into use within eight years after the date of receipt by the Bureau of the relevant complete information. A request for a modification that has not been included in that Plan within eight years after the date of receipt by the Bureau of the relevant complete information shall also lapse. (WRC-23)

4.2.6*bis* The regulatory time-limit for bringing into use of an assignment in the Region 2 Plan obtained through application of § 4.2 may be extended once by no more than three years due to launch failure in the following cases:

– the destruction of the satellite intended to bring the assignment into use; *or*

– the destruction of the satellite launched to replace an already operating satellite which is intended to be relocated to bring another assignment into use; *or*

– the satellite is launched, but fails to reach its assigned orbital location.

For this extension to be granted, the launch failure must have occurred at least five years after the date of receipt of the complete Appendix **4** data. In no case shall the period of the extension of the regulatory time-limit exceed the difference in time between the three-year period and the period remaining from the date of the launch failure to the end of the regulatory time-limit[18]. In order to take advantage of this extension, the administration shall have, within one month of the launch failure or one month after 5 July 2003, whichever comes later, notified the Bureau in writing of such failure, and shall also provide the following information to the Bureau before the end of the regulatory time-limit of § 4.2.6:

– date of launch failure;

– due diligence information as required in Resolution **49 (Rev.WRC-15)***[*] for the assignment with respect to the satellite that suffered the launch failure, if that information has not already been provided.

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[16] Whenever, under this provision, an administration acts on behalf of a group of named administrations, all members of that group retain the right to respond in respect of their own networks or systems. (WRC-03)

[17] (SUP – WRC-23)

[18] For a launch failure which occurred before 5 July 2003, the maximum extension of three years shall apply as from 5 July 2003. (WRC-03)

[*] *Note by the Secretariat*: This Resolution was revised by WRC-19 and WRC-23.

If, 11 months after the request for extension, the administration has not provided to the Bureau updated Resolution **49 (Rev.WRC-15)*** information, the Bureau shall promptly send a reminder to the notifying administration. If, within one year of the request for extension, the administration has not provided to the Bureau updated Resolution **49 (Rev.WRC-15)*** information for the new satellite under procurement, the related frequency assignments shall lapse. (WRC-15)

4.2.7 If the information received by the Bureau under § 4.2.6 is found to be incomplete, the Bureau shall immediately seek from the administration concerned any clarification required and information not provided.

4.2.8 The Bureau shall determine, on the basis of Annex 1, the administrations whose frequency assignments are considered to be affected within the meaning of § 4.2.2. The Bureau shall publish[19], in a Special Section of its BR IFIC, the complete information received under § 4.2.6, together with the names of the affected administrations, the corresponding fixed-satellite service networks, and the corresponding feeder links to broadcasting-satellite service assignments, as appropriate. The Bureau shall immediately send a telegram/fax to the administration proposing the modification to the Region 2 feeder-link Plan, drawing its attention to the information contained in the relevant BR IFIC. (WRC-07)

4.2.9 The Bureau shall send a telegram/fax to the administrations listed in the Special Section of its BR IFIC, drawing their attention to the information it contains. (WRC-07)

4.2.10 An administration which considers that it should have been included in the publication referred to under § 4.2.8 above shall, within four months of the date of publication in the relevant BR IFIC, and giving the technical reasons for so doing, request the Bureau to include its name in the publication. The Bureau shall study this information on the basis of Annex 1 and shall inform both administrations of its conclusions. Should the Bureau agree to the administration's request, it shall publish an addendum to the publication under § 4.2.8. (WRC-07)

4.2.11 Except as provided under § 4.2.21A to 4.2.21D, any modification to a frequency assignment which is in conformity with the Region 2 feeder-link Plan or any inclusion in that Plan of a new frequency assignment which would have the effect of exceeding the limits specified in Annex 1 shall be subject to the agreement of all affected administrations. (WRC-03)

4.2.12 The administration seeking agreement or the administration with which agreement is sought may request any additional technical information it considers necessary. The administrations shall inform the Bureau of such requests.

4.2.13 Comments from administrations on the information published pursuant to § 4.2.8 should be sent either directly to the administration proposing the modification or through the Bureau. In any event, the Bureau shall be informed that comments have been made.

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* *Note by the Secretariat*: This Resolution was revised by WRC-19 and WRC-23.

[19] If the payments are not received in accordance with the provisions of Council Decision 482, as amended, on the implementation of cost recovery for satellite network filings, the Bureau shall cancel the publication, after informing the administration concerned. The Bureau shall inform all administrations of such action and that the network specified in the publication in question no longer has to be taken into consideration by the Bureau and other administrations. The Bureau shall send a reminder to the notifying administration not later than two months prior to the deadline for the payment in accordance with the above-mentioned Council Decision 482 unless the payment has already been received. (WRC-07)

4.2.14 An administration which has not notified its comments either to the administration seeking agreement or to the Bureau within a period of four months following the date of the BR IFIC referred to in § 4.2.8 shall be deemed to have agreed to the proposed modification. This time-limit may be extended by up to three months for an administration which has requested additional information under § 4.2.12 or for an administration which has requested the assistance of the Bureau under § 4.2.22. In the latter case, the Bureau shall inform the administrations concerned of this request.

4.2.14*bis* Thirty days prior to the expiry of the same four-month period the Bureau shall dispatch a reminder telegram or fax to an administration which has not made its comments under § 4.2.14, bringing the matter to its attention. (WRC-03)

4.2.14*ter* After expiry of the deadline for comments in respect of the proposed assignment, the Bureau shall, according to its records, publish a Special Section, indicating the list of administrations whose agreements are required for completion of the procedure of Article 4. (WRC-03)

4.2.15 If, in seeking agreement, an administration modifies its initial proposal, it shall again apply the provisions of § 4.2 and the consequent procedure with respect to any other administration whose services might be affected as a result of modifications to the initial proposal.

4.2.16[19*bis*] If no comments have been received on the expiry of the periods specified in § 4.2.14, or if agreement has been reached with the administrations which have made comments and with which agreement is necessary, the administration proposing the modification may continue with the appropriate procedure in Article 5, and shall so inform the Bureau, indicating the final characteristics of the frequency assignment together with the names of the administrations with which agreement has been reached. (WRC-19)

4.2.16*bis* In application of § 4.2.16, an administration may indicate the changes to the information communicated to the Bureau under § 4.2.6 and published under § 4.2.8. In submitting such information, noting the requirements of § 5.1.6, the administration may also request the Bureau to examine the submission in respect of notification under § 5.1.2. (WRC-19)

4.2.17 The agreement of the administrations affected may also be obtained in accordance with this Article, for a specified period. When this specific period of agreement expires for an assignment in the Plan, the assignment in question shall be maintained in the Plan until the end of the period referred to in § 4.2.6 above. After that date this assignment in the Plan shall lapse unless the agreement of the administrations affected is renewed[19*ter*]. (WRC-19)

[19*bis*] For any remaining affected networks whose assignments were entered in the Plan before the notice received under § 4.2.16, the Bureau shall use the method in Annex 1 to further examine if the remaining corresponding assignments in the Plan are still considered as being affected. The examination in respect of those remaining affected networks is conducted independently using the Appendices **30** and **30A** master database corresponding to the Part B Special Section that was published under § 4.2.19. (WRC-19)

[19*ter*] Unless the Bureau has been informed by the notifying administration of the renewal of the agreement, it shall, no later than six months before the end of the specified period, send a reminder to the notifying administration. (WRC-19)

4.2.18 When the proposed modification to the Region 2 feeder-link Plan involves developing countries, administrations shall seek all practicable solutions conducive to the economical development of the broadcasting-satellite systems of these countries.

4.2.19 The Bureau shall publish[20] in a Special Section of its BR IFIC the information received under § 4.2.16 together with the names of any administrations with which the provisions of this Article have been successfully applied. The frequency assignment concerned shall enjoy the same status as those appearing in the Region 2 feeder-link Plan and will be considered as a frequency assignment in conformity with that Plan. (WRC-03)

4.2.20 When an administration proposing to modify the characteristics of a frequency assignment or to make a new frequency assignment receives notice of disagreement on the part of an administration whose agreement it has sought, it shall first endeavour to solve the problem by exploring all possible means of meeting its requirement. If the problem still cannot be solved by such means, the administration whose agreement has been sought should endeavour to overcome the difficulties as far as possible, and shall state the technical reasons for any disagreement if the administration seeking the agreement requests it to do so. (WRC-19)

4.2.21 If no agreement is reached between the administrations concerned, the Bureau shall carry out any study that may be requested by these administrations; the Bureau shall inform them of the result of the study and shall make such recommendations as it may be able to offer for the solution of the problem.

4.2.21A If, in spite of the application of § 4.2.20 and 4.2.21, there is still continuing disagreement and the assignment which was the basis of the disagreement is not an assignment in the Region 2 feeder-link Plan, or in the Regions 1 and 3 feeder-link Plan or List, or for which the procedure of § 4.1 or 4.2 has been initiated, and if the notifying administration insists that the proposed assignment be included in the Region 2 feeder-link Plan, the Bureau shall provisionally enter the assignment in the Region 2 feeder-link Plan with an indication of those administrations whose assignments were the basis of the disagreement; however, the entry shall be changed from provisional to definitive recording in the Region 2 feeder-link Plan only if the Bureau is informed that the new or modified assignment in the Region 2 feeder-link Plan has been in use, together with the assignment which was the basis for the disagreement, for at least four months without any complaint of harmful interference being made. (WRC-03)

4.2.21B When requesting the application of § 4.2.21A, the notifying administration shall undertake to meet the requirements of § 4.2.21D and provide to the administration in respect of which § 4.2.21A has been applied, with a copy to the Bureau, a description of the steps by which it undertakes to meet these requirements. (WRC-03)

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[20] If the payments are not received in accordance with the provisions of Council Decision 482, as amended, on the implementation of cost recovery for satellite network filings, the Bureau shall cancel the publication, after informing the administration concerned. The Bureau shall inform all administrations of such action and that the network specified in the publication in question no longer has to be taken into consideration by the Bureau and other administrations. The Bureau shall send a reminder to the notifying administration not later than two months prior to the deadline for the payment in accordance with the above-mentioned Council Decision 482 unless the payment has already been received. (WRC-07)

4.2.21C Should the assignments that were the basis of the disagreement not be brought into use within the period specified in No. **11.44**, the status of the assignment in the Region 2 feeder-link Plan shall be reviewed accordingly. (WRC-03)

4.2.21D Should harmful interference be caused by an assignment included in the Region 2 feeder-link Plan under § 4.2.21A to any recorded assignment in the Master Register which was the basis of the disagreement, the administration using the frequency assignment included in the Region 2 feeder-link Plan under § 4.2.21A shall, upon receipt of advice thereof, immediately eliminate this harmful interference. (WRC-03)

4.2.22 An administration may at any stage in the procedure described, or before applying it, request the assistance of the Bureau.

4.2.23 The relevant provisions of Article 5 shall be applied when frequency assignments are notified to the Bureau.

4.2.24 Cancellation of frequency assignments

When a frequency assignment in conformity with the Region 2 feeder-link Plan is no longer required, whether or not as a result of a modification, the administration concerned shall immediately so inform the Bureau. The Bureau shall publish this information in a Special Section of its BR IFIC and delete the assignment from the Region 2 feeder-link Plan.

4.2.25 Master copy of the Region 2 feeder-link Plan

4.2.25.1 The Bureau shall maintain an up-to-date master copy of the Region 2 feeder-link Plan, including the overall equivalent protection margins of each assignment, taking account of the application of the procedure set out in this Article. This master copy shall contain the overall equivalent protection margins derived from that Plan as established by the 1983 Conference and those derived from all modifications to that Plan as a result of the successful completion of the modification procedure set out in this Article.

4.2.25.2 An up-to-date version of the Region 2 feeder-link Plan shall be published by the Secretary-General when justified by the circumstances.

ARTICLE 5 (REV.WRC--23)

Coordination, notification, examination and recording in the Master International Frequency Register of frequency assignments to feeder-link transmitting earth stations and receiving space stations in the fixed-satellite service[21, 22] (WRC-19)

5.1 Coordination and notification

5.1.1 When an administration wishes to determine whether it is possible to use, at a given location, an amount of power control which is in excess of that contained in column 12 of the Regions 1 and 3 feeder-link Plan, it shall request the Bureau to determine the amount of permissible power control (not to exceed 10 dB) from that given location using the procedure contained in § 3.11 of Annex 3.

5.1.2 Whenever an administration[23] intends to bring into use a frequency assignment to a transmitting earth station or receiving space station in the fixed-satellite service in the bands between 14.5 GHz and 14.8 GHz and between 17.3 GHz and 18.1 GHz in Regions 1 and 3, and between 17.3 GHz and 17.8 GHz in Region 2, it shall notify this frequency assignment to the Bureau. For this purpose, the notifying administration shall apply the following provisions. (WRC-03)

5.1.2*bis* Frequency assignments relating to a number of earth stations may be notified in the form of the characteristics of a typical earth station and the intended geographical area of operation. Individual notices of frequency assignments are however necessary in the case of earth stations whose coordination area includes all or part of the territory of another administration. (WRC-03)

5.1.3 Before an administration in Region 1 or 3 notifies to the Bureau or brings into use any frequency assignment to a specific transmitting feeder-link earth station in the bands 14.5-14.8 GHz and 17.7-18.1 GHz with an e.i.r.p. greater than the sum of the values specified in columns 11 and 12 of the Regions 1 and 3 feeder-link Plan, it shall effect coordination of this assignment with each administration whose territory lies wholly or partly within the coordination area of the planned earth station using the method detailed in Appendix **7**. (WRC-03)

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[21] Notification of assignments to transmitting feeder-link earth stations included in the Region 2 feeder-link Plan after 2 June 2000, or included in the feeder-link List, following successful application of Article 4, shall be effected applying the provisions of Article **11** following completion of the procedure of Article **9**. (WRC-03)

[22] If the payments are not received in accordance with the provisions of Council Decision 482, as amended, on the implementation of cost recovery for satellite network filings, the Bureau shall cancel the publication specified in § 5.1.10 and the corresponding entries in the Master Register under § 5.2.2, § 5.2.2.1, § 5.2.2.2 or § 5.2.6, as appropriate, and the corresponding entries included in the Plan on and after 3 June 2000 or in the List, as appropriate, after informing the administration concerned. The Bureau shall inform all administrations of such action. The Bureau shall send a reminder to the notifying administration not later than two months prior to the deadline for the payment in accordance with the above-mentioned Council Decision 482 unless the payment has already been received. (WRC-19)

[23] A frequency assignment to a space station or typical earth station in the satellite network may be notified by one administration acting on behalf of a group of named administrations. Any further notice (modification or deletion) relating to that assignment shall, in the absence of information to the contrary, be regarded as having been submitted on behalf of the entire group. (WRC-03)

5.1.4 Before an administration in Region 1 or 3 notifies to the Bureau or brings into use any frequency assignment to a specific transmitting feeder-link earth station in the bands 14.5-14.8 GHz and 17.7-18.1 GHz, it shall effect coordination of this assignment with each administration whose territory lies wholly or partly within the coordination area of the planned earth station, using the method detailed in Appendix **7**, in respect of notices concerning stations of the mobile and fixed services in the bands 14.5-14.8 GHz and 17.7-18.1 GHz and of the fixed-satellite service (space-to-Earth) in the band 17.7-18.1 GHz received by the Bureau prior to 3 June 2000 for recording in the International Master Frequency Register (Master Register) and subsequently recorded with a favourable finding[24]. (WRC-03)

5.1.5 If an administration with which coordination is sought under § 5.1.4 does not respond within three months, the administration intending to bring into use a frequency assignment to a feeder-link earth station shall notify this frequency assignment in accordance with § 5.1.2 above.

5.1.6 For any notification under § 5.1.2, an individual notice for each frequency assignment shall be drawn up as prescribed in Appendix **4**, the various sections of which specify the basic characteristics to be provided as appropriate. It is recommended that the notifying administration should also supply any other data it may consider useful.

5.1.6*bis* In application of § 5.1.2, an administration may identify the characteristics of assignments in the Plans or the List as notification and send to the Bureau the changes thereto. (WRC-03)

5.1.7 Each notice must reach the Bureau not earlier than three years before the date on which the frequency assignment is to be brought into use. In any case, the notice must reach the Bureau not later than three months before that date.

5.1.8 Any frequency assignment the notice of which reaches the Bureau after the applicable period specified in § 5.1.7 shall, where it is to be recorded, bear a remark in the Master Register to indicate that it is not in conformity with § 5.1.7.

5.1.9 Any notice made under § 5.1.2 which does not contain the characteristics specified in Appendix **4** shall be returned by the Bureau immediately by airmail to the notifying administration with the relevant reasons.

5.1.10 Upon receipt of a complete notice, the Bureau shall include its particulars, with the date of receipt, in its BR IFIC which shall contain the particulars of all such notices received since the publication of the previous Circular.

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[24] In cases where assignments from the WRC-97 Plans without Remarks were included in the WRC-2000 Regions 1 and 3 feeder-link Plan without change, or with conversion of modulation from analogue to digital, or a change from normal roll-off to fast roll-off antenna pattern, the coordination status afforded by the WRC-97 Plans shall be preserved.

In cases where assignments from the WRC-97 Plans with Remarks were included in the WRC-2000 Regions 1 and 3 feeder-link Plan without change, or with conversion of modulation from analogue to digital, or a change from normal roll-off to fast roll-off antenna pattern, the compatibility shall be reassessed using the revised criteria and methodology in force and the Remarks of the WRC-97 Plans assignment shall either be maintained or reduced on the basis of the results of this analysis. (WRC-03)

5.1.10*bis* Upon receipt of a complete notice, the Bureau shall immediately send a telefax to administrations which have applied § 4.1.13*bis* with regard to this notice, if any. This telefax shall inform the administrations concerned of the notification under § 5.1.1 of this notice and the date on which the frequency assignment which is the subject of the agreement under § 4.1.13*bis* is planned to be brought into use. (WRC-23)

5.1.11 The Circular shall constitute the acknowledgements to the notifying administration of the receipt of a complete notice.

5.1.12 Complete notices shall be considered by the Bureau in order of receipt. The Bureau shall not postpone its finding unless it lacks sufficient data to reach a decision; moreover, the Bureau shall not act upon any notice which has a technical bearing on an earlier notice still under consideration by the Bureau until it has reached a finding with respect to such earlier notice.

5.2 Examination and recording

5.2.1 The Bureau shall examine each notice:

a) with respect to its conformity with the Convention and the relevant provisions of the Radio Regulations (with the exception of those relating to § *b)*, *c)*, *d)*, *e)* and *f)* below); *and*

b) with respect to its conformity with the appropriate Regional feeder-link Plan or the Regions 1 and 3 feeder-link List, as appropriate; *or* (WRC-03)

c) with respect to the coordination requirements specified in the Remarks column of Article **9** or Article **9A**; *or*

d) with respect to its conformity with the appropriate Regional feeder-link Plan or the Regions 1 and 3 feeder-link List, however, having characteristics differing from those in this Plan or in the Regions 1 and 3 feeder-link List in one or more of the following aspects:

– use of a reduced e.i.r.p.,

– use of a reduced coverage area entirely situated within the coverage area appearing in the Plan or in the Regions 1 and 3 feeder-link List,

– use of other modulating signals in accordance with the provisions of § 3.1.3 to Annex 5 of Appendix **30**,

– in the case of Region 2, use of an orbital position under the conditions specified in § B of Annex 7 to Appendix **30**,

– in the case of Regions 1 and 3, use of the assignment for transmissions in the fixed-satellite service (Earth-to-space) other than for feeder links to the broadcasting-satellite service provided that such transmissions do not cause more interference, or require more protection from interference, than the feeder-link transmissions operating in conformity with the Plan or the List, as appropriate; (WRC-03)

e) for Region 2, with respect to its conformity with the provisions of Resolution **42 (Rev.WRC-19)**; (WRC-19)

f) for Regions 1 and 3, with respect to its conformity with the provisions of § 5.1.3 and also its conformity with § 5.1.4 or 5.1.5 relating to coordination.

5.2.2 When the Bureau reaches a favourable finding with respect to § 5.2.1 *a)*, 5.2.1 *b)*, 5.2.1 *c)* and 5.2.1 *f)*, the frequency assignment of an administration shall be recorded in the Master Register. The date of receipt of the notice by the Bureau shall be entered in the Master Register. In relations between administrations all frequency assignments brought into use in conformity with the feeder-link Plan and recorded in the Master Register shall be considered to have the same status irrespective of the dates of receipt entered in the Master Register for such frequency assignments. (WRC-07)

5.2.2.1 When the Bureau reaches a favourable finding with respect to § 5.2.1 *a)*, 5.2.1 *c)*, 5.2.1 *d)* and 5.2.1 *f)*, the frequency assignment shall be recorded in the Master Register. The date of receipt of the notice by the Bureau shall be entered in the Master Register. In relations between administrations, all frequency assignments brought into use in conformity with the feeder-link Plan and recorded in the Master Register shall be considered to have the same status irrespective of the dates of receipt entered in the Master Register for such frequency assignments. When recording these assignments, the Bureau shall indicate by an appropriate symbol the characteristics having a value different from that appearing in that Plan. (WRC-07)

5.2.2.2 In the case of Region 2, when the Bureau reaches a favourable finding with respect to § 5.2.1 *a)* and 5.2.1 *c)* but an unfavourable finding with respect to § 5.2.1 *b)* and 5.2.1 *d)*, it shall examine the notice with respect to the successful application of the provisions of Resolution **42 (Rev.WRC-19)**. A frequency assignment for which the provisions of Resolution **42 (Rev.WRC-19)** have been successfully applied shall be recorded in the Master Register with an appropriate symbol to indicate its interim status. The date of receipt of the notice by the Bureau shall be entered in the Master Register. In relations between administrations all frequency assignments brought into use following the successful application of the provisions of Resolution **42 (Rev.WRC-19)** and recorded in the Master Register shall be considered to have the same status irrespective of the dates of receipt entered in the Master Register for such frequency assignments. If the finding with respect to § 5.2.1 *e)*, where applicable, is unfavourable, the notice shall be returned immediately by airmail to the notifying administration. (WRC-19)

5.2.2.3 In the case of Regions 1 and 3, when the Bureau reaches a favourable finding with respect to § 5.2.1 *a)* and 5.2.1 *c)* but an unfavourable finding with respect to § 5.2.1 *b)* and 5.2.1 *d)*, the notice shall be returned immediately by airmail to the notifying administration with the Bureau's reasons for this finding and with such suggestions as the Bureau may be able to offer with a view to a satisfactory solution of the problem.

5.2.2.4 In the case of Regions 1 and 3, when the Bureau reaches a favourable finding with respect to § 5.2.1 *a)*, 5.2.1 *b)*, 5.2.1 *c)* and 5.2.1 *d)* but an unfavourable finding with respect to § 5.2.1 *f)*, the notice shall be returned immediately by airmail to the notifying administration with the Bureau's reasons for this finding and with such suggestions as the Bureau may be able to offer with a view to a satisfactory solution of the problem. If the unfavourable finding under § 5.2.1 *f)* is due to the coordination under § 5.1.3 only not being effected, the administration shall undertake only to bring this assignment into use with an e.i.r.p. level not greater than the sum of the values specified in columns 11 and 12 of the Regions 1 and 3 feeder-link Plan.

5.2.2.5 When an assignment is recorded as a result of a favourable finding with respect to § 5.2.1 *f)*, a remark shall be included indicating that coordination has been effected.

5.2.3 Whenever a frequency assignment is recorded in the Master Register, the finding reached by the Bureau shall be indicated. (WRC-07)

5.2.4 When the Bureau reaches an unfavourable finding with respect to:

– § 5.2.1 *a)*, *or*

– § 5.2.1 *c)*, *or*

– § 5.2.1 *b)* and 5.2.1 *d)* and, where appropriate, § 5.2.1 *e)*,

the notice shall be returned immediately by airmail to the notifying administration with the Bureau's reasons for this finding and with such suggestions as the Bureau may be able to offer with a view to a satisfactory solution of the problem.

5.2.5 When the notifying administration resubmits the notice and the finding of the Bureau becomes favourable with respect to the appropriate parts of § 5.2.1, the notice shall be treated as in § 5.2.2, 5.2.2.1 or 5.2.2.2 as appropriate.

5.2.6 If the notifying administration resubmits the notice without modification and insists on its reconsideration, and if the Bureau's finding with respect to § 5.2.1 remains unfavourable, the notice is returned to the notifying administration in accordance with § 5.2.4. In this case, the notifying administration undertakes not to bring into use the frequency assignment until the condition specified in § 5.2.5 is fulfilled. For Regions 1, 2 and 3, in the event that the Bureau has been informed of agreement to new or modified frequency assignments in the Plan for a specified period of time in accordance with Article 4, the frequency assignment shall be recorded in the Master Register with a note indicating that the frequency assignment is valid only for the period specified. The notifying administration using the frequency assignment over a specified period shall not subsequently invoke this fact to justify the continued use of the frequency beyond the period specified unless it obtains the agreement of the administration(s) concerned. (WRC-19)

5.2.7 If a frequency assignment notified in advance of bringing into use in conformity with § 5.1.3 has received a favourable finding by the Bureau with respect to the provisions of § 5.2.1, it shall be entered provisionally in the Master Register with a special symbol in the Remarks Column indicating the provisional nature of that entry.

5.2.8 When the Bureau has received confirmation that the frequency assignment has been brought into use, the Bureau shall remove the symbol in the Master Register.

5.2.9 The date of bringing into use notified by the administration concerned shall be recorded in the Master Register. (WRC-07)

5.2.10 Wherever the use of a frequency assignment to a space station recorded in the Master Register and emanating from the Regions 1 and 3 List is suspended for a period exceeding six months, the notifying administration shall inform the Bureau of the date on which such use was suspended. When the recorded assignment is brought back into use, the notifying administration shall so inform the Bureau, as soon as possible. On receipt of the information sent under this provision, the Bureau shall make that information available on the ITU website as soon as possible and shall publish it in the BR IFIC. The date on which the recorded assignment is brought back into use[24*bis*, 24*ter*] shall be no later than three years from the date on which the use of the frequency assignment was suspended, provided that the notifying administration informs the Bureau of the suspension within six months from the date on which the use was suspended. If the notifying administration informs the Bureau of the suspension more than six months after the date on which the use of the frequency assignment was suspended, this three-year time period shall be reduced. In this case, the amount by which the three-year period shall be reduced shall be equal to the amount of time that has elapsed between the end of the six-month period and the date that the Bureau is informed of the suspension. If the notifying administration informs the Bureau of the suspension more than 21 months after the date on which the use of the frequency assignment was suspended, the frequency assignment shall be cancelled. (WRC-23)

5.2.11 If a recorded frequency assignment stemming from the Regions 1 and 3 List is not brought back into use within the suspension period resulting from the application of § 5.2.10 above, the Bureau shall cancel the assignment from the Master Register and the assignment in the List, unless the assignment is one to which § 4.1.26 or § 4.1.27 is being applied. (WRC-15)

5.3 Cancellation of entries in the Master Register

5.3.1 Any notified frequency assignment to which the Article 4 procedures have been applied and which has been provisionally recorded under § 5.2.7 shall be brought into use no later than the end of the period provided under § 4.1.3, 4.1.3*bis*, 4.2.6 or 4.2.6*bis* of Article 4. Any other frequency assignment provisionally recorded under § 5.2.7 shall be brought into use by the date specified in the notice. Unless the Bureau has been informed by the notifying administration of the bringing into use of the assignment under § 5.2.8, it shall, no later than 15 days before the notified date of bringing into use or the end of the regulatory period established under § 4.1.3, 4.1.3*bis*, 4.2.6 or 4.2.6*bis* of Article 4, as appropriate, send a reminder requesting confirmation that the assignment has been brought into use within the regulatory period. If the Bureau does not receive that confirmation within 30 days following the notified date of bringing into use or the period provided under § 4.1.3, 4.1.3*bis*, 4.2.6 or 4.2.6*bis* of Article 4, as the case may be, it shall cancel the entry in the Master Register. (WRC-15)

24*bis* The date of bringing back into use of a frequency assignment to a space station in the geostationary-satellite orbit shall be the commencement of the 90-day period defined below. A frequency assignment to a space station in the geostationary-satellite orbit shall be considered as having been brought back into use when a space station in the geostationary-satellite orbit with the capability of transmitting or receiving that frequency assignment has been deployed and maintained at the notified orbital position for a continuous period of 90 days. The notifying administration shall inform the Bureau within 30 days from the end of the 90-day period. Resolution **40 (Rev.WRC-19)** shall apply. (WRC-19)

24*ter* If the notifying administration has informed the Bureau of the date of commencement of the 90-day bringing-back-into-use period, but, as of 15 days after the end of the 90-day bringing-back-into-use period, has not yet informed the Bureau of the completion of the bringing-back-into-use period in accordance with footnote 24*bis*, the Bureau shall promptly send the notifying administration a reminder of its obligation to inform the Bureau of the completion of the bringing-back-into-use period under footnote 24*bis*. (WRC-23)

5.3.2 If the use of any recorded frequency assignment is permanently discontinued, the notifying administration shall so inform the Bureau within three months, whereupon the entry shall be removed from the Master Register.

ARTICLE 6 (REV.WRC-15)

Coordination, notification and recording in the Master International Frequency Register of frequency assignments to receiving terrestrial stations in Regions 1 and 3 in the bands 14.5-14.8 GHz and 17.7-18.1 GHz, and in Region 2 in the band 17.7-17.8 GHz, when frequency assignments to feeder-link transmitting earth stations for the broadcasting-satellite service in conformity with the Regions 1 and 3 feeder-link Plan or the Region 2 feeder-link Plan[25] are involved[26]

6.1 Administrations planning to implement assignments for terrestrial stations in Regions 1 and 3 in the bands 14.5-14.8 GHz and 17.7-18.1 GHz, and in Region 2 in the band 17.7-17.8 GHz should evaluate the level of interference assessed on the basis of coordination contours calculated in accordance with Appendix **7**[27], which might be caused by a feeder-link earth station located on the territory of another administration and included in the service area of an assignment to a broadcasting-satellite service feeder-link space station which is in conformity with the appropriate regional feeder-link Plan. Should the administration planning terrestrial stations find that interference may be caused by such a feeder-link earth station, it may request the administration responsible for the feeder-link earth station to indicate the geographical coordinates, the antenna characteristics and the horizon elevation angle around its existing and planned feeder-link earth stations.

6.2 In the case of Region 2, when the entry in the feeder-link Plan contains information on specific earth stations, this shall be used in the interference calculations referred to in § 6.1 above. Where such information is not contained in the Region 2 feeder-link Plan, an administration which receives a request under § 6.1 shall, within a period of four months, communicate the details of the feeder-link earth stations to the administration planning the terrestrial station, and to the Bureau in order to update this Plan.

6.3 In the case of Regions 1 and 3, an administration which receives a request under § 6.1 shall, within a period of four months, communicate the details of the feeder-link stations to the administration planning the terrestrial station, and to the Bureau for information.

6.4 If, at the end of the period of four months, the administration responsible for the terrestrial station does not receive a reply, it may request the assistance of the Bureau.

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[25] Only assignments included in the Region 2 feeder-link Plan before 3 June 2000 shall be taken into account. (WRC-03)

[26] These procedures do not replace the procedures prescribed for terrestrial stations in Articles **9** and **11**. (WRC-03)

[27] In the case of Regions 1 and 3, the feeder-link earth-station power to be taken into account is obtained by adding the values specified in Columns 11 and 12 of the feeder-link Plan.

6.5 If the administration responsible for the feeder-link earth station does not communicate to the Bureau, within a period of four months, the information requested under § 6.1, this administration shall only implement its feeder-link earth station provided it does not cause harmful interference to the terrestrial station under consideration.

6.6 If, as a result of the application of this Article, an agreement is reached with the administration responsible for the feeder-link earth station or no comments have been received, the administration responsible for the terrestrial station may notify this station under Article **11** for recording in the Master Register. A remark shall be included indicating either that an agreement has been reached or that no comments have been received.

ARTICLE 7 (REV.WRC-23)

Coordination, notification and recording in the Master International Frequency Register of frequency assignments to stations in the fixed-satellite service (space-to-Earth) in Regions 1 and 2 in the frequency band 17.3-18.1 GHz and in Region 3 in the frequency band 17.7-18.1 GHz, to stations in the fixed-satellite service (Earth-to-space) in Region 2 in the frequency bands 14.5-14.8 GHz and 17.8-18.1 GHz, to stations in the fixed-satellite service (Earth-to-space) in countries listed in Resolution 163 (WRC-15) in the frequency band 14.5-14.75 GHz and in countries listed in Resolution 164 (WRC-15) in the frequency band 14.5-14.8 GHz where those stations are not for feeder links for the broadcasting-satellite service, and to stations in the broadcasting-satellite service in Region 2 in the frequency band 17.3-17.8 GHz when frequency assignments to feeder links for broadcasting-satellite stations in the frequency bands 14.5-14.8 GHz and 17.3-18.1 GHz in Regions 1 and 3 or in the frequency band 17.3-17.8 GHz in Region 2 are involved[28] (Rev.WRC-23)

Section I – Coordination of transmitting space or earth stations in the fixed-satellite service or transmitting space stations in the broadcasting-satellite service with assignments to broadcasting-satellite service feeder links

7.1 The provisions of No. **9.7** and the associated provisions under Articles **9** and **11** are applicable to transmitting space stations in the fixed-satellite service in Regions 1 and 2 in the frequency band 17.3-18.1 GHz, to transmitting space stations in the fixed-satellite service in Region 3 in the frequency band 17.7-18.1 GHz, to transmitting earth stations in the fixed-satellite service in Region 2 in the frequency bands 14.5-14.8 GHz and 17.8-18.1 GHz, to transmitting earth stations in the fixed-satellite service in countries listed in Resolution **163 (WRC-15)** in the frequency band 14.5-14.75 GHz and in countries listed in Resolution **164 (WRC-15)** in the frequency band 14.5-14.8 GHz where those stations are not for feeder links for the broadcasting-satellite service, and to transmitting space stations in the broadcasting-satellite service in Region 2 in the frequency band 17.3-17.8 GHz. (WRC-23)

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[28] These provisions do not replace the procedures prescribed in Articles **9** and **11** when stations other than those for feeder links in the broadcasting-satellite service subject to a Plan are involved. (WRC-03)

[29] (SUP – WRC-19)

7.2 In applying the procedures referred to in § 7.1, the provisions of Appendix **5** are replaced by the following:

7.2.1 The frequency assignments to be taken into account are:

a) the assignments in conformity with the appropriate Regional feeder-link Plan in Appendix **30A**;

b) the assignments included in the Regions 1 and 3 feeder-link List;

c) the assignments for which the procedure of Article 4 has been initiated as from the date of receipt of the complete Appendix **4** information under § 4.1.3 or 4.2.6. (WRC-03)

7.2.2 The criteria to be applied are those given in Annex 4.

7.2*bis* In applying the procedures referred to in § 7.1 for FSS frequency assignments in countries listed in Resolution **163 (WRC-15)** in the frequency band 14.5-14.75 GHz and in countries listed in Resolution **164 (WRC-15)** in the frequency band 14.5-14.8 GHz not for feeder links for the broadcasting-satellite service, the provision of No. **11.41** is replaced by the following provision. No. **11.41.2** continues to apply. (WRC-15)

7.2*bis*.1 If, after a notice is returned under No. **11.38**, the notifying administration resubmits the notice and insists upon its reconsideration, and the assignment which was the basis of the unfavourable finding is neither an assignment in the Regions 1 and 3 Plan, nor an assignment of definitive recording in the Regions 1 and 3 feeder-link List or one for which the complete Appendix **4** information has been received under § 4.1.12 for the definitive recording by the date of submission pursuant to No. **9.30** of this notice, the Bureau shall enter the assignment in the Master Register with an indication of those administrations whose assignments were the basis of the unfavourable finding, provided that such resubmission is accompanied with a formal commitment indicating that, if unacceptable interference is caused to the Regions 1 and 3 recorded assignments which were the basis of the unfavourable finding, the notifying administration of the FSS shall immediately eliminate this unacceptable interference (see also No. **11.42**). (WRC-15)

Section II – Coordination with assignments in conformity with the appropriate Regional feeder-link Plan in Appendix 30A

7.3 Administrations planning to implement assignments for receiving earth stations in all Regions in the band 17.7-18.1 GHz in the fixed-satellite service (space-to-Earth) or in the band 17.3-17.8 GHz in the broadcasting-satellite service should evaluate the level of interference, assessed on the basis of coordination contours calculated in accordance with Appendix **7**, which might be caused by a feeder-link earth station located on the territory of another administration and included in the service area of an assignment to a broadcasting-satellite service feeder-link space station which is in conformity with the appropriate Regional feeder-link Plan. Should the administration planning receiving earth stations find that interference may be caused by such a feeder-link earth station, it may request the administration responsible for the feeder-link earth station to indicate the geographical coordinates, the antenna characteristics and the elevation angle of the horizon around its existing and planned feeder-link earth stations.

7.4 In the case of Region 2, when the entry in the feeder-link Plan contains information on specific earth stations this shall be used in the interference calculations mentioned in § 7.3 above. Where such information is not contained in this Plan an administration which receives a request under § 7.3 shall, within a period of four months, communicate the details of the feeder-link earth stations to the administration planning the receiving earth station, and to the Bureau in order to update this Plan.

7.5 In the case of Regions 1 and 3, an administration which receives a request under § 7.3 shall, within a period of four months, communicate the details of the feeder-link earth stations to the administration planning the receiving earth station, and to the Bureau for information.

7.6 If, at the end of the period of four months, the administration responsible for the fixed-satellite or broadcasting-satellite receiving earth station(s) does not receive a reply, it may request the assistance of the Bureau.

7.7 If the administration responsible for the feeder-link earth stations does not communicate to the Bureau, within a period of four months, the information requested under § 7.3, this administration shall only implement its feeder-link earth station provided it does not cause harmful interference to the fixed-satellite or broadcasting-satellite earth station(s) under consideration.

7.8 If, as a result of the application of this Article, an agreement is reached with the administration responsible for the feeder-link earth station or no comments have been received, and where the station is recorded in the Master Register in accordance with Article **11**, the Bureau shall enter a remark indicating either that an agreement has been reached or that no comments have been received.

Section III – Coordination with assignments in the Regions 1 and 3 feeder-link List, or for which the procedure of Article 4 has been initiated

7.9 The provisions of No. **9.17A** and the associated provisions under Articles **9** and **11** and Appendix **5** are applicable to fixed-satellite service and broadcasting-satellite service receiving earth stations, in respect of frequency assignments to transmitting broadcasting-satellite service feeder-link earth stations, in the fixed-satellite service in the bands 17.3-18.1 GHz in Regions 1 and 3 and 17.3-17.8 GHz in Region 2 which correspond to assignments to receiving broadcasting-satellite service feeder-link space stations already included in the Regions 1 and 3 feeder-link List, or for which the procedure of Article 4 has been initiated, as from the date of receipt of the complete Appendix **4** information. (WRC-03)

ARTICLE 8

Miscellaneous provisions relating to the procedures*

Section I – Studies and Recommendations

8.1.1 If it is requested by any administration, the Board, using such means at its disposal as are appropriate in the circumstances, shall conduct a study of cases of alleged contravention or non-observance of these provisions, or of harmful interference.

8.1.2 The Board shall thereupon prepare and forward to the administrations concerned a report containing its findings and recommendations for the solution of the problem.

8.1.3 On receiving the Board's recommendations for the solution of the problem, an administration shall promptly acknowledge the receipt by telegram and shall subsequently indicate the action it intends to take. In cases when the Board's suggestions or recommendations are unacceptable to the administrations concerned, further efforts should be made by the Board to find an acceptable solution to the problem.

8.1.4 In a case where, as a result of a study, the Board submits to one or more administrations suggestions or recommendations for the solution of a problem, and where no answer has been received from one or more of these administrations within a period of four months, the Board shall consider that the suggestions or recommendations concerned are unacceptable to the administrations which did not answer. If it was the requesting administration which failed to answer within this period, the Board shall close the study.

Section II – Miscellaneous provisions

8.2.1 If it is requested by any administration, particularly by an administration of a country in need of special assistance, the Board, using such means at its disposal as are appropriate in the circumstances, shall render the following assistance:

a) computation necessary in the application of Annexes 1, 3 and 4;

b) any other assistance of a technical nature for completion of the procedures in this Appendix.

8.2.2 In making a request to the Board under § 8.2.1, the administration shall furnish the Board with the necessary information.

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* *Note by the Secretariat*: WRC-97 did not review this Article. The subject matter is also dealt with in Articles **13** and **14**, which were reviewed by WRC-97.

ARTICLE 9 (REV.WRC-19)

Plan for feeder links for the broadcasting-satellite service in the fixed-satellite service in the frequency band 17.3-17.8 GHz in Region 2

9.1 COLUMN HEADINGS OF THE PLAN

Col. 1 *Beam identification* (column 1 contains the symbol designating the country or the geographical area taken from Table B1 of the Preface to the International Frequency Information Circular (BR IFIC) followed by the symbol designating the service area).

Col. 2 *Nominal orbital position*, in degrees and hundredths of a degree.

Col. 3 *Channel number* (see Table 2 showing channel numbers and corresponding assigned frequencies).

Col. 4 *Boresight geographical coordinates*, in degrees and hundredths of a degree.

Col. 5 *Antenna beamwidth*. This column contains two figures corresponding to the major axis and the minor axis respectively of the elliptical cross section half-power beam, in degrees and hundredths of a degree.

Col. 6 *Orientation of the ellipse* determined as follows: in a plane normal to the beam axis, the direction of a major axis of the ellipse is specified as the angle measured anticlockwise from a line parallel to the equatorial plane to the major axis of the ellipse to the nearest degree.

Col. 7 *Polarization* (1 = direct, 2 = indirect)[30].

Col. 8 Earth station *e.i.r.p.* in the direction of maximum radiation, in dBW.

Col. 9 Remarks[31].

9.2 TEXT FOR NOTES IN REMARKS COLUMN OF THE PLAN

1 Fast roll-off space station receiving antenna as defined in Annex 3 (§ 4.6.3).

2 Television standard with 625 lines using greater video bandwidth and necessary bandwidth of 27 MHz.

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[30] See Annex 3 (§ 4.8) to this Appendix.

[31] The location of earth stations, together with the antenna characteristics and elevation angle of the horizon, are given as an annex to this Plan, and will be published when the Plan is republished in accordance with § 4.2.25.2 of Article 4.

3 This assignment may cause interference to feeder-link assignments* of Spain, Guinea-Bissau and Portugal in the Regions 1 and 3 feeder-link Plan adopted at the 1988 Conference and shall only be brought into use if:

a) the administrations of Spain, Guinea-Bissau and Portugal agree: *or*

b) their feeder-link equivalent protection margins, as defined in § 1.7 of Annex 3, are positive.

The affected administrations shall be informed by the notifying administration of the required changes in characteristics before this assignment is brought into use.

4 This assignment may be utilized in the geographical area of Anguilla (AIA) (which is in the beam area).

5 Feeder-link earth stations for this assignment may also be located in the territories of Puerto Rico and the United States Virgin Islands. Such operation shall not cause more interference nor require more protection than the assignment under the Plan.

6 Feeder-link earth stations for this assignment may also be located in the States of Alaska and Hawaii. Such operation shall not cause more interference nor require more protection than the assignment under the Plan.

7 The feeder-link earth station for this assignment may also be located at the point with geographical coordinates 3° 31′ West, 48° 46′ North. Such operation shall not cause more interference nor require more protection than the assignment under the Plan.

8 Feeder-link earth stations for this assignment may also be located at the points with the following geographical coordinates:

47° 55′ West	15° 47′ South	34° 53′ West	08° 04′ South
43° 13′ West	22° 55′ South	60° 02′ West	03° 06′ South
46° 38′ West	23° 33′ South	38° 31′ West	12° 56′ South
51° 13′ West	30° 02′ South	49° 15′ West	16° 40′ South

Such operation shall not cause more interference nor require more protection than the assignment under the Plan.

* *Note by the Secretariat*: Since the orbital positions of these countries were changed by WRC-97, this paragraph might need to be revised.

9/GR . . This assignment is part of a group, the number of which follows the symbol. The group consists of the beams and has the number of channels assigned to it as indicated in Table 1.

a) The overall equivalent protection margin to be used for the application of Article 4 and Resolution **42 (Rev.WRC-19)** shall be calculated on the following basis:

– for the calculation of interference to assignments that are part of a group, only the interference contributions from assignments that are not part of the same group are to be included; *and*

– for the calculation of interference from assignments belonging to a group, to assignments that are not part of that same group, only the worst interference contribution from that group shall be used on a test point to test point basis. (WRC-03).

b) If an administration notifies the same frequency in more than one beam of a group for use at the same time, the overall *C*/*I* produced by all emissions from that group shall not exceed the *C*/*I* calculated on the basis of § *a)* above.

TABLE 1

Group	Beams in the group	Number of channels assigned to the group
GR1	ALS00002 HWA00002 USAPSA02	32 channels
GR2	ALS00003 HWA00003 USAPSA03	32 channels
GR3	ARGINSU4 ARGSUR04	16 channels
GR4	ARGINSU5 ARGSUR05	12 channels
GR5	BOLAND01 CLMAND01 EQACAND1 EQAGAND1 PRUAND02 VENAND03	16 channels
GR6	B SU111 B SU211	32 channels
GR7	B CE311 B CE411 B CE511	32 channels
GR8	B NO611 B NO711 B NO811	32 channels
GR9	B SU112 B SU212 B CE312 B CE412	32 channels
GR10	CAN01101 CAN01201	32 channels
GR11	*Not used*	
GR12	CAN01203 CAN01303 CAN01403	32 channels
GR13	CAN01304 CAN01404 CAN01504	32 channels
GR14	CAN01405 CAN01505 CAN01605	32 channels
GR15	*Not used*	
GR16	CHLCONT4 CHLCONT6	16 channels
GR17	CHLCONT5 PAQPAC01 CHLPAC02	16 channels
GR18	CRBBER01 CRBBLZ01 CRBJMC01 CRBBAH01 CRBEC001	16 channels
GR19	EQACOO01 EQAGOO01	16 channels
GR20	PTRVIR01 USAEHO02	32 channels
GR21	PTRVIR02 USAEHO03	32 channels
GR22	VEN02VEN VEN11VEN	4 channels

Country symbols

1 For the explanation of symbols designating countries or geographical areas in Region 2, see the Preface to the BR IFIC.

2 One additional symbol, CRB, has been created for the purposes of the 1983 Conference only, to designate to geographical area in the Caribbean Area. The five Caribbean beams are identified as follows:

CRBBAH01, CRBBER01, CRBBLZ01, CRBEC001 and CRBJMC01

and are intended collectively to provide coverage for the following countries or geographical areas: AIA, ATG, BAH, BER, BLZ, BRB, CYM, DMA, GRD, GUY, JMC, LCA, MSR, KNA, SUR, TCA, TRD, VCT and VRG to be so used if approved by them.

TABLE 2

Table showing correspondence between channel numbers and assigned frequencies

Channel No.	Assigned frequency (MHz)	Channel No.	Assigned frequency (MHz)
1	17 324.00	17	17 557.28
2	17 338.58	18	17 571.86
3	17 353.16	19	17 586.44
4	17 367.74	20	17 601.02
5	17 382.32	21	17 615.60
6	17 396.90	22	17 630.18
7	17 411.48	23	17 644.76
8	17 426.06	24	17 659.34
9	17 440.64	25	17 673.92
10	17 455.22	26	17 688.50
11	17 469.80	27	17 703.08
12	17 484.38	28	17 717.66
13	17 498.96	29	17 732.24
14	17 513.54	30	17 746.82
15	17 528.12	31	17 761.40
16	17 542.70	32	17 775.98

17 324.00 MHz (1)

1	2	3	4		5		6	7	8	9
ALS00002	−166.20	1	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
ALS000/03	−175.20	1	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
ARGINSU4	−94.20	1	−52.98	−59.81	3.40	0.68	19	1	87.4	9/GR3
ARGSUR04	−94.20	1	−65.04	−43.33	3.32	1.50	40	1	87.4	9/GR3
B CE311	−64.20	1	−40.60	−6.07	3.04	2.06	174	1	87.4	8 9/GR7
B CE312	−45.20	1	−40.27	−6.06	3.44	2.09	174	1	87.4	8 9/GR9
B CE411	−64.20	1	−50.97	−15.27	3.86	1.38	49	1	87.4	8 9/GR7
B CE412	−45.20	1	−50.71	−15.30	3.57	1.56	52	1	87.4	8 9/GR9
B CE511	−64.20	1	−53.10	−2.90	2.44	2.13	104	1	87.4	8 9/GR7
B NO611	−74.20	1	−59.60	−11.62	2.85	1.69	165	2	87.4	8 9/GR8
B NO711	−74.20	1	−60.70	−1.78	3.54	1.78	126	2	87.4	8 9/GR8
B NO811	−74.20	1	−68.76	−4.71	2.37	1.65	73	2	87.4	8 9/GR8
B SU111	−81.20	1	−51.12	−25.63	2.76	1.05	50	1	87.4	8 9/GR6
B SU112	−45.20	1	−50.75	−25.62	2.47	1.48	56	1	87.4	8 9/GR9
B SU211	−81.20	1	−44.51	−16.95	3.22	1.36	60	1	87.4	8 9/GR6
B SU212	−45.20	1	−44.00	−16.87	3.20	1.96	58	1	87.4	8 9/GR9
BAHIFRB1	−87.20	1	−76.06	24.16	1.81	0.70	142	1	87.4	
BERBERMU	−96.20	1	−64.77	32.32	0.60	0.60	90	2	87.4	
BERBER02	−31.00	1	−64.77	32.32	0.60	0.60	90	1	87.4	2 3
BOLAND01	−115.20	1	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CAN01101	−138.20	1	−114.60	51.08	7.28	1.10	160	1	87.4	9/GR10
CAN01201	−138.20	1	−114.60	51.08	7.28	1.10	160	1	87.4	9/GR10
CAN01202	−72.70	1	−81.34	50.02	7.96	2.55	5	1	87.4	
CAN01203	−129.20	1	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01303	−129.20	1	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01304	−91.20	1	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01403	−129.20	1	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01404	−91.20	1	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01405	−82.20	1	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01504	−91.20	1	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01505	−82.20	1	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01605	−82.20	1	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01606	−70.70	1	−80.77	50.03	7.88	2.53	6	1	87.4	
CHLCONT5	−106.20	1	−72.23	−35.57	2.60	0.68	55	1	87.4	9/GR17
CHLPAC02	−106.20	1	−80.06	−30.06	1.36	0.68	69	1	87.4	9/GR17
CLMAND01	−115.20	1	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CLM00001	−103.20	1	−74.50	5.87	3.98	1.96	118	1	87.4	
EQACAND1	−115.20	1	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
EQAGAND1	−115.20	1	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
FLKANT01	−57.20	1	−44.54	−60.13	3.54	0.68	12	1	87.4	2
FLKFALKS	−31.00	1	−59.90	−51.64	0.60	0.60	90	1	87.4	2 3
GRD00002	−42.20	1	−61.58	12.29	0.60	0.60	90	1	87.4	
HWA00002	−166.20	1	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
HWA00003	−175.20	1	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
MEX01NTE	−78.20	1	−105.81	26.01	2.89	2.08	155	1	87.4	1
MEX01SUR	−69.20	1	−94.84	19.82	3.05	2.09	4	1	87.4	1
MEX02NTE	−136.20	1	−107.21	26.31	3.84	1.55	148	1	87.4	1
MEX02SUR	−127.20	1	−96.39	19.88	3.18	1.87	157	1	87.4	1
PAQPAC01	−106.20	1	−109.18	−27.53	0.60	0.60	90	1	87.4	9/GR17
PRG00002	−99.20	1	−58.66	−23.32	1.45	1.04	76	1	87.4	
PRUAND02	−115.20	1	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
PTRVIR01	−101.20	1	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
PTRVIR02	−110.20	1	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
SPMFRAN3	−53.20	1	−67.24	47.51	3.16	0.79	7	1	87.4	2 7
TRD00001	−84.70	1	−61.23	10.70	0.60	0.60	90	1	87.4	
URG00001	−71.70	1	−56.22	−32.52	1.02	0.89	11	1	87.4	
USAEH001	−61.70	1	−87.57	36.17	6.42	3.49	12	1	87.4	1 5 6
USAEH002	−101.20	1	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
USAEH003	−110.20	1	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
USAEH004	−119.20	1	−96.45	36.21	8.20	3.12	165	1	87.4	1 5 6
USAPSA02	−166.20	1	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
USAPSA03	−175.20	1	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
USAWH101	−148.20	1	−111.02	40.68	4.36	2.15	162	1	87.4	
USAWH102	−157.20	1	−113.07	40.74	3.72	1.78	149	1	87.4	
VENAND03	−115.20	1	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
VRG00001	−79.70	1	−64.37	18.48	0.60	0.60	90	1	87.4	4

17 338.58 MHz (2)

1	2	3	4		5		6	7	8	9
ALS00002	−165.80	2	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
ALS00003	−174.80	2	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
ARGNORT4	−93.80	2	−63.96	−30.01	3.86	1.99	48	2	87.4	
ARGNORT5	−54.80	2	−62.85	−29.80	3.24	2.89	47	2	87.4	
ATNBEAM1	−52.80	2	−66.44	14.87	1.83	0.68	39	2	87.4	
B CE311	−63.80	2	−40.60	−6.07	3.04	2.06	174	2	87.4	8 9/GR7
B CE312	−44.80	2	−40.26	−6.06	3.44	2.09	174	2	87.4	8 9/GR9
B CE411	−63.80	2	−50.97	−15.26	3.86	1.38	49	2	87.4	8 9/GR7
B CE412	−44.80	2	−50.71	−15.30	3.57	1.56	52	2	87.4	8 9/GR9
B CE511	−63.80	2	−53.11	−2.98	2.42	2.15	107	2	87.4	8 9/GR7
B NO611	−73.80	2	−59.60	−11.62	2.86	1.69	165	1	87.4	8 9/GR8
B NO711	−73.80	2	−60.70	−1.78	3.54	1.78	126	1	87.4	8 9/GR8
B NO811	−73.80	2	−68.75	−4.71	2.37	1.65	73	1	87.4	8 9/GR8
B SE911	−101.80	2	−45.99	−19.09	2.22	0.79	62	2	87.4	8
B SU111	−80.80	2	−51.10	−25.64	2.76	1.06	50	2	87.4	8 9/GR6
B SU112	−44.80	2	−50.76	−25.62	2.47	1.48	56	2	87.4	8 9/GR9
B SU211	−80.80	2	−44.51	−16.94	3.22	1.37	60	2	87.4	8 9/GR6
B SU212	−44.80	2	−43.99	−16.97	3.27	1.92	59	2	87.4	8 9/GR9
CAN01101	−137.80	2	−114.10	50.92	7.22	1.11	160	2	87.4	9/GR10
CAN01201	−137.80	2	−114.10	50.92	7.22	1.11	160	2	87.4	9/GR10
CAN01202	−72.30	2	−81.23	50.12	7.99	2.53	5	2	87.4	
CAN01203	−128.80	2	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01303	−128.80	2	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01304	−90.80	2	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01403	−128.80	2	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01404	−90.80	2	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01405	−81.80	2	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01504	−90.80	2	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01505	−81.80	2	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01605	−81.80	2	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01606	−70.30	2	−80.64	50.02	7.88	2.52	6	2	87.4	
CHLCONT4	−105.80	2	−69.59	−23.20	2.21	0.69	68	2	87.4	9/GR16
CHLCONT6	−105.80	2	−73.52	−55.52	3.65	1.31	39	2	87.4	9/GR16
CRBBAH01	−92.30	2	−76.09	24.13	1.83	0.68	141	1	87.4	9/GR18
CRBBER01	−92.30	2	−64.76	32.13	0.60	0.60	90	1	87.4	9/GR18
CRBBLZ01	−92.30	2	−88.61	17.26	0.64	0.64	90	1	87.4	9/GR18
CRBEC001	−92.30	2	−60.07	8.26	4.20	0.86	115	1	87.4	9/GR18
CRBJMC01	−92.30	2	−79.45	17.97	0.99	0.68	151	1	87.4	9/GR18
CTR00201	−130.80	2	−84.33	9.67	0.82	0.68	119	2	87.4	
EQAC0001	−94.80	2	−78.31	−1.52	1.48	1.15	65	1	87.4	9/GR19
EQAG0001	−94.80	2	−90.36	−0.57	0.94	0.89	99	1	87.4	9/GR19
GUY00302	−33.80	2	−59.07	4.77	1.43	0.85	91	2	87.4	
HNDIFRB2	−107.30	2	−86.23	15.16	1.14	0.85	8	1	87.4	
HTI00002	−83.30	2	−73.28	18.96	0.82	0.68	11	2	87.4	
HWA00002	−165.80	2	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
HWA00003	−174.80	2	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
MEX01NTE	−77.80	2	−105.80	25.99	2.88	2.07	155	2	87.4	1
MEX02NTE	−135.80	2	−107.36	26.32	3.80	1.57	149	2	87.4	1
MEX02SUR	−126.80	2	−96.39	19.88	3.19	1.87	158	2	87.4	1
PRU00004	−85.80	2	−74.19	−8.39	3.74	2.45	112	2	87.4	
PTRVIR01	−100.80	2	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
PTRVIR02	−109.80	2	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
TCA00001	−115.80	2	−71.79	21.53	0.60	0.60	90	2	87.4	
USAEH001	−61.30	2	−87.53	36.18	6.41	3.49	12	2	87.4	1 5 6
USAEH002	−100.80	2	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
USAEH003	−109.80	2	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH004	−118.80	2	−96.42	36.21	8.20	3.12	165	2	87.4	1 5 6
USAPSA02	−165.80	2	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
USAPSA03	−174.80	2	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
USAWH101	−147.80	2	−111.01	40.67	4.38	2.15	162	2	87.4	
USAWH102	−156.80	2	−113.01	40.71	3.74	1.79	149	2	87.4	
VCT00001	−79.30	2	−61.18	13.23	0.60	0.60	90	2	87.4	
VEN11VEN	−103.80	2	−66.79	6.90	2.50	1.77	122	2	87.4	

17 353.16 MHz (3)

1	2	3	4		5		6	7	8	9
ALS00002	−166.20	3	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
ALS00003	−175.20	3	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
ARGINSU4	−94.20	3	−52.98	−59.81	3.40	0.68	19	1	87.4	9/GR3
ARGINSU5	−55.20	3	−44.17	−59.91	3.77	0.70	13	1	87.4	9/GR4
ARGSUR04	−94.20	3	−65.04	−43.33	3.32	1.50	40	1	87.4	9/GR3
ARGSUR05	−55.20	3	−63.68	−43.01	2.54	2.38	152	1	87.4	9/GR4
ATGSJN01	−79.70	3	−61.79	17.07	0.60	0.60	90	1	87.4	
B CE311	−64.20	3	−40.60	−6.07	3.04	2.06	174	1	87.4	8 9/GR7
B CE312	−45.20	3	−40.27	−6.06	3.44	2.09	174	1	87.4	8 9/GR9
B CE411	−64.20	3	−50.97	−15.27	3.86	1.38	49	1	87.4	8 9/GR7
B CE412	−45.20	3	−50.71	−15.30	3.57	1.56	52	1	87.4	8 9/GR9
B CE511	−64.20	3	−53.10	−2.90	2.44	2.13	104	1	87.4	8 9/GR7
B NO611	−74.20	3	−59.60	−11.62	2.85	1.69	165	2	87.4	8 9/GR8
B NO711	−74.20	3	−60.70	−1.78	3.54	1.78	126	2	87.4	8 9/GR8
B NO811	−74.20	3	−68.76	−4.71	2.37	1.65	73	2	87.4	8 9/GR8
B SU111	−81.20	3	−51.12	−25.63	2.76	1.05	50	1	87.4	8 9/GR6
B SU112	−45.20	3	−50.75	−25.62	2.47	1.48	56	1	87.4	8 9/GR9
B SU211	−81.20	3	−44.51	−16.95	3.22	1.36	60	1	87.4	8 9/GR6
B SU212	−45.20	3	−44.00	−16.87	3.20	1.96	58	1	87.4	8 9/GR9
BERBERMU	−96.20	3	−64.77	32.32	0.60	0.60	90	2	87.4	
BOLAND01	−115.20	3	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
BOL00001	−87.20	3	−64.61	−16.71	2.52	2.19	85	1	87.4	
BRB00001	−92.70	3	−59.85	12.93	0.60	0.60	90	2	87.4	
CAN01101	−138.20	3	−114.60	51.08	7.28	1.10	160	1	87.4	9/GR10
CAN01201	−138.20	3	−114.60	51.08	7.28	1.10	160	1	87.4	9/GR10
CAN01202	−72.70	3	−81.34	50.02	7.96	2.55	5	1	87.4	
CAN01203	−129.20	3	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01303	−129.20	3	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01304	−91.20	3	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01403	−129.20	3	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01404	−91.20	3	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01405	−82.20	3	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01504	−91.20	3	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01505	−82.20	3	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01605	−82.20	3	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01606	−70.70	3	−80.77	50.03	7.88	2.53	6	1	87.4	
CHLCONT5	−106.20	3	−72.23	−35.57	2.60	0.68	55	1	87.4	9/GR17
CHLPAC02	−106.20	3	−80.06	−30.06	1.36	0.68	69	1	87.4	9/GR17
CLMAND01	−115.20	3	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CLM00001	−103.20	3	−74.50	5.87	3.98	1.96	118	1	87.4	
CUB00001	−89.20	3	−79.81	21.62	2.24	0.68	168	1	87.4	
EQACAND1	−115.20	3	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
EQAGAND1	−115.20	3	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
GRD00002	−42.20	3	−61.58	12.29	0.60	0.60	90	1	87.4	
GRD00059	−57.20	3	−61.58	12.29	0.60	0.60	90	1	87.4	
GRLDNK01	−53.20	3	−44.89	66.56	2.70	0.82	173	1	87.4	2
HWA00002	−166.20	3	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
HWA00003	−175.20	3	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
MEX01NTE	−78.20	3	−105.81	26.01	2.89	2.08	155	1	87.4	1
MEX01SUR	−69.20	3	−94.84	19.82	3.05	2.09	4	1	87.4	1
MEX02NTE	−136.20	3	−107.21	26.31	3.84	1.55	148	1	87.4	1
MEX02SUR	−127.20	3	−96.39	19.88	3.18	1.87	157	1	87.4	1
PAQPAC01	−106.20	3	−109.18	−27.53	0.60	0.60	90	1	87.4	9/GR17
PRG00002	−99.20	3	−58.66	−23.32	1.45	1.04	76	1	87.4	
PRUAND02	−115.20	3	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
PTRVIR01	−101.20	3	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
PTRVIR02	−110.20	3	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
SURINAM2	−84.70	3	−55.69	4.35	1.00	0.69	86	1	87.4	
URG00001	−71.70	3	−56.22	−32.52	1.02	0.89	11	1	87.4	
USAEH001	−61.70	3	−87.57	36.17	6.42	3.49	12	1	87.4	1 5 6
USAEH002	−101.20	3	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
USAEH003	−110.20	3	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
USAEH004	−119.20	3	−96.45	36.21	8.20	3.12	165	1	87.4	1 5 6
USAPSA02	−166.20	3	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
USAPSA03	−175.20	3	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
USAWH101	−148.20	3	−111.02	40.68	4.36	2.15	162	1	87.4	
USAWH102	−157.20	3	−113.07	40.74	3.72	1.78	149	1	87.4	
VENAND03	−115.20	3	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5

17 367.74 MHz (4)

1	2	3	4		5		6	7	8	9
ALS00002	−165.80	4	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
ALS00003	−174.80	4	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
ARGNORT4	−93.80	4	−63.96	−30.01	3.86	1.99	48	2	87.4	
ARGNORT5	−54.80	4	−62.85	−29.80	3.24	2.89	47	2	87.4	
B CE311	−63.80	4	−40.60	−6.07	3.04	2.06	174	2	87.4	8 9/GR7
B CE312	−44.80	4	−40.26	−6.06	3.44	2.09	174	2	87.4	8 9/GR9
B CE411	−63.80	4	−50.97	−15.26	3.86	1.38	49	2	87.4	8 9/GR7
B CE412	−44.80	4	−50.71	−15.30	3.57	1.56	52	2	87.4	8 9/GR9
B CE511	−63.80	4	−53.11	−2.98	2.42	2.15	107	2	87.4	8 9/GR7
B NO611	−73.80	4	−59.60	−11.62	2.86	1.69	165	1	87.4	8 9/GR8
B NO711	−73.80	4	−60.70	−1.78	3.54	1.78	126	1	87.4	8 9/GR8
B NO811	−73.80	4	−68.75	−4.71	2.37	1.65	73	1	87.4	8 9/GR8
B SE911	−101.80	4	−45.99	−19.09	2.22	0.79	62	2	87.4	8
B SU111	−80.80	4	−51.10	−25.64	2.76	1.06	50	2	87.4	8 9/GR6
B SU112	−44.80	4	−50.76	−25.62	2.47	1.48	56	2	87.4	8 9/GR9
B SU211	−80.80	4	−44.51	−16.94	3.22	1.37	60	2	87.4	8 9/GR6
B SU212	−44.80	4	−43.99	−16.97	3.27	1.92	59	2	87.4	8 9/GR9
CAN01101	−137.80	4	−114.10	50.92	7.22	1.11	160	2	87.4	9/GR10
CAN01201	−137.80	4	−114.10	50.92	7.22	1.11	160	2	87.4	9/GR10
CAN01202	−72.30	4	−81.23	50.12	7.99	2.53	5	2	87.4	
CAN01203	−128.80	4	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01303	−128.80	4	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01304	−90.80	4	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01403	−128.80	4	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01404	−90.80	4	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01405	−81.80	4	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01504	−90.80	4	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01505	−81.80	4	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01605	−81.80	4	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01606	−70.30	4	−80.64	50.02	7.88	2.52	6	2	87.4	
CHLCONT4	−105.80	4	−69.59	−23.20	2.21	0.69	68	2	87.4	9/GR16
CHLCONT6	−105.80	4	−73.52	−55.52	3.65	1.31	39	2	87.4	9/GR16
CRBBAH01	−92.30	4	−76.09	24.13	1.83	0.68	141	1	87.4	9/GR18
CRBBER01	−92.30	4	−64.76	32.13	0.60	0.60	90	1	87.4	9/GR18
CRBBLZ01	−92.30	4	−88.61	17.26	0.64	0.64	90	1	87.4	9/GR18
CRBEC001	−92.30	4	−60.07	8.26	4.20	0.86	115	1	87.4	9/GR18
CRBJMC01	−92.30	4	−79.45	17.97	0.99	0.68	151	1	87.4	9/GR18
CYM00001	−115.80	4	−80.58	19.57	0.60	0.60	90	2	87.4	
DOMIFRB2	−83.30	4	−70.51	18.79	0.98	0.69	167	2	87.4	
EQAC0001	−94.80	4	−78.31	−1.52	1.48	1.15	65	1	87.4	9/GR19
EQAG0001	−94.80	4	−90.36	−0.57	0.94	0.89	99	1	87.4	9/GR19
GUFMGG02	−52.80	4	−56.42	8.47	4.16	0.81	123	2	87.4	2 7
HWA00002	−165.80	4	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
HWA00003	−174.80	4	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
JMC00005	−33.80	4	−77.27	18.12	0.60	0.60	90	2	87.4	
LCAIFRB1	−79.30	4	−61.15	13.90	0.60	0.60	90	2	87.4	
MEX01NTE	−77.80	4	−105.80	25.99	2.88	2.07	155	2	87.4	1
MEX02NTE	−135.80	4	−107.36	26.32	3.80	1.57	149	2	87.4	1
MEX02SUR	−126.80	4	−96.39	19.88	3.19	1.87	158	2	87.4	1
PRU00004	−85.80	4	−74.19	−8.39	3.74	2.45	112	2	87.4	
PTRVIR01	−100.80	4	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
PTRVIR02	−109.80	4	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
SLVIFRB2	−107.30	4	−88.91	13.59	0.60	0.60	90	1	87.4	
USAEH001	−61.30	4	−87.53	36.18	6.41	3.49	12	2	87.4	1 5 6
USAEH002	−100.80	4	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
USAEH003	−109.80	4	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH004	−118.80	4	−96.42	36.21	8.20	3.12	165	2	87.4	1 5 6
USAPSA02	−165.80	4	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
USAPSA03	−174.80	4	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
USAWH101	−147.80	4	−111.01	40.67	4.38	2.15	162	2	87.4	
USAWH102	−156.80	4	−113.01	40.71	3.74	1.79	149	2	87.4	
VEN11VEN	−103.80	4	−66.79	6.90	2.50	1.77	122	2	87.4	

17 382.32 MHz (5)

1	2	3	4		5		6	7	8	9
ALS00002	−166.20	5	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
ALS00003	−175.20	5	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
ARGINSU4	−94.20	5	−52.98	−59.81	3.40	0.68	19	1	87.4	9/GR3
ARGSUR04	−94.20	5	−65.04	−43.33	3.32	1.50	40	1	87.4	9/GR3
B CE311	−64.20	5	−40.60	−6.07	3.04	2.06	174	1	87.4	89/GR7
B CE312	−45.20	5	−40.27	−6.06	3.44	2.09	174	1	87.4	89/GR9
B CE411	−64.20	5	−50.97	−15.27	3.86	1.38	49	1	87.4	89/GR7
B CE412	−45.20	5	−50.71	−15.30	3.57	1.56	52	1	87.4	89/GR9
B CE511	−64.20	5	−53.10	−2.90	2.44	2.13	104	1	87.4	89/GR7
B NO611	−74.20	5	−59.60	−11.62	2.85	1.69	165	2	87.4	89/GR8
B NO711	−74.20	5	−60.70	−1.78	3.54	1.78	126	2	87.4	89/GR8
B NO811	−74.20	5	−68.76	−4.71	2.37	1.65	73	2	87.4	89/GR8
B SU111	−81.20	5	−51.12	−25.63	2.76	1.05	50	1	87.4	89/GR6
B SU112	−45.20	5	−50.75	−25.62	2.47	1.48	56	1	87.4	89/GR9
B SU211	−81.20	5	−44.51	−16.95	3.22	1.36	60	1	87.4	89/GR6
B SU212	−45.20	5	−44.00	−16.87	3.20	1.96	58	1	87.4	89/GR9
BAHIFRB1	−87.20	5	−76.06	24.16	1.81	0.70	142	1	87.4	
BERBERMU	−96.20	5	−64.77	32.32	0.60	0.60	90	2	87.4	
BERBER02	−31.00	5	−64.77	32.32	0.60	0.60	90	1	87.4	2 3
BOLAND01	−115.20	5	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CAN01101	−138.20	5	−114.60	51.08	7.28	1.10	160	1	87.4	9/GR10
CAN01201	−138.20	5	−114.60	51.08	7.28	1.10	160	1	87.4	9/GR10
CAN01202	−72.70	5	−81.34	50.02	7.96	2.55	5	1	87.4	
CAN01203	−129.20	5	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01303	−129.20	5	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01304	−91.20	5	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01403	−129.20	5	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01404	−91.20	5	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01405	−82.20	5	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01504	−91.20	5	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01505	−82.20	5	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01605	−82.20	5	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01606	−70.70	5	−80.77	50.03	7.88	2.53	6	1	87.4	
CHLCONT5	−106.20	5	−72.23	−35.57	2.60	0.68	55	1	87.4	9/GR17
CHLPAC02	−106.20	5	−80.06	−30.06	1.36	0.68	69	1	87.4	9/GR17
CLMAND01	−115.20	5	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CLM00001	−103.20	5	−74.50	5.87	3.98	1.96	118	1	87.4	
EQACAND1	−115.20	5	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
EQAGAND1	−115.20	5	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
FLKANT01	−57.20	5	−44.54	−60.13	3.54	0.68	12	1	87.4	2
FLKFALKS	−31.00	5	−59.90	−51.64	0.60	0.60	90	1	87.4	2 3
GRD00002	−42.20	5	−61.58	12.29	0.60	0.60	90	1	87.4	
HWA00002	−166.20	5	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
HWA00003	−175.20	5	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
MEX01NTE	−78.20	5	−105.81	26.01	2.89	2.08	155	1	87.4	1
MEX01SUR	−69.20	5	−94.84	19.82	3.05	2.09	4	1	87.4	1
MEX02NTE	−136.20	5	−107.21	26.31	3.84	1.55	148	1	87.4	1
MEX02SUR	−127.20	5	−96.39	19.88	3.18	1.87	157	1	87.4	1
PAQPAC01	−106.20	5	−109.18	−27.53	0.60	0.60	90	1	87.4	9/GR17
PRG00002	−99.20	5	−58.66	−23.32	1.45	1.04	76	1	87.4	
PRUAND02	−115.20	5	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
PTRVIR01	−101.20	5	−93.94	36.32	8.24	3.56	171	1	87.4	169/GR20
PTRVIR02	−110.20	5	−95.23	36.29	8.27	3.37	168	1	87.4	169/GR21
SPMFRAN3	−53.20	5	−67.24	47.51	3.16	0.79	7	1	87.4	2 7
TRD00001	−84.70	5	−61.23	10.70	0.60	0.60	90	1	87.4	
URG00001	−71.70	5	−56.22	−32.52	1.02	0.89	11	1	87.4	
USAEH001	−61.70	5	−87.57	36.17	6.42	3.49	12	1	87.4	156
USAEH002	−101.20	5	−93.94	36.32	8.24	3.56	171	1	87.4	169/GR20
USAEH003	−110.20	5	−95.23	36.29	8.27	3.37	168	1	87.4	169/GR21
USAEH004	−119.20	5	−96.45	36.21	8.20	3.12	165	1	87.4	156
USAPSA02	−166.20	5	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
USAPSA03	−175.20	5	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
USAWH101	−148.20	5	−111.02	40.68	4.36	2.15	162	1	87.4	
USAWH102	−157.20	5	−113.07	40.74	3.72	1.78	149	1	87.4	
VENAND03	−115.20	5	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
VRG00001	−79.70	5	−64.37	18.48	0.60	0.60	90	1	87.4	4

17 396.90 MHz (6)

1	2	3	4		5		6	7	8	9
ALS00002	−165.80	6	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
ALS00003	−174.80	6	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
ARGNORT4	−93.80	6	−63.96	−30.01	3.86	1.99	48	2	87.4	
ARGNORT5	−54.80	6	−62.85	−29.80	3.24	2.89	47	2	87.4	
ATNBEAM1	−52.80	6	−66.44	14.87	1.83	0.68	39	2	87.4	
B CE311	−63.80	6	−40.60	−6.07	3.04	2.06	174	2	87.4	8 9/GR7
B CE312	−44.80	6	−40.26	−6.06	3.44	2.09	174	2	87.4	8 9/GR9
B CE411	−63.80	6	−50.97	−15.26	3.86	1.38	49	2	87.4	8 9/GR7
B CE412	−44.80	6	−50.71	−15.30	3.57	1.56	52	2	87.4	8 9/GR9
B CE511	−63.80	6	−53.11	−2.98	2.42	2.15	107	2	87.4	8 9/GR7
B NO611	−73.80	6	−59.60	−11.62	2.86	1.69	165	1	87.4	8 9/GR8
B NO711	−73.80	6	−60.70	−1.78	3.54	1.78	126	1	87.4	8 9/GR8
B NO811	−73.80	6	−68.75	−4.71	2.37	1.65	73	1	87.4	8 9/GR8
B SE911	−101.80	6	−45.99	−19.09	2.22	0.79	62	2	87.4	8
B SU111	−80.80	6	−51.10	−25.64	2.76	1.06	50	2	87.4	8 9/GR6
B SU112	−44.80	6	−50.76	−25.62	2.47	1.48	56	2	87.4	8 9/GR9
B SU211	−80.80	6	−44.51	−16.94	3.22	1.37	60	2	87.4	8 9/GR6
B SU212	−44.80	6	−43.99	−16.97	3.27	1.92	59	2	87.4	8 9/GR9
CAN01101	−137.80	6	−114.10	50.92	7.22	1.11	160	2	87.4	9/GR10
CAN01201	−137.80	6	−114.10	50.92	7.22	1.11	160	2	87.4	9/GR10
CAN01202	−72.30	6	−81.23	50.12	7.99	2.53	5	2	87.4	
CAN01203	−128.80	6	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01303	−128.80	6	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01304	−90.80	6	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01403	−128.80	6	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01404	−90.80	6	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01405	−81.80	6	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01504	−90.80	6	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01505	−81.80	6	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01605	−81.80	6	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01606	−70.30	6	−80.64	50.02	7.88	2.52	6	2	87.4	
CHLCONT4	−105.80	6	−69.59	−23.20	2.21	0.69	68	2	87.4	9/GR16
CHLCONT6	−105.80	6	−73.52	−55.52	3.65	1.31	39	2	87.4	9/GR16
CRBBAH01	−92.30	6	−76.09	24.13	1.83	0.68	141	1	87.4	9/GR18
CRBBER01	−92.30	6	−64.76	32.13	0.60	0.60	90	1	87.4	9/GR18
CRBBLZ01	−92.30	6	−88.61	17.26	0.64	0.64	90	1	87.4	9/GR18
CRBEC001	−92.30	6	−60.07	8.26	4.20	0.86	115	1	87.4	9/GR18
CRBJMC01	−92.30	6	−79.45	17.97	0.99	0.68	151	1	87.4	9/GR18
CTR00201	−130.80	6	−84.33	9.67	0.82	0.68	119	2	87.4	
EQAC0001	−94.80	6	−78.31	−1.52	1.48	1.15	65	1	87.4	9/GR19
EQAG0001	−94.80	6	−90.36	−0.57	0.94	0.89	99	1	87.4	9/GR19
GUY00302	−33.80	6	−59.07	4.77	1.43	0.85	91	2	87.4	
HNDIFRB2	−107.30	6	−86.23	15.16	1.14	0.85	8	1	87.4	
HTI00002	−83.30	6	−73.28	18.96	0.82	0.68	11	2	87.4	
HWA00002	−165.80	6	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
HWA00003	−174.80	6	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
MEX01NTE	−77.80	6	−105.80	25.99	2.88	2.07	155	2	87.4	1
MEX02NTE	−135.80	6	−107.36	26.32	3.80	1.57	149	2	87.4	1
MEX02SUR	−126.80	6	−96.39	19.88	3.19	1.87	158	2	87.4	1
PRU00004	−85.80	6	−74.19	−8.39	3.74	2.45	112	2	87.4	
PTRVIR01	−100.80	6	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
PTRVIR02	−109.80	6	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
TCA00001	−115.80	6	−71.79	21.53	0.60	0.60	90	2	87.4	
USAEH001	−61.30	6	−87.53	36.18	6.41	3.49	12	2	87.4	1 5 6
USAEH002	−100.80	6	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
USAEH003	−109.80	6	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH004	−118.80	6	−96.42	36.21	8.20	3.12	165	2	87.4	1 5 6
USAPSA02	−165.80	6	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
USAPSA03	−174.80	6	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
USAWH101	−147.80	6	−111.01	40.67	4.38	2.15	162	2	87.4	
USAWH102	−156.80	6	−113.01	40.71	3.74	1.79	149	2	87.4	
VCT00001	−79.30	6	−61.18	13.23	0.60	0.60	90	2	87.4	
VEN11VEN	−103.80	6	−66.79	6.90	2.50	1.77	122	2	87.4	

17 411.48 MHz (7)

1	2	3	4		5		6	7	8	9
ALS00002	−166.20	7	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
ALS00003	−175.20	7	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
ARGINSU4	−94.20	7	−52.98	−59.81	3.40	0.68	19	1	87.4	9/GR3
ARGINSU5	−55.20	7	−44.17	−59.91	3.77	0.70	13	1	87.4	9/GR4
ARGSUR04	−94.20	7	−65.04	−43.33	3.32	1.50	40	1	87.4	9/GR3
ARGSUR05	−55.20	7	−63.68	−43.01	2.54	2.38	152	1	87.4	9/GR4
ATGSJN01	−79.70	7	−61.79	17.07	0.60	0.60	90	1	87.4	
B CE311	−64.20	7	−40.60	−6.07	3.04	2.06	174	1	87.4	8 9/GR7
B CE312	−45.20	7	−40.27	−6.06	3.44	2.09	174	1	87.4	8 9/GR9
B CE411	−64.20	7	−50.97	−15.27	3.86	1.38	49	1	87.4	8 9/GR7
B CE412	−45.20	7	−50.71	−15.30	3.57	1.56	52	1	87.4	8 9/GR9
B CE511	−64.20	7	−53.10	−2.90	2.44	2.13	104	1	87.4	8 9/GR7
B NO611	−74.20	7	−59.60	−11.62	2.85	1.69	165	2	87.4	8 9/GR8
B NO711	−74.20	7	−60.70	−1.78	3.54	1.78	126	2	87.4	8 9/GR8
B NO811	−74.20	7	−68.76	−4.71	2.37	1.65	73	2	87.4	8 9/GR8
B SU111	−81.20	7	−51.12	−25.63	2.76	1.05	50	1	87.4	8 9/GR6
B SU112	−45.20	7	−50.75	−25.62	2.47	1.48	56	1	87.4	8 9/GR9
B SU211	−81.20	7	−44.51	−16.95	3.22	1.36	60	1	87.4	8 9/GR6
B SU212	−45.20	7	−44.00	−16.87	3.20	1.96	58	1	87.4	8 9/GR9
BERBERMU	−96.20	7	−64.77	32.32	0.60	0.60	90	2	87.4	
BOLAND01	−115.20	7	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
BOL00001	−87.20	7	−64.61	−16.71	2.52	2.19	85	1	87.4	
BRB00001	−92.70	7	−59.85	12.93	0.60	0.60	90	2	87.4	
CAN01101	−138.20	7	−114.60	51.08	7.28	1.10	160	1	87.4	9/GR10
CAN01201	−138.20	7	−114.60	51.08	7.28	1.10	160	1	87.4	9/GR10
CAN01202	−72.70	7	−81.34	50.02	7.96	2.55	5	1	87.4	
CAN01203	−129.20	7	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01303	−129.20	7	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01304	−91.20	7	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01403	−129.20	7	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01404	−91.20	7	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01405	−82.20	7	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01504	−91.20	7	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01505	−82.20	7	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01605	−82.20	7	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01606	−70.70	7	−80.77	50.03	7.88	2.53	6	1	87.4	
CHLCONT5	−106.20	7	−72.23	−35.57	2.60	0.68	55	1	87.4	9/GR17
CHLPAC02	−106.20	7	−80.06	−30.06	1.36	0.68	69	1	87.4	9/GR17
CLMAND01	−115.20	7	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CLM00001	−103.20	7	−74.50	5.87	3.98	1.96	118	1	87.4	
CUB00001	−89.20	7	−79.81	21.62	2.24	0.68	168	1	87.4	
EQACAND1	−115.20	7	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
EQAGAND1	−115.20	7	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
GRD00002	−42.20	7	−61.58	12.29	0.60	0.60	90	1	87.4	
GRD00059	−57.20	7	−61.58	12.29	0.60	0.60	90	1	87.4	
GRLDNK01	−53.20	7	−44.89	66.56	2.70	0.82	173	1	87.4	2
HWA00002	−166.20	7	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
HWA00003	−175.20	7	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
MEX01NTE	−78.20	7	−105.81	26.01	2.89	2.08	155	1	87.4	1
MEX01SUR	−69.20	7	−94.84	19.82	3.05	2.09	4	1	87.4	1
MEX02NTE	−136.20	7	−107.21	26.31	3.84	1.55	148	1	87.4	1
MEX02SUR	−127.20	7	−96.39	19.88	3.18	1.87	157	1	87.4	1
PAQPAC01	−106.20	7	−109.18	−27.53	0.60	0.60	90	1	87.4	9/GR17
PRG00002	−99.20	7	−58.66	−23.32	1.45	1.04	76	1	87.4	
PRUAND02	−115.20	7	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
PTRVIR01	−101.20	7	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
PTRVIR02	−110.20	7	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
SURINAM2	−84.70	7	−55.69	4.35	1.00	0.69	86	1	87.4	
URG00001	−71.70	7	−56.22	−32.52	1.02	0.89	11	1	87.4	
USAEH001	−61.70	7	−87.57	36.17	6.42	3.49	12	1	87.4	1 5 6
USAEH002	−101.20	7	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
USAEH003	−110.20	7	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
USAEH004	−119.20	7	−96.45	36.21	8.20	3.12	165	1	87.4	1 5 6
USAPSA02	−166.20	7	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
USAPSA03	−175.20	7	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
USAWH101	−148.20	7	−111.02	40.68	4.36	2.15	162	1	87.4	
USAWH102	−157.20	7	−113.07	40.74	3.72	1.78	149	1	87.4	
VENAND03	−115.20	7	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5

17 426.06 MHz (8)

1	2	3	4		5		6	7	8	9
ALS00002	−165.80	8	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
ALS00003	−174.80	8	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
ARGNORT4	−93.80	8	−63.96	−30.01	3.86	1.99	48	2	87.4	
ARGNORT5	−54.80	8	−62.85	−29.80	3.24	2.89	47	2	87.4	
B CE311	−63.80	8	−40.60	−6.07	3.04	2.06	174	2	87.4	8 9/GR7
B CE312	−44.80	8	−40.26	−6.06	3.44	2.09	174	2	87.4	8 9/GR9
B CE411	−63.80	8	−50.97	−15.26	3.86	1.38	49	2	87.4	8 9/GR7
B CE412	−44.80	8	−50.71	−15.30	3.57	1.56	52	2	87.4	8 9/GR9
B CE511	−63.80	8	−53.11	−2.98	2.42	2.15	107	2	87.4	8 9/GR7
B NO611	−73.80	8	−59.60	−11.62	2.86	1.69	165	1	87.4	8 9/GR8
B NO711	−73.80	8	−60.70	−1.78	3.54	1.78	126	1	87.4	8 9/GR8
B NO811	−73.80	8	−68.75	−4.71	2.37	1.65	73	1	87.4	8 9/GR8
B SE911	−101.80	8	−45.99	−19.09	2.22	0.79	62	2	87.4	8
B SU111	−80.80	8	−51.10	−25.64	2.76	1.06	50	2	87.4	8 9/GR6
B SU112	−44.80	8	−50.76	−25.62	2.47	1.48	56	2	87.4	8 9/GR9
B SU211	−80.80	8	−44.51	−16.94	3.22	1.37	60	2	87.4	8 9/GR6
B SU212	−44.80	8	−43.99	−16.97	3.27	1.92	59	2	87.4	8 9/GR9
CAN01101	−137.80	8	−114.10	50.92	7.22	1.11	160	2	87.4	9/GR10
CAN01201	−137.80	8	−114.10	50.92	7.22	1.11	160	2	87.4	9/GR10
CAN01202	−72.30	8	−81.23	50.12	7.99	2.53	5	2	87.4	
CAN01203	−128.80	8	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01303	−128.80	8	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01304	−90.80	8	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01403	−128.80	8	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01404	−90.80	8	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01405	−81.80	8	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01504	−90.80	8	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01505	−81.80	8	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01605	−81.80	8	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01606	−70.30	8	−80.64	50.02	7.88	2.52	6	2	87.4	
CHLCONT4	−105.80	8	−69.59	−23.20	2.21	0.69	68	2	87.4	9/GR16
CHLCONT6	−105.80	8	−73.52	−55.52	3.65	1.31	39	2	87.4	9/GR16
CRBBAH01	−92.30	8	−76.09	24.13	1.83	0.68	141	1	87.4	9/GR18
CRBBER01	−92.30	8	−64.76	32.13	0.60	0.60	90	1	87.4	9/GR18
CRBBLZ01	−92.30	8	−88.61	17.26	0.64	0.64	90	1	87.4	9/GR18
CRBEC001	−92.30	8	−60.07	8.26	4.20	0.86	115	1	87.4	9/GR18
CRBJMC01	−92.30	8	−79.45	17.97	0.99	0.68	151	1	87.4	9/GR18
CYM00001	−115.80	8	−80.58	19.57	0.60	0.60	90	2	87.4	
DOMIFRB2	−83.30	8	−70.51	18.79	0.98	0.69	167	2	87.4	
EQAC0001	−94.80	8	−78.31	−1.52	1.48	1.15	65	1	87.4	9/GR19
EQAG0001	−94.80	8	−90.36	−0.57	0.94	0.89	99	1	87.4	9/GR19
GUFMGG02	−52.80	8	−56.42	8.47	4.16	0.81	123	2	87.4	2 7
HWA00002	−165.80	8	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
HWA00003	−174.80	8	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
JMC00005	−33.80	8	−77.27	18.12	0.60	0.60	90	2	87.4	
LCAIFRB1	−79.30	8	−61.15	13.90	0.60	0.60	90	2	87.4	
MEX01NTE	−77.80	8	−105.80	25.99	2.88	2.07	155	2	87.4	1
MEX02NTE	−135.80	8	−107.36	26.32	3.80	1.57	149	2	87.4	1
MEX02SUR	−126.80	8	−96.39	19.88	3.19	1.87	158	2	87.4	1
PRU00004	−85.80	8	−74.19	−8.39	3.74	2.45	112	2	87.4	
PTRVIR01	−100.80	8	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
PTRVIR02	−109.80	8	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
SLVIFRB2	−107.30	8	−88.91	13.59	0.60	0.60	90	1	87.4	
USAEH001	−61.30	8	−87.53	36.18	6.41	3.49	12	2	87.4	1 5 6
USAEH002	−100.80	8	−93.85	36.31	8.26	3.55	71	2	87.4	1 6 9/GR20
USAEH003	−109.80	8	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH004	−118.80	8	−96.42	36.21	8.20	3.12	165	2	87.4	1 5 6
USAPSA02	−165.80	8	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
USAPSA03	−174.80	8	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
USAWH101	−147.80	8	−111.01	40.67	4.38	2.15	162	2	87.4	
USAWH102	−156.80	8	−113.01	40.71	3.74	1.79	149	2	87.4	
VEN11VEN	−103.80	8	−66.79	6.90	2.50	1.77	122	2	87.4	

17 440.64 MHz (9)

1	2	3	4		5		6	7	8	9
ALS00002	−166.20	9	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
ALS00003	−175.20	9	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
ARGINSU4	−94.20	9	−52.98	−59.81	3.40	0.68	19	1	87.4	9/GR3
ARGSUR04	−94.20	9	−65.04	−43.33	3.32	1.50	40	1	87.4	9/GR3
B CE311	−64.20	9	−40.60	−6.07	3.04	2.06	174	1	87.4	8 9/GR7
B CE312	−45.20	9	−40.27	−6.06	3.44	2.09	174	1	87.4	8 9/GR9
B CE411	−64.20	9	−50.97	−15.27	3.86	1.38	49	1	87.4	8 9/GR7
B CE412	−45.20	9	−50.71	−15.30	3.57	1.56	52	1	87.4	8 9/GR9
B CE511	−64.20	9	−53.10	−2.90	2.44	2.13	104	1	87.4	8 9/GR7
B NO611	−74.20	9	−59.60	−11.62	2.85	1.69	165	2	87.4	8 9/GR8
B NO711	−74.20	9	−60.70	−1.78	3.54	1.78	126	2	87.4	8 9/GR8
B NO811	−74.20	9	−68.76	−4.71	2.37	1.65	73	2	87.4	8 9/GR8
B SU111	−81.20	9	−51.12	−25.63	2.76	1.05	50	1	87.4	8 9/GR6
B SU112	−45.20	9	−50.75	−25.62	2.47	1.48	56	1	87.4	8 9/GR9
B SU211	−81.20	9	−44.51	−16.95	3.22	1.36	60	1	87.4	8 9/GR6
B SU212	−45.20	9	−44.00	−16.87	3.20	1.96	58	1	87.4	8 9/GR9
BAHIFRB1	−87.20	9	−76.06	24.16	1.81	0.70	142	1	87.4	
BERBERMU	−96.20	9	−64.77	32.32	0.60	0.60	90	2	87.4	
BERBER02	−31.00	9	−64.77	32.32	0.60	0.60	90	1	87.4	2 3
BOLAND01	−115.20	9	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CAN01101	−138.20	9	−114.60	51.08	7.28	1.10	160	1	87.4	9/GR10
CAN01201	−138.20	9	−114.60	51.08	7.28	1.10	160	1	87.4	9/GR10
CAN01202	−72.70	9	−81.34	50.02	7.96	2.55	5	1	87.4	
CAN01203	−129.20	9	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01303	−129.20	9	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01304	−91.20	9	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01403	−129.20	9	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01404	−91.20	9	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01405	−82.20	9	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01504	−91.20	9	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01505	−82.20	9	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01605	−82.20	9	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01606	−70.70	9	−80.77	50.03	7.88	2.53	6	1	87.4	
CHLCONT5	−106.20	9	−72.23	−35.57	2.60	0.68	55	1	87.4	9/GR17
CHLPAC02	−106.20	9	−80.06	−30.06	1.36	0.68	69	1	87.4	9/GR17
CLMAND01	−115.20	9	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CLM00001	−103.20	9	−74.50	5.87	3.98	1.96	118	1	87.4	
EQACAND1	−115.20	9	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
EQAGAND1	−115.20	9	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
FLKANT01	−57.20	9	−44.54	−60.13	3.54	0.68	12	1	87.4	2
FLKFALKS	−31.00	9	−59.90	−51.64	0.60	0.60	90	1	87.4	2 3
GRD00002	−42.20	9	−61.58	12.29	0.60	0.60	90	1	87.4	
HWA00002	−166.20	9	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
HWA00003	−175.20	9	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
MEX01NTE	−78.20	9	−105.81	26.01	2.89	2.08	155	1	87.4	1
MEX01SUR	−69.20	9	−94.84	19.82	3.05	2.09	4	1	87.4	1
MEX02NTE	−136.20	9	−107.21	26.31	3.84	1.55	148	1	87.4	1
MEX02SUR	−127.20	9	−96.39	19.88	3.18	1.87	157	1	87.4	1
PAQPAC01	−106.20	9	−109.18	−27.53	0.60	0.60	90	1	87.4	9/GR17
PRG00002	−99.20	9	−58.66	−23.32	1.45	1.04	76	1	87.4	
PRUAND02	−115.20	9	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
PTRVIR01	−101.20	9	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
PTRVIR02	−110.20	9	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
SPMFRAN3	−53.20	9	−67.24	47.51	3.16	0.79	7	1	87.4	2 7
TRD00001	−84.70	9	−61.23	10.70	0.60	0.60	90	1	87.4	
URG00001	−71.70	9	−56.22	−32.52	1.02	0.89	11	1	87.4	
USAEH001	−61.70	9	−87.57	36.17	6.42	3.49	12	1	87.4	1 5 6
USAEH002	−101.20	9	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
USAEH003	−110.20	9	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
USAEH004	−119.20	9	−96.45	36.21	8.20	3.12	165	1	87.4	1 5 6
USAPSA02	−166.20	9	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
USAPSA03	−175.20	9	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
USAWH101	−148.20	9	−111.02	40.68	4.36	2.15	162	1	87.4	
USAWH102	−157.20	9	−113.07	40.74	3.72	1.78	149	1	87.4	
VENAND03	−115.20	9	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
VRG00001	−79.70	9	−64.37	18.48	0.60	0.60	90	1	87.4	4

17 455.22 MHz (10)

1	2	3	4		5		6	7	8	9
ALS00002	−165.80	10	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
ALS00003	−174.80	10	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
ARGNORT4	−93.80	10	−63.96	−30.01	3.86	1.99	48	2	87.4	
ARGNORT5	−54.80	10	−62.85	−29.80	3.24	2.89	47	2	87.4	
ATNBEAM1	−52.80	10	−66.44	14.87	1.83	0.68	39	2	87.4	
B CE311	−63.80	10	−40.60	−6.07	3.04	2.06	174	2	87.4	8 9/GR7
B CE312	−44.80	10	−40.26	−6.06	3.44	2.09	174	2	87.4	8 9/GR9
B CE411	−63.80	10	−50.97	−15.26	3.86	1.38	49	2	87.4	8 9/GR7
B CE412	−44.80	10	−50.71	−15.30	3.57	1.56	52	2	87.4	8 9/GR9
B CE511	−63.80	10	−53.11	−2.98	2.42	2.15	107	2	87.4	8 9/GR7
B NO611	−73.80	10	−59.60	−11.62	2.86	1.69	165	1	87.4	8 9/GR8
B NO711	−73.80	10	−60.70	−1.78	3.54	1.78	126	1	87.4	8 9/GR8
B NO811	−73.80	10	−68.75	−4.71	2.37	1.65	73	1	87.4	8 9/GR8
B SE911	−101.80	10	−45.99	−19.09	2.22	0.79	62	2	87.4	8
B SU111	−80.80	10	−51.10	−25.64	2.76	1.06	50	2	87.4	8 9/GR6
B SU112	−44.80	10	−50.76	−25.62	2.47	1.48	56	2	87.4	8 9/GR9
B SU211	−80.80	10	−44.51	−16.94	3.22	1.37	60	2	87.4	8 9/GR6
B SU212	−44.80	10	−43.99	−16.97	3.27	1.92	59	2	87.4	8 9/GR9
CAN01101	−137.80	10	−114.10	50.92	7.22	1.11	160	2	87.4	9/GR10
CAN01201	−137.80	10	−114.10	50.92	7.22	1.11	160	2	87.4	9/GR10
CAN01202	−72.30	10	−81.23	50.12	7.99	2.53	5	2	87.4	
CAN01203	−128.80	10	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01303	−128.80	10	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01304	−90.80	10	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01403	−128.80	10	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01404	−90.80	10	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01405	−81.80	10	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01504	−90.80	10	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01505	−81.80	10	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01605	−81.80	10	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01606	−70.30	10	−80.64	50.02	7.88	2.52	6	2	87.4	
CHLCONT4	−105.80	10	−69.59	−23.20	2.21	0.69	68	2	87.4	9/GR16
CHLCONT6	−105.80	10	−73.52	−55.52	3.65	1.31	39	2	87.4	9/GR16
CRBBAH01	−92.30	10	−76.09	24.13	1.83	0.68	141	1	87.4	9/GR18
CRBBER01	−92.30	10	−64.76	32.13	0.60	0.60	90	1	87.4	9/GR18
CRBBLZ01	−92.30	10	−88.61	17.26	0.64	0.64	90	1	87.4	9/GR18
CRBEC001	−92.30	10	−60.07	8.26	4.20	0.86	115	1	87.4	9/GR18
CRBJMC01	−92.30	10	−79.45	17.97	0.99	0.68	151	1	87.4	9/GR18
CTR00201	−130.80	10	−84.33	9.67	0.82	0.68	119	2	87.4	
EQAC0001	−94.80	10	−78.31	−1.52	1.48	1.15	65	1	87.4	9/GR19
EQAG0001	−94.80	10	−90.36	−0.57	0.94	0.89	99	1	87.4	9/GR19
GUY00302	−33.80	10	−59.07	4.77	1.43	0.85	91	2	87.4	
HNDIFRB2	−107.30	10	−86.23	15.16	1.14	0.85	8	1	87.4	
HTI00002	−83.30	10	−73.28	18.96	0.82	0.68	11	2	87.4	
HWA00002	−165.80	10	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
HWA00003	−174.80	10	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
MEX01NTE	−77.80	10	−105.80	25.99	2.88	2.07	155	2	87.4	1
MEX02NTE	−135.80	10	−107.36	26.32	3.80	1.57	149	2	87.4	1
MEX02SUR	−126.80	10	−96.39	19.88	3.19	1.87	158	2	87.4	1
PRU00004	−85.80	10	−74.19	−8.39	3.74	2.45	112	2	87.4	
PTRVIR01	−100.80	10	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
PTRVIR02	−109.80	10	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
TCA00001	−115.80	10	−71.79	21.53	0.60	0.60	90	2	87.4	
USAEH001	−61.30	10	−87.53	36.18	6.41	3.49	12	2	87.4	1 5 6
USAEH002	−100.80	10	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
USAEH003	−109.80	10	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH004	−118.80	10	−96.42	36.21	8.20	3.12	165	2	87.4	1 5 6
USAPSA02	−165.80	10	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
USAPSA03	−174.80	10	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
USAWH101	−147.80	10	−111.01	40.67	4.38	2.15	162	2	87.4	
USAWH102	−156.80	10	−113.01	40.71	3.74	1.79	149	2	87.4	
VCT00001	−79.30	10	−61.18	13.23	0.60	0.60	90	2	87.4	
VEN11VEN	−103.80	10	−66.79	6.90	2.50	1.77	122	2	87.4	

17 469.80 MHz (11)

1	2	3	4		5		6	7	8	9
ALS00002	−166.20	11	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
ALS00003	−175.20	11	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
ARGINSU4	−94.20	11	−52.98	−59.81	3.40	0.68	19	1	87.4	9/GR3
ARGINSU5	−55.20	11	−44.17	−59.91	3.77	0.70	13	1	87.4	9/GR4
ARGSUR04	−94.20	11	−65.04	−43.33	3.32	1.50	40	1	87.4	9/GR3
ARGSUR05	−55.20	11	−63.68	−43.01	2.54	2.38	152	1	87.4	9/GR4
ATGSJN01	−79.70	11	−61.79	17.07	0.60	0.60	90	1	87.4	
B CE311	−64.20	11	−40.60	−6.07	3.04	2.06	174	1	87.4	8 9/GR7
B CE312	−45.20	11	−40.27	−6.06	3.44	2.09	174	1	87.4	8 9/GR9
B CE411	−64.20	11	−50.97	−15.27	3.86	1.38	49	1	87.4	8 9/GR7
B CE412	−45.20	11	−50.71	−15.30	3.57	1.56	52	1	87.4	8 9/GR9
B CE511	−64.20	11	−53.10	−2.90	2.44	2.13	104	1	87.4	8 9/GR7
B NO611	−74.20	11	−59.60	−11.62	2.85	1.69	165	2	87.4	8 9/GR8
B NO711	−74.20	11	−60.70	−1.78	3.54	1.78	126	2	87.4	8 9/GR8
B NO811	−74.20	11	−68.76	−4.71	2.37	1.65	73	2	87.4	8 9/GR8
B SU111	−81.20	11	−51.12	−25.63	2.76	1.05	50	1	87.4	8 9/GR6
B SU112	−45.20	11	−50.75	−25.62	2.47	1.48	56	1	87.4	8 9/GR9
B SU211	−81.20	11	−44.51	−16.95	3.22	1.36	60	1	87.4	8 9/GR6
B SU212	−45.20	11	−44.00	−16.87	3.20	1.96	58	1	87.4	8 9/GR9
BERBERMU	−96.20	11	−64.77	32.32	0.60	0.60	90	2	87.4	
BOLAND01	−115.20	11	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
BOL00001	−87.20	11	−64.61	−16.71	2.52	2.19	85	1	87.4	
BRB00001	−92.70	11	−59.85	12.93	0.60	0.60	90	2	87.4	
CAN01101	−138.20	11	−114.60	51.08	7.28	1.10	160	1	87.4	9/GR10
CAN01201	−138.20	11	−114.60	51.08	7.28	1.10	160	1	87.4	9/GR10
CAN01202	−72.70	11	−81.34	50.02	7.96	2.55	5	1	87.4	
CAN01203	−129.20	11	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01303	−129.20	11	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01304	−91.20	11	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01403	−129.20	11	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01404	−91.20	11	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01405	−82.20	11	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01504	−91.20	11	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01505	−82.20	11	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01605	−82.20	11	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01606	−70.70	11	−80.77	50.03	7.88	2.53	6	1	87.4	
CHLCONT5	−106.20	11	−72.23	−35.57	2.60	0.68	55	1	87.4	9/GR17
CHLPAC02	−106.20	11	−80.06	−30.06	1.36	0.68	69	1	87.4	9/GR17
CLMAND01	−115.20	11	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CLM00001	−103.20	11	−74.50	5.87	3.98	1.96	118	1	87.4	
CUB00001	−89.20	11	−79.81	21.62	2.24	0.68	168	1	87.4	
EQACAND1	−115.20	11	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
EQAGAND1	−115.20	11	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
GRD00002	−42.20	11	−61.58	12.29	0.60	0.60	90	1	87.4	
GRD00059	−57.20	11	−61.58	12.29	0.60	0.60	90	1	87.4	
GRLDNK01	−53.20	11	−44.89	66.56	2.70	0.82	173	1	87.4	2
GUY00201	−84.70	11	−59.19	4.78	1.44	0.85	95	1	87.4	
HWA00002	−166.20	11	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
HWA00003	−175.20	11	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
MEX01NTE	−78.20	11	−105.81	26.01	2.89	2.08	155	1	87.4	1
MEX01SUR	−69.20	11	−94.84	19.82	3.05	2.09	4	1	87.4	1
MEX02NTE	−136.20	11	−107.21	26.31	3.84	1.55	148	1	87.4	1
MEX02SUR	−127.20	11	−96.39	19.88	3.18	1.87	157	1	87.4	1
PAQPAC01	−106.20	11	−109.18	−27.53	0.60	0.60	90	1	87.4	9/GR17
PRG00002	−99.20	11	−58.66	−23.32	1.45	1.04	76	1	87.4	
PRUAND02	−115.20	11	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
PTRVIR01	−101.20	11	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
PTRVIR02	−110.20	11	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
URG00001	−71.70	11	−56.22	−32.52	1.02	0.89	11	1	87.4	
USAEH001	−61.70	11	−87.57	36.17	6.42	3.49	12	1	87.4	1 5 6
USAEH002	−101.20	11	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
USAEH003	−110.20	11	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
USAEH004	−119.20	11	−96.45	36.21	8.20	3.12	165	1	87.4	1 5 6
USAPSA02	−166.20	11	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
USAPSA03	−175.20	11	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
USAWH101	−148.20	11	−111.02	40.68	4.36	2.15	162	1	87.4	
USAWH102	−157.20	11	−113.07	40.74	3.72	1.78	149	1	87.4	
VENAND03	−115.20	11	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5

17 484.38 MHz (12)

1	2	3	4		5		6	7	8	9
ALS00002	−165.80	12	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
ALS00003	−174.80	12	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
ARGNORT4	−93.80	12	−63.96	−30.01	3.86	1.99	48	2	87.4	
ARGNORT5	−54.80	12	−62.85	−29.80	3.24	2.89	47	2	87.4	
B CE311	−63.80	12	−40.60	−6.07	3.04	2.06	174	2	87.4	8 9/GR7
B CE312	−44.80	12	−40.26	−6.06	3.44	2.09	174	2	87.4	8 9/GR9
B CE411	−63.80	12	−50.97	−15.26	3.86	1.38	49	2	87.4	8 9/GR7
B CE412	−44.80	12	−50.71	−15.30	3.57	1.56	52	2	87.4	8 9/GR9
B CE511	−63.80	12	−53.11	−2.98	2.42	2.15	107	2	87.4	8 9/GR7
B NO611	−73.80	12	−59.60	−11.62	2.86	1.69	165	1	87.4	8 9/GR8
B NO711	−73.80	12	−60.70	−1.78	3.54	1.78	126	1	87.4	8 9/GR8
B NO811	−73.80	12	−68.75	−4.71	2.37	1.65	73	1	87.4	8 9/GR8
B SE911	−101.80	12	−45.99	−19.09	2.22	0.79	62	2	87.4	8
B SU111	−80.80	12	−51.10	−25.64	2.76	1.06	50	2	87.4	8 9/GR6
B SU112	−44.80	12	−50.76	−25.62	2.47	1.48	56	2	87.4	8 9/GR9
B SU211	−80.80	12	−44.51	−16.94	3.22	1.37	60	2	87.4	8 9/GR6
B SU212	−44.80	12	−43.99	−16.97	3.27	1.92	59	2	87.4	8 9/GR9
CAN01101	−137.80	12	−114.10	50.92	7.22	1.11	160	2	87.4	9/GR10
CAN01201	−137.80	12	−114.10	50.92	7.22	1.11	160	2	87.4	9/GR10
CAN01202	−72.30	12	−81.23	50.12	7.99	2.53	5	2	87.4	
CAN01203	−128.80	12	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01303	−128.80	12	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01304	−90.80	12	−86.57	50.48	8.58	2.54	178	2	87.4	9/GR13
CAN01403	−128.80	12	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01404	−90.80	12	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01405	−81.80	12	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01504	−90.80	12	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01505	−81.80	12	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01605	−81.80	12	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01606	−70.30	12	−80.64	50.02	7.88	2.52	6	2	87.4	
CHLCONT4	−105.80	12	−69.59	−23.20	2.21	0.69	68	2	87.4	9/GR16
CHLCONT6	−105.80	12	−73.52	−55.52	3.65	1.31	39	2	87.4	9/GR16
CRBBAH01	−92.30	12	−76.09	24.13	1.83	0.68	141	1	87.4	9/GR18
CRBBER01	−92.30	12	−64.76	32.13	0.60	0.60	90	1	87.4	9/GR18
CRBBLZ01	−92.30	12	−88.61	17.26	0.64	0.64	90	1	87.4	9/GR18
CRBEC001	−92.30	12	−60.07	8.26	4.20	0.86	115	1	87.4	9/GR18
CRBJMC01	−92.30	12	−79.45	17.97	0.99	0.68	151	1	87.4	9/GR18
CYM00001	−115.80	12	−80.58	19.57	0.60	0.60	90	2	87.4	
DOMIFRB2	−83.30	12	−70.51	18.79	0.98	0.69	167	2	87.4	
EQAC0001	−94.80	12	−78.31	−1.52	1.48	1.15	65	1	87.4	9/GR19
EQAG0001	−94.80	12	−90.36	−0.57	0.94	0.89	99	1	87.4	9/GR19
GUFMGG02	−52.80	12	−56.42	8.47	4.16	0.81	123	2	87.4	2 7
HWA00002	−165.80	12	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
HWA00003	−174.80	12	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
JMC00005	−33.80	12	−77.27	18.12	0.60	0.60	90	2	87.4	
LCAIFRB1	−79.30	12	−61.15	13.90	0.60	0.60	90	2	87.4	
MEX01NTE	−77.80	12	−105.80	25.99	2.88	2.07	155	2	87.4	1
MEX02NTE	−135.80	12	−107.36	26.32	3.80	1.57	149	2	87.4	1
MEX02SUR	−126.80	12	−96.39	19.88	3.19	1.87	158	2	87.4	1
PRU00004	−85.80	12	−74.19	−8.39	3.74	2.45	112	2	87.4	
PTRVIR01	−100.80	12	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
PTRVIR02	−109.80	12	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
SLVIFRB2	−107.30	12	−88.91	13.59	0.60	0.60	90	1	87.4	
USAEH001	−61.30	12	−87.53	36.18	6.41	3.49	12	2	87.4	1 5 6
USAEH002	−100.80	12	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
USAEH003	−109.80	12	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH004	−118.80	12	−96.42	36.21	8.20	3.12	165	2	87.4	1 5 6
USAPSA02	−165.80	12	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
USAPSA03	−174.80	12	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
USAWH101	−147.80	12	−111.01	40.67	4.38	2.15	162	2	87.4	
USAWH102	−156.80	12	−113.01	40.71	3.74	1.79	149	2	87.4	
VEN11VEN	−103.80	12	−66.79	6.90	2.50	1.77	122	2	87.4	

17 498.96 MHz (13)

1	2	3	4		5		6	7	8	9
ALS00002	−166.20	13	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
ALS00003	−175.20	13	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
ARGINSU4	−94.20	13	−52.98	−59.81	3.40	0.68	19	1	87.4	9/GR3
ARGSUR04	−94.20	13	−65.04	−43.33	3.32	1.50	40	1	87.4	9/GR3
B CE311	−64.20	13	−40.60	−6.07	3.04	2.06	174	1	87.4	8 9/GR7
B CE312	−45.20	13	−40.27	−6.06	3.44	2.09	174	1	87.4	8 9/GR9
B CE411	−64.20	13	−50.97	−15.27	3.86	1.38	49	1	87.4	8 9/GR7
B CE412	−45.20	13	−50.71	−15.30	3.57	1.56	52	1	87.4	8 9/GR9
B CE511	−64.20	13	−53.10	−2.90	2.44	2.13	104	1	87.4	8 9/GR7
B NO611	−74.20	13	−59.60	−11.62	2.85	1.69	165	2	87.4	8 9/GR8
B NO711	−74.20	13	−60.70	−1.78	3.54	1.78	126	2	87.4	8 9/GR8
B NO811	−74.20	13	−68.76	−4.71	2.37	1.65	73	2	87.4	8 9/GR8
B SU111	−81.20	13	−51.12	−25.63	2.76	1.05	50	1	87.4	8 9/GR6
B SU112	−45.20	13	−50.75	−25.62	2.47	1.48	56	1	87.4	8 9/GR9
B SU211	−81.20	13	−44.51	−16.95	3.22	1.36	60	1	87.4	8 9/GR6
B SU212	−45.20	13	−44.00	−16.87	3.20	1.96	58	1	87.4	8 9/GR9
BAHIFRB1	−87.20	13	−76.06	24.16	1.81	0.70	142	1	87.4	
BERBERMU	−96.20	13	−64.77	32.32	0.60	0.60	90	2	87.4	
BERBER02	−31.00	13	−64.77	32.32	0.60	0.60	90	1	87.4	2 3
BOLAND01	−115.20	13	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CAN01101	−138.20	13	−114.60	51.08	7.28	1.10	160	1	87.4	9/GR10
CAN01201	−138.20	13	−114.60	51.08	7.28	1.10	160	1	87.4	9/GR10
CAN01202	−72.70	13	−81.34	50.02	7.96	2.55	5	1	87.4	
CAN01203	−129.20	13	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01303	−129.20	13	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01304	−91.20	13	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01403	−129.20	13	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01404	−91.20	13	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01405	−82.20	13	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01504	−91.20	13	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01505	−82.20	13	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01605	−82.20	13	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01606	−70.70	13	−80.77	50.03	7.88	2.53	6	1	87.4	
CHLCONT5	−106.20	13	−72.23	−35.57	2.60	0.68	55	1	87.4	9/GR17
CHLPAC02	−106.20	13	−80.06	−30.06	1.36	0.68	69	1	87.4	9/GR17
CLMAND01	−115.20	13	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CLM00001	−103.20	13	−74.50	5.87	3.98	1.96	118	1	87.4	
EQACAND1	−115.20	13	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
EQAGAND1	−115.20	13	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
FLKANT01	−57.20	13	−44.54	−60.13	3.54	0.68	12	1	87.4	2
FLKFALKS	−31.00	13	−59.90	−51.64	0.60	0.60	90	1	87.4	2 3
GRD00002	−42.20	13	−61.58	12.29	0.60	0.60	90	1	87.4	
HWA00002	−166.20	13	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
HWA00003	−175.20	13	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
MEX01NTE	−78.20	13	−105.81	26.01	2.89	2.08	155	1	87.4	1
MEX01SUR	−69.20	13	−94.84	19.82	3.05	2.09	4	1	87.4	1
MEX02NTE	−136.20	13	−107.21	26.31	3.84	1.55	148	1	87.4	1
MEX02SUR	−127.20	13	−96.39	19.88	3.18	1.87	157	1	87.4	1
PAQPAC01	−106.20	13	−109.18	−27.53	0.60	0.60	90	1	87.4	9/GR17
PRG00002	−99.20	13	−58.66	−23.32	1.45	1.04	76	1	87.4	
PRUAND02	−115.20	13	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
PTRVIR01	−101.20	13	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
PTRVIR02	−110.20	13	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
SPMFRAN3	−53.20	13	−67.24	47.51	3.16	0.79	7	1	87.4	2 7
TRD00001	−84.70	13	−61.23	10.70	0.60	0.60	90	1	87.4	
URG00001	−71.70	13	−56.22	−32.52	1.02	0.89	11	1	87.4	
USAEH001	−61.70	13	−87.57	36.17	6.42	3.49	12	1	87.4	1 5 6
USAEH002	−101.20	13	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
USAEH003	−110.20	13	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
USAEH004	−119.20	13	−96.45	36.21	8.20	3.12	165	1	87.4	1 5 6
USAPSA02	−166.20	13	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
USAPSA03	−175.20	13	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
USAWH101	−148.20	13	−111.02	40.68	4.36	2.15	162	1	87.4	
USAWH102	−157.20	13	−113.07	40.74	3.72	1.78	149	1	87.4	
VENAND03	−115.20	13	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
VRG00001	−79.70	13	−64.37	18.48	0.60	0.60	90	1	87.4	4

17 513.54 MHz (14)

1	2	3	4		5		6	7	8	9
ALS00002	−165.80	14	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
ALS00003	−174.80	14	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
ARGNORT4	−93.80	14	−63.96	−30.01	3.86	1.99	48	2	87.4	
ARGNORT5	−54.80	14	−62.85	−29.80	3.24	2.89	47	2	87.4	
ATNBEAM1	−52.80	14	−66.44	14.87	1.83	0.68	39	2	87.4	
B CE311	−63.80	14	−40.60	−6.07	3.04	2.06	174	2	87.4	8 9/GR7
B CE312	−44.80	14	−40.26	−6.06	3.44	2.09	174	2	87.4	8 9/GR9
B CE411	−63.80	14	−50.97	−15.26	3.86	1.38	49	2	87.4	8 9/GR7
B CE412	−44.80	14	−50.71	−15.30	3.57	1.56	52	2	87.4	8 9/GR9
B CE511	−63.80	14	−53.11	−2.98	2.42	2.15	107	2	87.4	8 9/GR7
B NO611	−73.80	14	−59.60	−11.62	2.86	1.69	165	1	87.4	8 9/GR8
B NO711	−73.80	14	−60.70	−1.78	3.54	1.78	126	1	87.4	8 9/GR8
B NO811	−73.80	14	−68.75	−4.71	2.37	1.65	73	1	87.4	8 9/GR8
B SE911	−101.80	14	−45.99	−19.09	2.22	0.79	62	2	87.4	8
B SU111	−80.80	14	−51.10	−25.64	2.76	1.06	50	2	87.4	8 9/GR6
B SU112	−44.80	14	−50.76	−25.62	2.47	1.48	56	2	87.4	8 9/GR9
B SU211	−80.80	14	−44.51	−16.94	3.22	1.37	60	2	87.4	8 9/GR6
B SU212	−44.80	14	−43.99	−16.97	3.27	1.92	59	2	87.4	8 9/GR9
CAN01101	−137.80	14	−114.10	50.92	7.22	1.11	160	2	87.4	9/GR10
CAN01201	−137.80	14	−114.10	50.92	7.22	1.11	160	2	87.4	9/GR10
CAN01202	−72.30	14	−81.23	50.12	7.99	2.53	5	2	87.4	
CAN01203	−128.80	14	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01303	−128.80	14	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01304	−90.80	14	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01403	−128.80	14	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01404	−90.80	14	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01405	−81.80	14	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01504	−90.80	14	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01505	−81.80	14	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01605	−81.80	14	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01606	−70.30	14	−80.64	50.02	7.88	2.52	6	2	87.4	
CHLCONT4	−105.80	14	−69.59	−23.20	2.21	0.69	68	2	87.4	9/GR16
CHLCONT6	−105.80	14	−73.52	−55.52	3.65	1.31	39	2	87.4	9/GR16
CRBBAH01	−92.30	14	−76.09	24.13	1.83	0.68	141	1	87.4	9/GR18
CRBBER01	−92.30	14	−64.76	32.13	0.60	0.60	90	1	87.4	9/GR18
CRBBLZ01	−92.30	14	−88.61	17.26	0.64	0.64	90	1	87.4	9/GR18
CRBEC001	−92.30	14	−60.07	8.26	4.20	0.86	115	1	87.4	9/GR18
CRBJMC01	−92.30	14	−79.45	17.97	0.99	0.68	151	1	87.4	9/GR18
CTR00201	−130.80	14	−84.33	9.67	0.82	0.68	119	2	87.4	
EQAC0001	−94.80	14	−78.31	−1.52	1.48	1.15	65	1	87.4	9/GR19
EQAG0001	−94.80	14	−90.36	−0.57	0.94	0.89	99	1	87.4	9/GR19
GUY00302	−33.80	14	−59.07	4.77	1.43	0.85	91	2	87.4	
HNDIFRB2	−107.30	14	−86.23	15.16	1.14	0.85	8	1	87.4	
HTI00002	−83.30	14	−73.28	18.96	0.82	0.68	11	2	87.4	
HWA00002	−165.80	14	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
HWA00003	−174.80	14	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
MEX01NTE	−77.80	14	−105.80	25.99	2.88	2.07	155	2	87.4	1
MEX02NTE	−135.80	14	−107.36	26.32	3.80	1.57	149	2	87.4	1
MEX02SUR	−126.80	14	−96.39	19.88	3.19	1.87	158	2	87.4	1
PRU00004	−85.80	14	−74.19	−8.39	3.74	2.45	112	2	87.4	
PTRVIR01	−100.80	14	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
PTRVIR02	−109.80	14	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
TCA00001	−115.80	14	−71.79	21.53	0.60	0.60	90	2	87.4	
USAEH001	−61.30	14	−87.53	36.18	6.41	3.49	12	2	87.4	1 5 6
USAEH002	−100.80	14	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
USAEH003	−109.80	14	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH004	−118.80	14	−96.42	36.21	8.20	3.12	165	2	87.4	1 5 6
USAPSA02	−165.80	14	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
USAPSA03	−174.80	14	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
USAWH101	−147.80	14	−111.01	40.67	4.38	2.15	162	2	87.4	
USAWH102	−156.80	14	−113.01	40.71	3.74	1.79	149	2	87.4	
VCT00001	−79.30	14	−61.18	13.23	0.60	0.60	90	2	87.4	
VEN11VEN	−103.80	14	−66.79	6.90	2.50	1.77	122	2	87.4	

17 528.12 MHz (15)

1	2	3	4		5		6	7	8	9
ALS00002	−166.20	15	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
ALS00003	−175.20	15	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
ARGINSU4	−94.20	15	−52.98	−59.81	3.40	0.68	19	1	87.4	9/GR3
ARGINSU5	−55.20	15	−44.17	−59.91	3.77	0.70	13	1	87.4	9/GR4
ARGSUR04	−94.20	15	−65.04	−43.33	3.32	1.50	40	1	87.4	9/GR3
ARGSUR05	−55.20	15	−63.68	−43.01	2.54	2.38	152	1	87.4	9/GR4
ATGSJN01	−79.70	15	−61.79	17.07	0.60	0.60	90	1	87.4	
B CE311	−64.20	15	−40.60	−6.07	3.04	2.06	174	1	87.4	8 9/GR7
B CE312	−45.20	15	−40.27	−6.06	3.44	2.09	174	1	87.4	8 9/GR9
B CE411	−64.20	15	−50.97	−15.27	3.86	1.38	49	1	87.4	8 9/GR7
B CE412	−45.20	15	−50.71	−15.30	3.57	1.56	52	1	87.4	8 9/GR9
B CE511	−64.20	15	−53.10	−2.90	2.44	2.13	104	1	87.4	8 9/GR7
B NO611	−74.20	15	−59.60	−11.62	2.85	1.69	165	2	87.4	8 9/GR8
B NO711	−74.20	15	−60.70	−1.78	3.54	1.78	126	2	87.4	8 9/GR8
B NO811	−74.20	15	−68.76	−4.71	2.37	1.65	73	2	87.4	8 9/GR8
B SU111	−81.20	15	−51.12	−25.63	2.76	1.05	50	1	87.4	8 9/GR6
B SU112	−45.20	15	−50.75	−25.62	2.47	1.48	56	1	87.4	8 9/GR9
B SU211	−81.20	15	−44.51	−16.95	3.22	1.36	60	1	87.4	8 9/GR6
B SU212	−45.20	15	−44.00	−16.87	3.20	1.96	58	1	87.4	8 9/GR9
BERBERMU	−96.20	15	−64.77	32.32	0.60	0.60	90	2	87.4	
BOLAND01	−115.20	15	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
BOL00001	−87.20	15	−64.61	−16.71	2.52	2.19	85	1	87.4	
BRB00001	−92.70	15	−59.85	12.93	0.60	0.60	90	2	87.4	
CAN01101	−138.20	15	−114.60	51.08	7.28	1.10	160	1	87.4	9/GR10
CAN01201	−138.20	15	−114.60	51.08	7.28	1.10	160	1	87.4	9/GR10
CAN01202	−72.70	15	−81.34	50.02	7.96	2.55	5	1	87.4	
CAN01203	−129.20	15	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01303	−129.20	15	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01304	−91.20	15	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01403	−129.20	15	−113.02	51.08	7.47	1.26	162	1	87.4	9/GR12
CAN01404	−91.20	15	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01405	−82.20	15	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01504	−91.20	15	−86.71	50.48	8.58	2.54	178	1	87.4	9/GR13
CAN01505	−82.20	15	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01605	−82.20	15	−84.11	50.20	8.31	2.58	1	1	87.4	9/GR14
CAN01606	−70.70	15	−80.77	50.03	7.88	2.53	6	1	87.4	
CHLCONT5	−106.20	15	−72.23	−35.57	2.60	0.68	55	1	87.4	9/GR17
CHLPAC02	−106.20	15	−80.06	−30.06	1.36	0.68	69	1	87.4	9/GR17
CLMAND01	−115.20	15	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CLM00001	−103.20	15	−74.50	5.87	3.98	1.96	118	1	87.4	
CUB00001	−89.20	15	−79.81	21.62	2.24	0.68	168	1	87.4	
EQACAND1	−115.20	15	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
EQAGAND1	−115.20	15	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
GRD00002	−42.20	15	−61.58	12.29	0.60	0.60	90	1	87.4	
GRD00059	−57.20	15	−61.58	12.29	0.60	0.60	90	1	87.4	
GRLDNK01	−53.20	15	−44.89	66.56	2.70	0.82	173	1	87.4	2
GUY00201	−84.70	15	−59.19	4.78	1.44	0.85	95	1	87.4	
HWA00002	−166.20	15	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
HWA00003	−175.20	15	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
MEX01NTE	−78.20	15	−105.81	26.01	2.89	2.08	155	1	87.4	1
MEX01SUR	−69.20	15	−94.84	19.82	3.05	2.09	4	1	87.4	1
MEX02NTE	−136.20	15	−107.21	26.31	3.84	1.55	148	1	87.4	1
MEX02SUR	−127.20	15	−96.39	19.88	3.18	1.87	157	1	87.4	1
PAQPAC01	−106.20	15	−109.18	−27.53	0.60	0.60	90	1	87.4	9/GR17
PRG00002	−99.20	15	−58.66	−23.32	1.45	1.04	76	1	87.4	
PRUAND02	−115.20	15	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
PTRVIR01	−101.20	15	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
PTRVIR02	−110.20	15	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
URG00001	−71.70	15	−56.22	−32.52	1.02	0.89	11	1	87.4	
USAEH001	−61.70	15	−87.57	36.17	6.42	3.49	12	1	87.4	1 5 6
USAEH002	−101.20	15	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
USAEH003	−110.20	15	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
USAEH004	−119.20	15	−96.45	36.21	8.20	3.12	165	1	87.4	1 5 6
USAPSA02	−166.20	15	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
USAPSA03	−175.20	15	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
USAWH101	−148.20	15	−111.02	40.68	4.36	2.15	162	1	87.4	
USAWH102	−157.20	15	−113.07	40.74	3.72	1.78	149	1	87.4	
VENAND03	−115.20	15	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5

17 542.70 MHz (16)

1	2	3	4		5		6	7	8	9
ALS00002	−165.80	16	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
ALS00003	−174.80	16	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
ARGNORT4	−93.80	16	−63.96	−30.01	3.86	1.99	48	2	87.4	
ARGNORT5	−54.80	16	−62.85	−29.80	3.24	2.89	47	2	87.4	
B CE311	−63.80	16	−40.60	−6.07	3.04	2.06	174	2	87.4	8 9/GR7
B CE312	−44.80	16	−40.26	−6.06	3.44	2.09	174	2	87.4	8 9/GR9
B CE411	−63.80	16	−50.97	−15.26	3.86	1.38	49	2	87.4	8 9/GR7
B CE412	−44.80	16	−50.71	−15.30	3.57	1.56	52	2	87.4	8 9/GR9
B CE511	−63.80	16	−53.11	−2.98	2.42	2.15	107	2	87.4	8 9/GR7
B NO611	−73.80	16	−59.60	−11.62	2.86	1.69	165	1	87.4	8 9/GR8
B NO711	−73.80	16	−60.70	−1.78	3.54	1.78	126	1	87.4	8 9/GR8
B NO811	−73.80	16	−68.75	−4.71	2.37	1.65	73	1	87.4	8 9/GR8
B SE911	−101.80	16	−45.99	−19.09	2.22	0.79	62	2	87.4	8
B SU111	−80.80	16	−51.10	−25.64	2.76	1.06	50	2	87.4	8 9/GR6
B SU112	−44.80	16	−50.76	−25.62	2.47	1.48	56	2	87.4	8 9/GR9
B SU211	−80.80	16	−44.51	−16.94	3.22	1.37	60	2	87.4	8 9/GR6
B SU212	−44.80	16	−43.99	−16.97	3.27	1.92	59	2	87.4	8 9/GR9
CAN01101	−137.80	16	−114.10	50.92	7.22	1.11	160	2	87.4	9/GR10
CAN01201	−137.80	16	−114.10	50.92	7.22	1.11	160	2	87.4	9/GR10
CAN01202	−72.30	16	−81.23	50.12	7.99	2.53	5	2	87.4	
CAN01203	−128.80	16	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01303	−128.80	16	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01304	−90.80	16	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01403	−128.80	16	−113.04	51.04	7.53	1.26	162	2	87.4	9/GR12
CAN01404	−90.80	16	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01405	−81.80	16	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01504	−90.80	16	−86.57	50.48	8.59	2.54	178	2	87.4	9/GR13
CAN01505	−81.80	16	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01605	−81.80	16	−83.80	50.22	8.35	2.57	2	2	87.4	9/GR14
CAN01606	−70.30	16	−80.64	50.02	7.88	2.52	6	2	87.4	
CHLCONT4	−105.80	16	−69.59	−23.20	2.21	0.69	68	2	87.4	9/GR16
CHLCONT6	−105.80	16	−73.52	−55.52	3.65	1.31	39	2	87.4	9/GR16
CRBBAH01	−92.30	16	−76.09	24.13	1.83	0.68	141	1	87.4	9/GR18
CRBBER01	−92.30	16	−64.76	32.13	0.60	0.60	90	1	87.4	9/GR18
CRBBLZ01	−92.30	16	−88.61	17.26	0.64	0.64	90	1	87.4	9/GR18
CRBEC001	−92.30	16	−60.07	8.26	4.20	0.86	115	1	87.4	9/GR18
CRBJMC01	−92.30	16	−79.45	17.97	0.99	0.68	151	1	87.4	9/GR18
CYM00001	−115.80	16	−80.58	19.57	0.60	0.60	90	2	87.4	
DOMIFRB2	−83.30	16	−70.51	18.79	0.98	0.69	167	2	87.4	
EQAC0001	−94.80	16	−78.31	−1.52	1.48	1.15	65	1	87.4	9/GR19
EQAG0001	−94.80	16	−90.36	−0.57	0.94	0.89	99	1	87.4	9/GR19
GUFMGG02	−52.80	16	−56.42	8.47	4.16	0.81	123	2	87.4	2 7
HWA00002	−165.80	16	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
HWA00003	−174.80	16	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
JMC00005	−33.80	16	−77.27	18.12	0.60	0.60	90	2	87.4	
LCAIFRB1	−79.30	16	−61.15	13.90	0.60	0.60	90	2	87.4	
MEX01NTE	−77.80	16	−105.80	25.99	2.88	2.07	155	2	87.4	1
MEX02NTE	−135.80	16	−107.36	26.32	3.80	1.57	149	2	87.4	1
MEX02SUR	−126.80	16	−96.39	19.88	3.19	1.87	158	2	87.4	1
PRU00004	−85.80	16	−74.19	−8.39	3.74	2.45	112	2	87.4	
PTRVIR01	−100.80	16	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
PTRVIR02	−109.80	16	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
SLVIFRB2	−107.30	16	−88.91	13.59	0.60	0.60	90	1	87.4	
USAEH001	−61.30	16	−87.53	36.18	6.41	3.49	12	2	87.4	1 5 6
USAEH002	−100.80	16	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
USAEH003	−109.80	16	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH004	−118.80	16	−96.42	36.21	8.20	3.12	165	2	87.4	1 5 6
USAPSA02	−165.80	16	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
USAPSA03	−174.80	16	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
USAWH101	−147.80	16	−111.01	40.67	4.38	2.15	162	2	87.4	
USAWH102	−156.80	16	−113.01	40.71	3.74	1.79	149	2	87.4	
VEN11VEN	−103.80	16	−66.79	6.90	2.50	1.77	122	2	87.4	

17 557.28 MHz (17)

1	2	3	4		5		6	7	8	9
ALS00002	−166.20	17	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
ALS00003	−175.20	17	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
ARGINSU4	−94.20	17	−52.98	−59.81	3.40	0.68	19	1	87.4	9/GR3
ARGINSU5	−55.20	17	−44.17	−59.91	3.77	0.70	13	1	87.4	9/GR4
ARGSUR04	−94.20	17	−65.04	−43.33	3.32	1.50	40	1	87.4	9/GR3
ARGSUR05	−55.20	17	−63.68	−43.01	2.54	2.38	152	1	87.4	9/GR4
B CE311	−64.20	17	−40.60	−6.07	3.04	2.06	174	1	87.4	9/GR3
B CE312	−45.20	17	−40.27	−6.06	3.44	2.09	174	1	87.4	9/GR4
B CE411	−64.20	17	−50.97	−15.27	3.86	1.38	49	1	87.4	8 9/GR7
B CE412	−45.20	17	−50.71	−15.30	3.57	1.56	52	1	87.4	8 9/GR9
B CE511	−64.20	17	−53.10	−2.90	2.44	2.13	104	1	87.4	8 9/GR7
B NO611	−74.20	17	−59.60	−11.62	2.85	1.69	165	2	87.4	8 9/GR8
B NO711	−74.20	17	−60.70	−1.78	3.54	1.78	126	2	87.4	8 9/GR8
B NO811	−74.20	17	−68.76	−4.71	2.37	1.65	73	2	87.4	8 9/GR8
B SU111	−81.20	17	−51.12	−25.63	2.76	1.05	50	1	87.4	8 9/GR6
B SU112	−45.20	17	−50.75	−25.62	2.47	1.48	56	1	87.4	8 9/GR9
B SU211	−81.20	17	−44.51	−16.95	3.22	1.36	60	1	87.4	8 9/GR6
B SU212	−45.20	17	−44.00	−16.87	3.20	1.96	58	1	87.4	8 9/GR9
BERBERMU	−96.20	17	−64.77	32.32	0.60	0.60	90	2	87.4	
BERBER02	−31.00	17	−64.77	32.32	0.60	0.60	90	1	87.4	2 3
BOLAND01	−115.20	17	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CAN01101	−138.20	17	−125.63	57.24	3.45	1.27	157	1	87.4	9/GR10
CAN01201	−138.20	17	−112.04	55.95	3.35	0.97	151	1	87.4	9/GR10
CAN01202	−72.70	17	−107.70	55.63	2.74	1.12	32	1	87.4	
CAN01203	−129.20	17	−111.48	55.61	3.08	1.15	151	1	87.4	9/GR12
CAN01303	−129.20	17	−102.42	57.12	3.54	0.91	154	1	87.4	9/GR12
CAN01304	−91.20	17	−99.12	57.36	1.98	1.72	2	1	87.4	9/GR13
CAN01403	−129.20	17	−89.75	52.02	4.68	0.78	148	1	87.4	9/GR12
CAN01404	−91.20	17	−84.82	52.42	3.10	2.05	152	1	87.4	9/GR13
CAN01405	−82.20	17	−84.00	52.39	2.84	2.29	172	1	87.4	9/GR14
CAN01504	−91.20	17	−72.66	53.77	3.57	1.67	156	1	87.4	9/GR13
CAN01505	−82.20	17	−71.77	53.79	3.30	1.89	162	1	87.4	9/GR14
CAN01605	−82.20	17	−61.50	49.55	2.65	1.40	143	1	87.4	9/GR14
CAN01606	−70.70	17	−61.30	49.55	2.40	1.65	148	1	87.4	
CHLCONT5	−106.20	17	−72.23	−35.57	2.60	0.68	55	1	87.4	9/GR17
CHLPAC02	−106.20	17	−80.06	−30.06	1.36	0.68	69	1	87.4	9/GR17
CLMAND01	−115.20	17	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CLM00001	−103.20	17	−74.50	5.87	3.98	1.96	118	1	87.4	
EQACAND1	−115.20	17	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
EQAGAND1	−115.20	17	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
FLKFALKS	−31.00	17	−59.90	−51.64	0.60	0.60	90	1	87.4	2 3
HWA00002	−166.20	17	−165.79	23.42	4.20	0.68	160	1	87.4	9/GR1
HWA00003	−175.20	17	−166.10	23.42	4.25	0.68	159	1	87.4	9/GR2
JMC00002	−92.70	17	−77.30	18.12	0.62	0.62	90	2	87.4	
KNA00001	−79.70	17	−62.46	17.44	0.60	0.60	90	1	87.4	
MEX01NTE	−78.20	17	−105.81	26.01	2.89	2.08	155	1	87.4	1
MEX01SUR	−69.20	17	−94.84	19.82	3.05	2.09	4	1	87.4	1
MEX02NTE	−136.20	17	−107.21	26.31	3.84	1.55	148	1	87.4	1
MEX02SUR	−127.20	17	−96.39	19.88	3.18	1.87	157	1	87.4	1
PAQPAC01	−106.20	17	−109.18	−27.53	0.60	0.60	90	1	87.4	9/GR17
PRG00002	−99.20	17	−58.66	−23.32	1.45	1.04	76	1	87.4	
PRUAND02	−115.20	17	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
PTRVIR01	−101.20	17	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
PTRVIR02	−110.20	17	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
SPMFRAN3	−53.20	17	−67.24	47.51	3.16	0.79	7	1	87.4	2 7
SURINAM2	−84.70	17	−55.69	4.35	1.00	0.69	86	1	87.4	
URG00001	−71.70	17	−56.22	−32.52	1.02	0.89	11	1	87.4	
USAEH001	−61.70	17	−87.57	36.17	6.42	3.49	12	1	87.4	1 5 6
USAEH002	−101.20	17	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
USAEH003	−110.20	17	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
USAEH004	−119.20	17	−96.45	36.21	8.20	3.12	165	1	87.4	1 5 6
USAPSA02	−166.20	17	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
USAPSA03	−175.20	17	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
USAWH101	−148.20	17	−111.02	40.68	4.36	2.15	162	1	87.4	
USAWH102	−157.20	17	−113.07	40.74	3.72	1.78	149	1	87.4	
VENAND03	−115.20	17	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5

17 571.86 MHz (18)

1	2	3	4		5		6	7	8	9
ALS00002	−165.80	18	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
ALS00003	−174.80	18	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
ARGNORT4	−93.80	18	−63.96	−30.01	3.86	1.99	48	2	87.4	
ARGNORT5	−54.80	18	−62.85	−29.80	3.24	2.89	47	2	87.4	
ATNBEAM1	−52.80	18	−66.44	14.87	1.83	0.68	39	2	87.4	
B CE311	−63.80	18	−40.60	−6.07	3.04	2.06	174	2	87.4	8 9/GR7
B CE312	−44.80	18	−40.26	−6.06	3.44	2.09	174	2	87.4	8 9/GR9
B CE411	−63.80	18	−50.97	−15.26	3.86	1.38	49	2	87.4	8 9/GR7
B CE412	−44.80	18	−50.71	−15.30	3.57	1.56	52	2	87.4	8 9/GR9
B CE511	−63.80	18	−53.11	−2.98	2.42	2.15	107	2	87.4	8 9/GR7
B NO611	−73.80	18	−59.60	−11.62	2.86	1.69	165	1	87.4	8 9/GR8
B NO711	−73.80	18	−60.70	−1.78	3.54	1.78	126	1	87.4	8 9/GR8
B NO811	−73.80	18	−68.75	−4.71	2.37	1.65	73	1	87.4	8 9/GR8
B SE911	−101.80	18	−45.99	−19.09	2.22	0.79	62	2	87.4	8
B SU111	−80.80	18	−51.10	−25.64	2.76	1.06	50	2	87.4	8 9/GR6
B SU112	−44.80	18	−50.76	−25.62	2.47	1.48	56	2	87.4	8 9/GR9
B SU211	−80.80	18	−44.51	−16.94	3.22	1.37	60	2	87.4	8 9/GR6
B SU212	−44.80	18	−43.99	−16.97	3.27	1.92	59	2	87.4	8 9/GR9
BLZ00001	−115.80	18	−88.68	17.27	0.62	0.62	90	2	87.4	
CAN01101	−137.80	18	−125.60	57.24	3.45	1.27	157	2	87.4	9/GR10
CAN01201	−137.80	18	−111.92	55.89	3.33	0.98	151	2	87.4	9/GR10
CAN01202	−72.30	18	−107.64	55.62	2.75	1.11	32	2	87.4	
CAN01203	−128.80	18	−111.43	55.56	3.07	1.15	151	2	87.4	9/GR12
CAN01303	−128.80	18	−102.39	57.12	3.54	0.92	154	2	87.4	9/GR12
CAN01304	−90.80	18	−99.00	57.33	1.96	1.73	1	2	87.4	9/GR13
CAN01403	−128.80	18	−89.70	52.02	4.67	0.79	148	2	87.4	9/GR12
CAN01404	−90.80	18	−84.78	52.41	3.09	2.06	153	2	87.4	9/GR13
CAN01405	−81.80	18	−84.02	52.34	2.82	2.30	172	2	87.4	9/GR14
CAN01504	−90.80	18	−72.68	53.78	3.57	1.67	157	2	87.4	9/GR13
CAN01505	−81.80	18	−71.76	53.76	3.30	1.89	162	2	87.4	9/GR14
CAN01605	−81.80	18	−61.54	49.50	2.66	1.39	144	2	87.4	9/GR14
CAN01606	−70.30	18	−61.32	49.51	2.41	1.65	148	2	87.4	
CHLCONT4	−105.80	18	−69.59	−23.20	2.21	0.69	68	2	87.4	9/GR16
CHLCONT6	−105.80	18	−73.52	−55.52	3.65	1.31	39	2	87.4	9/GR16
CRBBAH01	−92.30	18	−76.09	24.13	1.83	0.68	141	1	87.4	9/GR18
CRBBER01	−92.30	18	−64.76	32.13	0.60	0.60	90	1	87.4	9/GR18
CRBBLZ01	−92.30	18	−88.61	17.26	0.64	0.64	90	1	87.4	9/GR18
CRBEC001	−92.30	18	−60.07	8.26	4.20	0.86	115	1	87.4	9/GR18
CRBJMC01	−92.30	18	−79.45	17.97	0.99	0.68	151	1	87.4	9/GR18
CTR00201	−130.80	18	−84.33	9.67	0.82	0.68	119	2	87.4	
DMAIFRB1	−79.30	18	−61.30	15.35	0.60	0.60	90	2	87.4	
EQAC0001	−94.80	18	−78.31	−1.52	1.48	1.15	65	1	87.4	9/GR19
EQAG0001	−94.80	18	−90.36	−0.57	0.94	0.89	99	1	87.4	9/GR19
HWA00002	−165.80	18	−165.79	23.32	4.20	0.68	160	2	87.4	9/GR1
HWA00003	−174.80	18	−166.10	23.42	4.25	0.68	159	2	87.4	9/GR2
MEX01NTE	−77.80	18	−105.80	25.99	2.88	2.07	155	2	87.4	1
MEX02NTE	−135.80	18	−107.36	26.32	3.80	1.57	149	2	87.4	1
MEX02SUR	−126.80	18	−96.39	19.88	3.19	1.87	158	2	87.4	1
NCG00003	−107.30	18	−84.99	12.90	1.05	1.01	176	1	87.4	
PRU00004	−85.80	18	−74.19	−8.39	3.74	2.45	112	2	87.4	
PTRVIR01	−100.80	18	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
PTRVIR02	−109.80	18	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH001	−61.30	18	−87.53	36.18	6.41	3.49	12	2	87.4	1 5 6
USAEH002	−100.80	18	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
USAEH003	−109.80	18	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH004	−118.80	18	−96.42	36.21	8.20	3.12	165	2	87.4	1 5 6
USAPSA02	−165.80	18	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
USAPSA03	−174.80	18	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
USAWH101	−147.80	18	−111.01	40.67	4.38	2.15	162	2	87.4	
USAWH102	−156.80	18	−113.01	40.71	3.74	1.79	149	2	87.4	
VEN11VEN	−103.80	18	−66.79	6.90	2.50	1.77	122	2	87.4	

17 586.44 MHz (19)

1	2	3	4		5		6	7	8	9
ALS00002	−166.20	19	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
ALS00003	−175.20	19	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
ARGINSU4	−94.20	19	−52.98	−59.81	3.40	0.68	19	1	87.4	9/GR3
ARGINSU5	−55.20	19	−44.17	−59.91	3.77	0.70	13	1	87.4	9/GR4
ARGSUR04	−94.20	19	−65.04	−43.33	3.32	1.50	40	1	87.4	9/GR3
ARGSUR05	−55.20	19	−63.68	−43.01	2.54	2.38	152	1	87.4	9/GR4
B CE311	−64.20	19	−40.60	−6.07	3.04	2.06	174	1	87.4	8 9/GR7
B CE312	−45.20	19	−40.27	−6.06	3.44	2.09	174	1	87.4	8 9/GR9
B CE411	−64.20	19	−50.97	−15.27	3.86	1.38	49	1	87.4	8 9/GR7
B CE412	−45.20	19	−50.71	−15.30	3.57	1.56	52	1	87.4	8 9/GR9
B CE511	−64.20	19	−53.10	−2.90	2.44	2.13	104	1	87.4	8 9/GR7
B NO611	−74.20	19	−59.60	−11.62	2.85	1.69	165	2	87.4	8 9/GR8
B NO711	−74.20	19	−60.70	−1.78	3.54	1.78	126	2	87.4	8 9/GR8
B NO811	−74.20	19	−68.76	−4.71	2.37	1.65	73	2	87.4	8 9/GR8
B SU111	−81.20	19	−51.12	−25.63	2.76	1.05	50	1	87.4	8 9/GR6
B SU112	−45.20	19	−50.75	−25.62	2.47	1.48	56	1	87.4	8 9/GR9
B SU211	−81.20	19	−44.51	−16.95	3.22	1.36	60	1	87.4	8 9/GR6
B SU212	−45.20	19	−44.00	−16.87	3.20	1.96	58	1	87.4	8 9/GR9
BERBERMU	−96.20	19	−64.77	32.32	0.60	0.60	90	2	87.4	
BOLAND01	−115.20	19	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
BOL00001	−87.20	19	−64.61	−16.71	2.52	2.19	85	1	87.4	
BRB00001	−92.70	19	−59.85	12.93	0.60	0.60	90	2	87.4	
CAN01101	−138.20	19	−125.63	57.24	3.45	1.27	157	1	87.4	9/GR10
CAN01201	−138.20	19	−112.04	55.95	3.35	0.97	151	1	87.4	9/GR10
CAN01202	−72.70	19	−107.70	55.63	2.74	1.12	32	1	87.4	
CAN01203	−129.20	19	−111.48	55.61	3.08	1.15	151	1	87.4	9/GR12
CAN01303	−129.20	19	−102.42	57.12	3.54	0.91	154	1	87.4	9/GR12
CAN01304	−91.20	19	−99.12	57.36	1.98	1.72	2	1	87.4	9/GR13
CAN01403	−129.20	19	−89.75	52.02	4.68	0.78	148	1	87.4	9/GR12
CAN01404	−91.20	19	−84.82	52.42	3.10	2.05	152	1	87.4	9/GR13
CAN01405	−82.20	19	−84.00	52.39	2.84	2.29	172	1	87.4	9/GR14
CAN01504	−91.20	19	−72.66	53.77	3.57	1.67	156	1	87.4	9/GR13
CAN01505	−82.20	19	−71.77	53.79	3.30	1.89	162	1	87.4	9/GR14
CAN01605	−82.20	19	−61.50	49.55	2.65	1.40	143	1	87.4	9/GR14
CAN01606	−70.70	19	−61.30	49.55	2.40	1.65	148	1	87.4	
CHLCONT5	−106.20	19	−72.23	−35.57	2.60	0.68	55	1	87.4	9/GR17
CHLPAC02	−106.20	19	−80.06	−30.06	1.36	0.68	69	1	87.4	9/GR17
CLMAND01	−115.20	19	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CLM00001	−103.20	19	−74.50	5.87	3.98	1.96	118	1	87.4	
CUB00001	−89.20	19	−79.81	21.62	2.24	0.68	168	1	87.4	
EQACAND1	−115.20	19	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
EQAGAND1	−115.20	19	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
GRD00059	−57.20	19	−61.58	12.29	0.60	0.60	90	1	87.4	
GRLDNK01	−53.20	19	−44.89	66.56	2.70	0.82	173	1	87.4	2
GUY00201	−84.70	19	−59.19	4.78	1.44	0.85	95	1	87.4	
HWA00002	−166.20	19	−165.79	23.42	4.20	0.68	160	1	87.4	9/GR1
HWA00003	−175.20	19	−166.10	23.42	4.25	0.68	159	1	87.4	9/GR2
MEX01NTE	−78.20	19	−105.81	26.01	2.89	2.08	155	1	87.4	1
MEX01SUR	−69.20	19	−94.84	19.82	3.05	2.09	4	1	87.4	1
MEX02NTE	−136.20	19	−107.21	26.31	3.84	1.55	148	1	87.4	1
MEX02SUR	−127.20	19	−96.39	19.88	3.18	1.87	157	1	87.4	1
MSR00001	−79.70	19	−61.73	16.75	0.60	0.60	90	1	87.4	4
PAQPAC01	−106.20	19	−109.18	−27.53	0.60	0.60	90	1	87.4	9/GR17
PRG00002	−99.20	19	−58.66	−23.32	1.45	1.04	76	1	87.4	
PRUAND02	−115.20	19	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
PTRVIR01	−101.20	19	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
PTRVIR02	−110.20	19	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
URG00001	−71.70	19	−56.22	−32.52	1.02	0.89	11	1	87.4	
USAEH001	−61.70	19	−87.57	36.17	6.42	3.49	12	1	87.4	1 5 6
USAEH002	−101.20	19	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
USAEH003	−110.20	19	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
USAEH004	−119.20	19	−96.45	36.31	8.20	3.12	165	1	87.4	1 5 6
USAPSA02	−166.20	19	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
USAPSA03	−175.20	19	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
USAWH101	−148.20	19	−111.02	40.68	4.36	2.15	162	1	87.4	
USAWH102	−157.20	19	−113.07	40.74	3.72	1.78	149	1	87.4	
VENAND03	−115.20	19	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5

17 601.02 MHz (20)

1	2	3	4		5		6	7	8	9
ALS00002	−165.80	20	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
ALS00003	−174.80	20	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
ARGNORT4	−93.80	20	−63.96	−30.01	3.86	1.99	48	2	87.4	
ARGNORT5	−54.80	20	−62.85	−29.80	3.24	2.89	47	2	87.4	
B CE311	−63.80	20	−40.60	−6.07	3.04	2.06	174	2	87.4	8 9/GR7
B CE312	−44.80	20	−40.26	−6.06	3.44	2.09	174	2	87.4	8 9/GR9
B CE411	−63.80	20	−50.97	−15.26	3.86	1.38	49	2	87.4	8 9/GR7
B CE412	−44.80	20	−50.71	−15.30	3.57	1.56	52	2	87.4	8 9/GR9
B CE511	−63.80	20	−53.11	−2.98	2.42	2.15	107	2	87.4	8 9/GR7
B NO611	−73.80	20	−59.60	−11.62	2.86	1.69	165	1	87.4	8 9/GR8
B NO711	−73.80	20	−60.70	−1.78	3.54	1.78	126	1	87.4	8 9/GR8
B NO811	−73.80	20	−68.75	−4.71	2.37	1.65	73	1	87.4	8 9/GR8
B SE911	−101.80	20	−45.99	−19.09	2.22	0.79	62	2	87.4	8
B SU111	−80.80	20	−51.10	−25.64	2.76	1.06	50	2	87.4	8 9/GR6
B SU112	−44.80	20	−50.76	−25.62	2.47	1.48	56	2	87.4	8 9/GR9
B SU211	−80.80	20	−44.51	−16.94	3.22	1.37	60	2	87.4	8 9/GR6
B SU212	−44.80	20	−43.99	−16.97	3.27	1.92	59	2	87.4	8 9/GR9
CAN01101	−137.80	20	−125.60	57.24	3.45	1.27	157	2	87.4	9/GR10
CAN01201	−137.80	20	−111.92	55.89	3.33	0.98	151	2	87.4	9/GR10
CAN01202	−72.30	20	−107.64	55.62	2.75	1.11	32	2	87.4	
CAN01203	−128.80	20	−111.43	55.56	3.07	1.15	151	2	87.4	9/GR12
CAN01303	−128.80	20	−102.39	57.12	3.54	0.92	154	2	87.4	9/GR12
CAN01304	−90.80	20	−99.00	57.33	1.96	1.73	1	2	87.4	9/GR13
CAN01403	−128.80	20	−89.70	52.02	4.67	0.79	148	2	87.4	9/GR12
CAN01404	−90.80	20	−84.78	52.41	3.09	2.06	153	2	87.4	9/GR13
CAN01405	−81.80	20	−84.02	52.34	2.82	2.30	172	2	87.4	9/GR14
CAN01504	−90.80	20	−72.68	53.78	3.57	1.67	157	2	87.4	9/GR13
CAN01505	−81.80	20	−71.76	53.76	3.30	1.89	162	2	87.4	9/GR14
CAN01605	−81.80	20	−61.54	49.50	2.66	1.39	144	2	87.4	9/GR14
CAN01606	−70.30	20	−61.32	49.51	2.41	1.65	148	2	87.4	
CHLCONT4	−105.80	20	−69.59	−23.20	2.21	0.69	68	2	87.4	9/GR16
CHLCONT6	−105.80	20	−73.52	−55.52	3.65	1.31	39	2	87.4	9/GR16
CRBBAH01	−92.30	20	−76.09	24.13	1.83	0.68	141	1	87.4	9/GR18
CRBBER01	−92.30	20	−64.76	32.13	0.60	0.60	90	1	87.4	9/GR18
CRBBLZ01	−92.30	20	−88.61	17.26	0.64	0.64	90	1	87.4	9/GR18
CRBEC001	−92.30	20	−60.07	8.26	4.20	0.86	115	1	87.4	9/GR18
CRBJMC01	−92.30	20	−79.45	17.97	0.99	0.68	151	1	87.4	9/GR18
EQAC0001	−94.80	20	−78.31	−1.52	1.48	1.15	65	1	87.4	9/GR19
EQAG0001	−94.80	20	−90.36	−0.57	0.94	0.89	99	1	87.4	9/GR19
GRD00003	−79.30	20	−61.62	12.34	0.60	0.60	90	2	87.4	
GTMIFRB2	−107.30	20	−90.50	15.64	1.03	0.74	84	1	87.4	
GUFMGG02	−52.80	20	−56.42	8.47	4.16	0.81	123	2	87.4	2 7
HWA00002	−165.80	20	−165.79	23.32	4.20	0.68	160	2	87.4	9/GR1
HWA00003	−174.80	20	−166.10	23.42	4.25	0.68	159	2	87.4	9/GR2
MEX01NTE	−77.80	20	−105.80	25.99	2.88	2.07	155	2	87.4	1
MEX02NTE	−135.80	20	−107.36	26.32	3.80	1.57	149	2	87.4	1
MEX02SUR	−126.80	20	−96.39	19.88	3.19	1.87	158	2	87.4	1
PNRIFRB2	−121.00	20	−80.15	8.46	1.01	0.73	170	1	87.4	
PRU00004	−85.80	20	−74.19	−8.39	3.74	2.45	112	2	87.4	
PTRVIR01	−100.80	20	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
PTRVIR02	−109.80	20	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH001	−61.30	20	−87.53	36.18	6.41	3.49	12	2	87.4	1 5 6
USAEH002	−100.80	20	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
USAEH003	−109.80	20	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH004	−118.80	20	−96.42	36.21	8.20	3.12	165	2	87.4	1 5 6
USAPSA02	−165.80	20	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
USAPSA03	−174.80	20	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
USAWH101	−147.80	20	−111.01	40.67	4.38	2.15	162	2	87.4	
USAWH102	−156.80	20	−113.01	40.71	3.74	1.79	149	2	87.4	
VEN02VEN	−103.80	20	−66.79	6.90	2.50	1.77	122	2	87.4	9/GR22
VEN11VEN	−103.80	20	−66.79	6.90	2.50	1.77	122	2	87.4	9/GR22

17 615.60 MHz (21)

1	2	3	4		5		6	7	8	9
ALS00002	−166.20	21	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
ALS00003	−175.20	21	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
ARGINSU4	−94.20	21	−52.98	−59.81	3.40	0.68	19	1	87.4	9/GR3
ARGINSU5	−55.20	21	−44.17	−59.91	3.77	0.70	13	1	87.4	9/GR4
ARGSUR04	−94.20	21	−65.04	−43.33	3.32	1.50	40	1	87.4	9/GR3
ARGSUR05	−55.20	21	−63.68	−43.01	2.54	2.38	152	1	87.4	9/GR4
B CE311	−64.20	21	−40.60	−6.07	3.04	2.06	174	1	87.4	8 9/GR7
B CE312	−45.20	21	−40.27	−6.06	3.44	2.09	174	1	87.4	8 9/GR9
B CE411	−64.20	21	−50.97	−15.27	3.86	1.38	49	1	87.4	8 9/GR7
B CE412	−45.20	21	−50.71	−15.30	3.57	1.56	52	1	87.4	8 9/GR9
B CE511	−64.20	21	−53.10	−2.90	2.44	2.13	104	1	87.4	8 9/GR7
B NO611	−74.20	21	−59.60	−11.62	2.85	1.69	165	2	87.4	8 9/GR8
B NO711	−74.20	21	−60.70	−1.78	3.54	1.78	126	2	87.4	8 9/GR8
B NO811	−74.20	21	−68.76	−4.71	2.37	1.65	73	2	87.4	8 9/GR8
B SU111	−81.20	21	−51.12	−25.63	2.76	1.05	50	1	87.4	8 9/GR6
B SU112	−45.20	21	−50.75	−25.62	2.47	1.48	56	1	87.4	8 9/GR9
B SU211	−81.20	21	−44.51	−16.95	3.22	1.36	60	1	87.4	8 9/GR6
B SU212	−45.20	21	−44.00	−16.87	3.20	1.96	58	1	87.4	8 9/GR9
BERBERMU	−96.20	21	−64.77	32.32	0.60	0.60	90	2	87.4	
BOLAND01	−115.20	21	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CAN01101	−138.20	21	−125.63	57.24	3.45	1.27	157	1	87.4	9/GR10
CAN01201	−138.20	21	−112.04	55.95	3.35	0.97	151	1	87.4	9/GR10
CAN01202	−72.70	21	−107.70	55.63	2.74	1.12	32	1	87.4	
CAN01203	−129.20	21	−111.48	55.61	3.08	1.15	151	1	87.4	9/GR12
CAN01303	−129.20	21	−102.42	57.12	3.54	0.91	154	1	87.4	9/GR12
CAN01304	−91.20	21	−99.12	57.36	1.98	1.72	2	1	87.4	9/GR13
CAN01403	−129.20	21	−89.75	52.02	4.68	0.78	148	1	87.4	9/GR12
CAN01404	−91.20	21	−84.82	52.42	3.10	2.05	152	1	87.4	9/GR13
CAN01405	−82.20	21	−84.00	52.39	2.84	2.29	172	1	87.4	9/GR14
CAN01504	−91.20	21	−72.66	53.77	3.57	1.67	156	1	87.4	9/GR13
CAN01505	−82.20	21	−71.77	53.79	3.30	1.89	162	1	87.4	9/GR14
CAN01605	−82.20	21	−61.50	49.55	2.65	1.40	143	1	87.4	9/GR14
CAN01606	−70.70	21	−61.30	49.55	2.40	1.65	148	1	87.4	
CHLCONT5	−106.20	21	−72.23	−35.57	2.60	0.68	55	1	87.4	9/GR17
CHLPAC02	−106.20	21	−80.06	−30.06	1.36	0.68	69	1	87.4	9/GR17
CLMAND01	−115.20	21	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CLM00001	−103.20	21	−74.50	5.87	3.98	1.96	118	1	87.4	
EQACAND1	−115.20	21	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
EQAGAND1	−115.20	21	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
HWA00002	−166.20	21	−165.79	23.42	4.20	0.68	160	1	87.4	9/GR1
HWA00003	−175.20	21	−166.10	23.42	4.25	0.68	159	1	87.4	9/GR2
JMC00002	−92.70	21	−77.30	18.12	0.62	0.62	90	2	87.4	
KNA00001	−79.70	21	−62.46	17.44	0.60	0.60	90	1	87.4	
MEX01NTE	−78.20	21	−105.81	26.01	2.89	2.08	155	1	87.4	1
MEX01SUR	−69.20	21	−94.84	19.82	3.05	2.09	4	1	87.4	1
MEX02NTE	−136.20	21	−107.21	26.31	3.84	1.55	148	1	87.4	1
MEX02SUR	−127.20	21	−96.39	19.88	3.18	1.87	157	1	87.4	1
PAQPAC01	−106.20	21	−109.18	−27.53	0.60	0.60	90	1	87.4	9/GR17
PRG00002	−99.20	21	−58.66	−23.32	1.45	1.04	76	1	87.4	
PRUAND02	−115.20	21	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
PTRVIR01	−101.20	21	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
PTRVIR02	−110.20	21	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
SPMFRAN3	−53.20	21	−67.24	47.51	3.16	0.79	7	1	87.4	2 7
SURINAM2	−84.70	21	−55.69	4.35	1.00	0.69	86	1	87.4	
URG00001	−71.70	21	−56.22	−32.52	1.02	0.89	11	1	87.4	
USAEH001	−61.70	21	−87.57	36.17	6.42	3.49	12	1	87.4	1 5 6
USAEH002	−101.20	21	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
USAEH003	−110.20	21	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
USAEH004	−119.20	21	−96.45	36.21	8.20	3.12	165	1	87.4	1 5 6
USAPSA02	−166.20	21	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
USAPSA03	−175.20	21	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
USAWH101	−148.20	21	−111.02	40.68	4.36	2.15	162	1	87.4	
USAWH102	−157.20	21	−113.07	40.74	3.72	1.78	149	1	87.4	
VENAND03	−115.20	21	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5

17 630.18 MHz (22)

1	2	3	4		5		6	7	8	9
ALS00002	−165.80	22	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
ALS00003	−174.80	22	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
ARGNORT4	−93.80	22	−63.96	−30.01	3.86	1.99	48	2	87.4	
ARGNORT5	−54.80	22	−62.85	−29.80	3.24	2.89	47	2	87.4	
ATNBEAM1	−52.80	22	−66.44	14.87	1.83	0.68	39	2	87.4	
B CE311	−63.80	22	−40.60	−6.07	3.04	2.06	174	2	87.4	8 9/GR7
B CE312	−44.80	22	−40.26	−6.06	3.44	2.09	174	2	87.4	8 9/GR9
B CE411	−63.80	22	−50.97	−15.26	3.86	1.38	49	2	87.4	8 9/GR7
B CE412	−44.80	22	−50.71	−15.30	3.57	1.56	52	2	87.4	8 9/GR9
B CE511	−63.80	22	−53.11	−2.98	2.42	2.15	107	2	87.4	8 9/GR7
B NO611	−73.80	22	−59.60	−11.62	2.86	1.69	165	1	87.4	8 9/GR8
B NO711	−73.80	22	−60.70	−1.78	3.54	1.78	126	1	87.4	8 9/GR8
B NO811	−73.80	22	−68.75	−4.71	2.37	1.65	73	1	87.4	8 9/GR8
B SE911	−101.80	22	−45.99	−19.09	2.22	0.79	62	2	87.4	8
B SU111	−80.80	22	−51.10	−25.64	2.76	1.06	50	2	87.4	8 9/GR6
B SU112	−44.80	22	−50.76	−25.62	2.47	1.48	56	2	87.4	8 9/GR9
B SU211	−80.80	22	−44.51	−16.94	3.22	1.37	60	2	87.4	8 9/GR6
B SU212	−44.80	22	−43.99	−16.97	3.27	1.92	59	2	87.4	8 9/GR9
BLZ00001	−115.80	22	−88.68	17.27	0.62	0.62	90	2	87.4	
CAN01101	−137.80	22	−125.60	57.24	3.45	1.27	157	2	87.4	9/GR10
CAN01201	−137.80	22	−111.92	55.89	3.33	0.98	151	2	87.4	9/GR10
CAN01202	−72.30	22	−107.64	55.62	2.75	1.11	32	2	87.4	
CAN01203	−128.80	22	−111.43	55.56	3.07	1.15	151	2	87.4	9/GR12
CAN01303	−128.80	22	−102.39	57.12	3.54	0.92	154	2	87.4	9/GR12
CAN01304	−90.80	22	−99.00	57.33	1.96	1.73	1	2	87.4	9/GR13
CAN01403	−128.80	22	−89.70	52.02	4.67	0.79	148	2	87.4	9/GR12
CAN01404	−90.80	22	−84.78	52.41	3.09	2.06	153	2	87.4	9/GR13
CAN01405	−81.80	22	−84.02	52.34	2.82	2.30	172	2	87.4	9/GR14
CAN01504	−90.80	22	−72.68	53.78	3.57	1.67	157	2	87.4	9/GR13
CAN01505	−81.80	22	−71.76	53.76	3.30	1.89	162	2	87.4	9/GR14
CAN01605	−81.80	22	−61.54	49.50	2.66	1.39	144	2	87.4	9/GR14
CAN01606	−70.30	22	−61.32	49.51	2.41	1.65	148	2	87.4	
CHLCONT4	−105.80	22	−69.59	−23.20	2.21	0.69	68	2	87.4	9/GR16
CHLCONT6	−105.80	22	−73.52	−55.52	3.65	1.31	39	2	87.4	9/GR16
CRBBAH01	−92.30	22	−76.09	24.13	1.83	0.68	141	1	87.4	9/GR18
CRBBER01	−92.30	22	−64.76	32.13	0.60	0.60	90	1	87.4	9/GR18
CRBBLZ01	−92.30	22	−88.61	17.26	0.64	0.64	90	1	87.4	9/GR18
CRBEC001	−92.30	22	−60.07	8.26	4.20	0.86	115	1	87.4	9/GR18
CRBJMC01	−92.30	22	−79.45	17.97	0.99	0.68	151	1	87.4	9/GR18
CTR00201	−130.80	22	−84.33	9.67	0.82	0.68	119	2	87.4	
DMAIFRB1	−79.30	22	−61.30	15.35	0.60	0.60	90	2	87.4	
EQAC0001	−94.80	22	−78.31	−1.52	1.48	1.15	65	1	87.4	9/GR19
EQAG0001	−94.80	22	−90.36	−0.57	0.94	0.89	99	1	87.4	9/GR19
HWA00002	−165.80	22	−165.79	23.32	4.20	0.68	160	2	87.4	9/GR1
HWA00003	−174.80	22	−166.10	23.42	4.25	0.68	159	2	87.4	9/GR2
MEX01NTE	−77.80	22	−105.80	25.99	2.88	2.07	155	2	87.4	1
MEX02NTE	−135.80	22	−107.36	26.32	3.80	1.57	149	2	87.4	1
MEX02SUR	−126.80	22	−96.39	19.88	3.19	1.87	158	2	87.4	1
NCG00003	−107.30	22	−84.99	12.90	1.05	1.01	176	1	87.4	
PRU00004	−85.80	22	−74.19	−8.39	3.74	2.45	112	2	87.4	
PTRVIR01	−100.80	22	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
PTRVIR02	−109.80	22	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH001	−61.30	22	−87.53	36.18	6.41	3.49	12	2	87.4	1 5 6
USAEH002	−100.80	22	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
USAEH003	−109.80	22	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH004	−118.80	22	−96.42	36.21	8.20	3.12	165	2	87.4	1 5 6
USAPSA02	−165.80	22	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
USAPSA03	−174.80	22	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
USAWH101	−147.80	22	−111.01	40.67	4.38	2.15	162	2	87.4	
USAWH102	−156.80	22	−113.01	40.71	3.74	1.79	149	2	87.4	
VEN11VEN	−103.80	22	−66.79	6.90	2.50	1.77	122	2	87.4	

17 644.76 MHz (23)

1	2	3	4		5		6	7	8	9
ALS00002	−166.20	23	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
ALS00003	−175.20	23	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
ARGINSU4	−94.20	23	−52.98	−59.81	3.40	0.68	19	1	87.4	9/GR3
ARGINSU5	−55.20	23	−44.17	−59.91	3.77	0.70	13	1	87.4	9/GR4
ARGSUR04	−94.20	23	−65.04	−43.33	3.32	1.50	40	1	87.4	9/GR3
ARGSUR05	−55.20	23	−63.68	−43.01	2.54	2.38	152	1	87.4	9/GR4
B CE311	−64.20	23	−40.60	−6.07	3.04	2.06	174	1	87.4	8 9/GR7
B CE312	−45.20	23	−40.27	−6.06	3.44	2.09	174	1	87.4	8 9/GR9
B CE411	−64.20	23	−50.97	−15.27	3.86	1.38	49	1	87.4	8 9/GR7
B CE412	−45.20	23	−50.71	−15.30	3.57	1.56	52	1	87.4	8 9/GR9
B CE511	−64.20	23	−53.10	−2.90	2.44	2.13	104	1	87.4	8 9/GR7
B NO611	−74.20	23	−59.60	−11.62	2.85	1.69	165	2	87.4	8 9/GR8
B NO711	−74.20	23	−60.70	−1.78	3.54	1.78	126	2	87.4	8 9/GR8
B NO811	−74.20	23	−68.76	−4.71	2.37	1.65	73	2	87.4	8 9/GR8
B SU111	−81.20	23	−51.12	−25.63	2.76	1.05	50	1	87.4	8 9/GR6
B SU112	−45.20	23	−50.75	−25.62	2.47	1.48	56	1	87.4	8 9/GR9
B SU211	−81.20	23	−44.51	−16.95	3.22	1.36	60	1	87.4	8 9/GR6
B SU212	−45.20	23	−44.00	−16.87	3.20	1.96	58	1	87.4	8 9/GR9
BERBERMU	−96.20	23	−64.77	32.32	0.60	0.60	90	2	87.4	
BOLAND01	−115.20	23	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
BOL00001	−87.20	23	−64.61	−16.71	2.52	2.19	85	1	87.4	
BRB00001	−92.70	23	−59.85	12.93	0.60	0.60	90	2	87.4	
CAN01101	−138.20	23	−125.63	57.24	3.45	1.27	157	1	87.4	9/GR10
CAN01201	−138.20	23	−112.04	55.95	3.35	0.97	151	1	87.4	9/GR10
CAN01202	−72.70	23	−107.70	55.63	2.74	1.12	32	1	87.4	
CAN01203	−129.20	23	−111.48	55.61	3.08	1.15	151	1	87.4	9/GR12
CAN01303	−129.20	23	−102.42	57.12	3.54	0.91	154	1	87.4	9/GR12
CAN01304	−91.20	23	−99.12	57.36	1.98	1.72	2	1	87.4	9/GR13
CAN01403	−129.20	23	−89.75	52.02	4.68	0.78	148	1	87.4	9/GR12
CAN01404	−91.20	23	−84.82	52.42	3.10	2.05	152	1	87.4	9/GR13
CAN01405	−82.20	23	−84.00	52.39	2.84	2.29	172	1	87.4	9/GR14
CAN01504	−91.20	23	−72.66	53.77	3.57	1.67	156	1	87.4	9/GR13
CAN01505	−82.20	23	−71.77	53.79	3.30	1.89	162	1	87.4	9/GR14
CAN01605	−82.20	23	−61.50	49.55	2.65	1.40	143	1	87.4	9/GR14
CAN01606	−70.70	23	−61.30	49.55	2.40	1.65	148	1	87.4	
CHLCONT5	−106.20	23	−72.23	−35.57	2.60	0.68	55	1	87.4	9/GR17
CHLPAC02	−106.20	23	−80.06	−30.06	1.36	0.68	69	1	87.4	9/GR17
CLMAND01	−115.20	23	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CLM00001	−103.20	23	−74.50	5.87	3.98	1.96	118	1	87.4	
CUB00001	−89.20	23	−79.81	21.62	2.24	0.68	168	1	87.4	
EQACAND1	−115.20	23	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
EQAGAND1	−115.20	23	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
GRD00059	−57.20	23	−61.58	12.29	0.60	0.60	90	1	87.4	
GRLDNK01	−53.20	23	−44.89	66.56	2.70	0.82	173	1	87.4	2
GUY00201	−84.70	23	−59.19	4.78	1.44	0.85	95	1	87.4	
HWA00002	−166.20	23	−165.79	23.42	4.20	0.68	160	1	87.4	9/GR1
HWA00003	−175.20	23	−166.10	23.42	4.25	0.68	159	1	87.4	9/GR2
MEX01NTE	−78.20	23	−105.81	26.01	2.89	2.08	155	1	87.4	1
MEX01SUR	−69.20	23	−94.84	19.82	3.05	2.09	4	1	87.4	1
MEX02NTE	−136.20	23	−107.21	26.31	3.84	1.55	148	1	87.4	1
MEX02SUR	−127.20	23	−96.39	19.88	3.18	1.87	157	1	87.4	1
MSR00001	−79.70	23	−61.73	16.75	0.60	0.60	90	1	87.4	4
PAQPAC01	−106.20	23	−109.18	−27.53	0.60	0.60	90	1	87.4	9/GR17
PRG00002	−99.20	23	−58.66	−23.32	1.45	1.04	76	1	87.4	
PRUAND02	−115.20	23	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
PTRVIR01	−101.20	23	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
PTRVIR02	−110.20	23	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
URG00001	−71.70	23	−56.22	−32.52	1.02	0.89	11	1	87.4	
USAEH001	−61.70	23	−87.57	36.17	6.42	3.49	12	1	87.4	1 5 6
USAEH002	−101.20	23	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
USAEH003	−110.20	23	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
USAEH004	−119.20	23	−96.45	36.21	8.20	3.12	165	1	87.4	1 5 6
USAPSA02	−166.20	23	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
USAPSA03	−175.20	23	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
USAWH101	−148.20	23	−111.02	40.68	4.36	2.15	162	1	87.4	
USAWH102	−157.20	23	−113.07	40.74	3.72	1.78	149	1	87.4	
VENAND03	−115.20	23	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5

17 659.34 MHz (24)

1	2	3	4		5		6	7	8	9
ALS00002	−165.80	24	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
ALS00003	−174.80	24	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
ARGNORT4	−93.80	24	−63.96	−30.01	3.86	1.99	48	2	87.4	
ARGNORT5	−54.80	24	−62.85	−29.80	3.24	2.89	47	2	87.4	
B CE311	−63.80	24	−40.60	−6.07	3.04	2.06	174	2	87.4	8 9/GR7
B CE312	−44.80	24	−40.26	−6.06	3.44	2.09	174	2	87.4	8 9/GR9
B CE411	−63.80	24	−50.97	−15.26	3.86	1.38	49	2	87.4	8 9/GR7
B CE412	−44.80	24	−50.71	−15.30	3.57	1.56	52	2	87.4	8 9/GR9
B CE511	−63.80	24	−53.11	−2.98	2.42	2.15	107	2	87.4	8 9/GR7
B NO611	−73.80	24	−59.60	−11.62	2.86	1.69	165	1	87.4	8 9/GR8
B NO711	−73.80	24	−60.70	−1.78	3.54	1.78	126	1	87.4	8 9/GR8
B NO811	−73.80	24	−68.75	−4.71	2.37	1.65	73	1	87.4	8 9/GR8
B SE911	−101.80	24	−45.99	−19.09	2.22	0.79	62	2	87.4	8
B SU111	−80.80	24	−51.10	−25.64	2.76	1.06	50	2	87.4	8 9/GR6
B SU112	−44.80	24	−50.76	−25.62	2.47	1.48	56	2	87.4	8 9/GR9
B SU211	−80.80	24	−44.51	−16.94	3.22	1.37	60	2	87.4	8 9/GR6
B SU212	−44.80	24	−43.99	−16.97	3.27	1.92	59	2	87.4	8 9/GR9
CAN01101	−137.80	24	−125.60	57.24	3.45	1.27	157	2	87.4	9/GR10
CAN01201	−137.80	24	−111.92	55.89	3.33	0.98	151	2	87.4	9/GR10
CAN01202	−72.30	24	−107.64	55.62	2.75	1.11	32	2	87.4	
CAN01203	−128.80	24	−111.43	55.56	3.07	1.15	151	2	87.4	9/GR12
CAN01303	−128.80	24	−102.39	57.12	3.54	0.92	154	2	87.4	9/GR12
CAN01304	−90.80	24	−99.00	57.33	1.96	1.73	1	2	87.4	9/GR13
CAN01403	−128.80	24	−89.70	52.02	4.67	0.79	148	2	87.4	9/GR12
CAN01404	−90.80	24	−84.78	52.41	3.09	2.06	153	2	87.4	9/GR13
CAN01405	−81.80	24	−84.02	52.34	2.82	2.30	172	2	87.4	9/GR14
CAN01504	−90.80	24	−72.68	53.78	3.57	1.67	157	2	87.4	9/GR13
CAN01505	−81.80	24	−71.76	53.76	3.30	1.89	162	2	87.4	9/GR14
CAN01605	−81.80	24	−61.54	49.50	2.66	1.39	144	2	87.4	9/GR14
CAN01606	−70.30	24	−61.32	49.51	2.41	1.65	148	2	87.4	
CHLCONT4	−105.80	24	−69.59	−23.20	2.21	0.69	68	2	87.4	9/GR16
CHLCONT6	−105.80	24	−73.52	−55.52	3.65	1.31	39	2	87.4	9/GR16
CRBBAH01	−92.30	24	−76.09	24.13	1.83	0.68	141	1	87.4	9/GR18
CRBBER01	−92.30	24	−64.76	32.13	0.60	0.60	90	1	87.4	9/GR18
CRBBLZ01	−92.30	24	−88.61	17.26	0.64	0.64	90	1	87.4	9/GR18
CRBEC001	−92.30	24	−60.07	8.26	4.20	0.86	115	1	87.4	9/GR18
CRBJMC01	−92.30	24	−79.45	17.97	0.99	0.68	151	1	87.4	9/GR18
EQAC0001	−94.80	24	−78.31	−1.52	1.48	1.15	65	1	87.4	9/GR19
EQAG0001	−94.80	24	−90.36	−0.57	0.94	0.89	99	1	87.4	9/GR19
GRD00003	−79.30	24	−61.62	12.34	0.60	0.60	90	2	87.4	
GTMIFRB2	−107.30	24	−90.50	15.64	1.03	0.74	84	1	87.4	
GUFMGG02	−52.80	24	−56.42	8.47	4.16	0.81	123	2	87.4	2 7
HWA00002	−165.80	24	−165.79	23.32	4.20	0.68	160	2	87.4	9/GR1
HWA00003	−174.80	24	−166.10	23.42	4.25	0.68	159	2	87.4	9/GR2
MEX01NTE	−77.80	24	−105.80	25.99	2.88	2.07	155	2	87.4	1
MEX02NTE	−135.80	24	−107.36	26.32	3.80	1.57	149	2	87.4	1
MEX02SUR	−126.80	24	−96.39	19.88	3.19	1.87	158	2	87.4	1
PNRIFRB2	−121.00	24	−80.15	8.46	1.01	0.73	170	1	87.4	
PRU00004	−85.80	24	−74.19	−8.39	3.74	2.45	112	2	87.4	
PTRVIR01	−100.80	24	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
PTRVIR02	−109.80	24	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH001	−61.30	24	−87.53	36.18	6.41	3.49	12	2	87.4	1 5 6
USAEH002	−100.80	24	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
USAEH003	−109.80	24	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH004	−118.80	24	−96.42	36.21	8.20	3.12	165	2	87.4	1 5 6
USAPSA02	−165.80	24	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
USAPSA03	−174.80	24	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
USAWH101	−147.80	24	−111.01	40.67	4.38	2.15	162	2	87.4	
USAWH102	−156.80	24	−113.01	40.71	3.74	1.79	149	2	87.4	
VEN02VEN	−103.80	24	−66.79	6.90	2.50	1.77	122	2	87.4	9/GR22
VEN11VEN	−103.80	24	−66.79	6.90	2.50	1.77	122	2	87.4	9/GR22

17 673.92 MHz (25)

1	2	3	4		5		6	7	8	9
ALS00002	−166.20	25	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
ALS00003	−175.20	25	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
ARGINSU4	−94.20	25	−52.98	−59.81	3.40	0.68	19	1	87.4	9/GR3
ARGINSU5	−55.20	25	−44.17	−59.91	3.77	0.70	13	1	87.4	9/GR4
ARGSUR04	−94.20	25	−65.04	−43.33	3.32	1.50	40	1	87.4	9/GR3
ARGSUR05	−55.20	25	−63.68	−43.01	2.54	2.38	152	1	87.4	9/GR4
B CE311	−64.20	25	−40.60	−6.07	3.04	2.06	174	1	87.4	8 9/GR7
B CE312	−45.20	25	−40.27	−6.06	3.44	2.09	174	1	87.4	8 9/GR9
B CE411	−64.20	25	−50.97	−15.27	3.86	1.38	49	1	87.4	8 9/GR7
B CE412	−45.20	25	−50.71	−15.30	3.57	1.56	52	1	87.4	8 9/GR9
B CE511	−64.20	25	−53.10	−2.90	2.44	2.13	104	1	87.4	8 9/GR7
B NO611	−74.20	25	−59.60	−11.62	2.85	1.69	165	2	87.4	8 9/GR8
B NO711	−74.20	25	−60.70	−1.78	3.54	1.78	126	2	87.4	8 9/GR8
B NO811	−74.20	25	−68.76	−4.71	2.37	1.65	73	2	87.4	8 9/GR8
B SU111	−81.20	25	−51.12	−25.63	2.76	1.05	50	1	87.4	8 9/GR6
B SU112	−45.20	25	−50.75	−25.62	2.47	1.48	56	1	87.4	8 9/GR9
B SU211	−81.20	25	−44.51	−16.95	3.22	1.36	60	1	87.4	8 9/GR6
B SU212	−45.20	25	−44.00	−16.87	3.20	1.96	58	1	87.4	8 9/GR9
BERBERMU	−96.20	25	−64.77	32.32	0.60	0.60	90	2	87.4	
BOLAND01	−115.20	25	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CAN01101	−138.20	25	−125.63	57.24	3.45	1.27	157	1	87.4	9/GR10
CAN01201	−138.20	25	−112.04	55.95	3.35	0.97	151	1	87.4	9/GR10
CAN01202	−72.70	25	−107.70	55.63	2.74	1.12	32	1	87.4	
CAN01203	−129.20	25	−111.48	55.61	3.08	1.15	151	1	87.4	9/GR12
CAN01303	−129.20	25	−102.42	57.12	3.54	0.91	154	1	87.4	9/GR12
CAN01304	−91.20	25	−99.12	57.36	1.98	1.72	2	1	87.4	9/GR13
CAN01403	−129.20	25	−89.75	52.02	4.68	0.78	148	1	87.4	9/GR12
CAN01404	−91.20	25	−84.82	52.42	3.10	2.05	152	1	87.4	9/GR13
CAN01405	−82.20	25	−84.00	52.39	2.84	2.29	172	1	87.4	9/GR14
CAN01504	−91.20	25	−72.66	53.77	3.57	1.67	156	1	87.4	9/GR13
CAN01505	−82.20	25	−71.77	53.79	3.30	1.89	162	1	87.4	9/GR14
CAN01605	−82.20	25	−61.50	49.55	2.65	1.40	143	1	87.4	9/GR14
CAN01606	−70.70	25	−61.30	49.55	2.40	1.65	148	1	87.4	
CHLCONT5	−106.20	25	−72.23	−35.57	2.60	0.68	55	1	87.4	9/GR17
CHLPAC02	−106.20	25	−80.06	−30.06	1.36	0.68	69	1	87.4	9/GR17
CLMAND01	−115.20	25	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CLM00001	−103.20	25	−74.50	5.87	3.98	1.96	118	1	87.4	
EQACAND1	−115.20	25	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
EQAGAND1	−115.20	25	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
HWA00002	−166.20	25	−165.79	23.42	4.20	0.68	160	1	87.4	9/GR1
HWA00003	−175.20	25	−166.10	23.42	4.25	0.68	159	1	87.4	9/GR2
JMC00002	−92.70	25	−77.30	18.12	0.62	0.62	90	2	87.4	
KNA00001	−79.70	25	−62.46	17.44	0.60	0.60	90	1	87.4	
MEX01NTE	−78.20	25	−105.81	26.01	2.89	2.08	155	1	87.4	1
MEX01SUR	−69.20	25	−94.84	19.82	3.05	2.09	4	1	87.4	1
MEX02NTE	−136.20	25	−107.21	26.31	3.84	1.55	148	1	87.4	1
MEX02SUR	−127.20	25	−96.39	19.88	3.18	1.87	157	1	87.4	1
PAQPAC01	−106.20	25	−109.18	−27.53	0.60	0.60	90	1	87.4	9/GR17
PRG00002	−99.20	25	−58.66	−23.32	1.45	1.04	76	1	87.4	
PRUAND02	−115.20	25	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
PTRVIR01	−101.20	25	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
PTRVIR02	−110.20	25	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
SPMFRAN3	−53.20	25	−67.24	47.51	3.16	0.79	7	1	87.4	2 7
SURINAM2	−84.70	25	−55.69	4.35	1.00	0.69	86	1	87.4	
URG00001	−71.70	25	−56.22	−32.52	1.02	0.89	11	1	87.4	
USAEH001	−61.70	25	−87.57	36.17	6.42	3.49	12	1	87.4	1 5 6
USAEH002	−101.20	25	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
USAEH003	−110.20	25	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
USAEH004	−119.20	25	−96.45	36.21	8.20	3.12	165	1	87.4	1 5 6
USAPSA02	−166.20	25	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
USAPSA03	−175.20	25	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
USAWH101	−148.20	25	−111.02	40.68	4.36	2.15	162	1	87.4	
USAWH102	−157.20	25	−113.07	40.74	3.72	1.78	149	1	87.4	
VENAND03	−115.20	25	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5

17 688.50 MHz (26)

1	2	3	4		5		6	7	8	9
ALS00002	−165.80	26	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
ALS00003	−174.80	26	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
ARGNORT4	−93.80	26	−63.96	−30.01	3.86	1.99	48	2	87.4	
ARGNORT5	−54.80	26	−62.85	−29.80	3.24	2.89	47	2	87.4	
ATNBEAM1	−52.80	26	−66.44	14.87	1.83	0.68	39	2	87.4	
B CE311	−63.80	26	−40.60	−6.07	3.04	2.06	174	2	87.4	8 9/GR7
B CE312	−44.80	26	−40.26	−6.06	3.44	2.09	174	2	87.4	8 9/GR9
B CE411	−63.80	26	−50.97	−15.26	3.86	1.38	49	2	87.4	8 9/GR7
B CE412	−44.80	26	−50.71	−15.30	3.57	1.56	52	2	87.4	8 9/GR9
B CE511	−63.80	26	−53.11	−2.98	2.42	2.15	107	2	87.4	8 9/GR7
B NO611	−73.80	26	−59.60	−11.62	2.86	1.69	165	1	87.4	8 9/GR8
B NO711	−73.80	26	−60.70	−1.78	3.54	1.78	126	1	87.4	8 9/GR8
B NO811	−73.80	26	−68.75	−4.71	2.37	1.65	73	1	87.4	8 9/GR8
B SE911	−101.80	26	−45.99	−19.09	2.22	0.79	62	2	87.4	8
B SU111	−80.80	26	−51.10	−25.64	2.76	1.06	50	2	87.4	8 9/GR6
B SU112	−44.80	26	−50.76	−25.62	2.47	1.48	56	2	87.4	8 9/GR9
B SU211	−80.80	26	−44.51	−16.94	3.22	1.37	60	2	87.4	8 9/GR6
B SU212	−44.80	26	−43.99	−16.97	3.27	1.92	59	2	87.4	8 9/GR9
BLZ00001	−115.80	26	−88.68	17.27	0.62	0.62	90	2	87.4	
CAN01101	−137.80	26	−125.60	57.24	3.45	1.27	157	2	87.4	9/GR10
CAN01201	−137.80	26	−111.92	55.89	3.33	0.98	151	2	87.4	9/GR10
CAN01202	−72.30	26	−107.64	55.62	2.75	1.11	32	2	87.4	
CAN01203	−128.80	26	−111.43	55.56	3.07	1.15	151	2	87.4	9/GR12
CAN01303	−128.80	26	−102.39	57.12	3.54	0.92	154	2	87.4	9/GR12
CAN01304	−90.80	26	−99.00	57.33	1.96	1.73	1	2	87.4	9/GR13
CAN01403	−128.80	26	−89.70	52.02	4.67	0.79	148	2	87.4	9/GR12
CAN01404	−90.80	26	−84.78	52.41	3.09	2.06	153	2	87.4	9/GR13
CAN01405	−81.80	26	−84.02	52.34	2.82	2.30	172	2	87.4	9/GR14
CAN01504	−90.80	26	−72.68	53.78	3.57	1.67	157	2	87.4	9/GR13
CAN01505	−81.80	26	−71.76	53.76	3.30	1.89	162	2	87.4	9/GR14
CAN01605	−81.80	26	−61.54	49.50	2.66	1.39	144	2	87.4	9/GR14
CAN01606	−70.30	26	−61.32	49.51	2.41	1.65	148	2	87.4	
CHLCONT4	−105.80	26	−69.59	−23.20	2.21	0.69	68	2	87.4	9/GR16
CHLCONT6	−105.80	26	−73.52	−55.52	3.65	1.31	39	2	87.4	9/GR16
CRBBAH01	−92.30	26	−76.09	24.13	1.83	0.68	141	1	87.4	9/GR18
CRBBER01	−92.30	26	−64.76	32.13	0.60	0.60	90	1	87.4	9/GR18
CRBBLZ01	−92.30	26	−88.61	17.26	0.64	0.64	90	1	87.4	9/GR18
CRBEC001	−92.30	26	−60.07	8.26	4.20	0.86	115	1	87.4	9/GR18
CRBJMC01	−92.30	26	−79.45	17.97	0.99	0.68	151	1	87.4	9/GR18
CTR00201	−130.80	26	−84.33	9.67	0.82	0.68	119	2	87.4	
DMAIFRB1	−79.30	26	−61.30	15.35	0.60	0.60	90	2	87.4	
EQAC0001	−94.80	26	−78.31	−1.52	1.48	1.15	65	1	87.4	9/GR19
EQAG0001	−94.80	26	−90.36	−0.57	0.94	0.89	99	1	87.4	9/GR19
HWA00002	−165.80	26	−165.79	23.32	4.20	0.68	160	2	87.4	9/GR1
HWA00003	−174.80	26	−166.10	23.42	4.25	0.68	159	2	87.4	9/GR2
MEX01NTE	−77.80	26	−105.80	25.99	2.88	2.07	155	2	87.4	1
MEX02NTE	−135.80	26	−107.36	26.32	3.80	1.57	149	2	87.4	1
MEX02SUR	−126.80	26	−96.39	19.88	3.19	1.87	158	2	87.4	1
NCG00003	−107.30	26	−84.99	12.90	1.05	1.01	176	1	87.4	
PRU00004	−85.80	26	−74.19	−8.39	3.74	2.45	112	2	87.4	
PTRVIR01	−100.80	26	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
PTRVIR02	−109.80	26	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH001	−61.30	26	−87.53	36.18	6.41	3.49	12	2	87.4	1 5 6
USAEH002	−100.80	26	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
USAEH003	−109.80	26	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH004	−118.80	26	−96.42	36.21	8.20	3.12	165	2	87.4	1 5 6
USAPSA02	−165.80	26	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
USAPSA03	−174.80	26	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
USAWH101	−147.80	26	−111.01	40.67	4.38	2.15	162	2	87.4	
USAWH102	−156.80	26	−113.01	40.71	3.74	1.79	149	2	87.4	
VEN11VEN	−103.80	26	−66.79	6.90	2.50	1.77	122	2	87.4	

17 703.08 MHz (27)

1	2	3	4		5		6	7	8	9
ALS00002	−166.20	27	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
ALS00003	−175.20	27	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
ARGINSU4	−94.20	27	−52.98	−59.81	3.40	0.68	19	1	87.4	9/GR3
ARGINSU5	−55.20	27	−44.17	−59.91	3.77	0.70	13	1	87.4	9/GR4
ARGSUR04	−94.20	27	−65.04	−43.33	3.32	1.50	40	1	87.4	9/GR3
ARGSUR05	−55.20	27	−63.68	−43.01	2.54	2.38	152	1	87.4	9/GR4
B CE311	−64.20	27	−40.60	−6.07	3.04	2.06	174	1	87.4	8 9/GR7
B CE312	−45.20	27	−40.27	−6.06	3.44	2.09	174	1	87.4	8 9/GR9
B CE411	−64.20	27	−50.97	−15.27	3.86	1.38	49	1	87.4	8 9/GR7
B CE412	−45.20	27	−50.71	−15.30	3.57	1.56	52	1	87.4	8 9/GR9
B CE511	−64.20	27	−53.10	−2.90	2.44	2.13	104	1	87.4	8 9/GR7
B NO611	−74.20	27	−59.60	−11.62	2.85	1.69	165	2	87.4	8 9/GR8
B NO711	−74.20	27	−60.70	−1.78	3.54	1.78	126	2	87.4	8 9/GR8
B NO811	−74.20	27	−68.76	−4.71	2.37	1.65	73	2	87.4	8 9/GR8
B SU111	−81.20	27	−51.12	−25.63	2.76	1.05	50	1	87.4	8 9/GR6
B SU112	−45.20	27	−50.75	−25.62	2.47	1.48	56	1	87.4	8 9/GR9
B SU211	−81.20	27	−44.51	−16.95	3.22	1.36	60	1	87.4	8 9/GR6
B SU212	−45.20	27	−44.00	−16.87	3.20	1.96	58	1	87.4	8 9/GR9
BERBERMU	−96.20	27	−64.77	32.32	0.60	0.60	90	2	87.4	
BOLAND01	−115.20	27	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
BOL00001	−87.20	27	−64.61	−16.71	2.52	2.19	85	1	87.4	
BRB00001	−92.70	27	−59.85	12.93	0.60	0.60	90	2	87.4	
CAN01101	−138.20	27	−125.63	57.24	3.45	1.27	157	1	87.4	9/GR10
CAN01201	−138.20	27	−112.04	55..95	3.35	0.97	151	1	87.4	9/GR10
CAN01202	−72.70	27	−107.70	55.63	2.74	1.12	32	1	87.4	
CAN01203	−129.20	27	−111.48	55.61	3.08	1.15	151	1	87.4	9/GR12
CAN01303	−129.20	27	−102.42	57.12	3.54	0.91	154	1	87.4	9/GR12
CAN01304	−91.20	27	−99.12	57.36	1.98	1.72	2	1	87.4	9/GR13
CAN01403	−129.20	27	−89.75	52.02	4.68	0.78	148	1	87.4	9/GR12
CAN01404	−91.20	27	−84.82	52.42	3.10	2.05	152	1	87.4	9/GR13
CAN01405	−82.20	27	−84.00	52.39	2.84	2.29	172	1	87.4	9/GR14
CAN01504	−91.20	27	−72.66	53.77	3.57	1.67	156	1	87.4	9/GR13
CAN01505	−82.20	27	−71.77	53.79	3.30	1.89	162	1	87.4	9/GR14
CAN01605	−82.20	27	−61.50	49.55	2.65	1.40	143	1	87.4	9/GR14
CAN01606	−70.70	27	−61.30	49.55	2.40	1.65	148	1	87.4	
CHLCONT5	−106.20	27	−72.23	−35.57	2.60	0.68	55	1	87.4	9/GR17
CHLPAC02	−106.20	27	−80.06	−30.06	1.36	0.68	69	1	87.4	9/GR17
CLMAND01	−115.20	27	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CLM00001	−103.20	27	−74.50	5.87	3.98	1.96	118	1	87.4	
CUB00001	−89.20	27	−79.81	21.62	2.24	0.68	168	1	87.4	
EQACAND1	−115.20	27	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
EQAGAND1	−115.20	27	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
GRD00059	−57.20	27	−61.58	12.29	0.60	0.60	90	1	87.4	
GRLDNK01	−53.20	27	−44.89	66.56	2.70	0.82	173	1	87.4	2
GUY00201	−84.70	27	−59.19	4.78	1.44	0.85	95	1	87.4	
HWA00002	−166.20	27	−165.79	23.42	4.20	0.68	160	1	87.4	9/GR1
HWA00003	−175.20	27	−166.10	23.42	4.25	0.68	159	1	87.4	9/GR2
MEX01NTE	−78.20	27	−105.81	26.01	2.89	2.08	155	1	87.4	1
MEX01SUR	−69.20	27	−94.84	19.82	3.05	2.09	4	1	87.4	1
MEX02NTE	−136.20	27	−107.21	26.31	3.84	1.55	148	1	87.4	1
MEX02SUR	−127.20	27	−96.39	19.88	3.18	1.87	157	1	87.4	1
MSR00001	−79.70	27	−61.73	16.75	0.60	0.60	90	1	87.4	4
PAQPAC01	−106.20	27	−109.18	−27.53	0.60	0.60	90	1	87.4	9/GR17
PRG00002	−99.20	27	−58.66	−23.32	1.45	1.04	76	1	87.4	
PRUAND02	−115.20	27	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
PTRVIR01	−101.20	27	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
PTRVIR02	−110.20	27	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
URG00001	−71.70	27	−56.22	−32.52	1.02	0.89	11	1	87.4	
USAEH001	−61.70	27	−87.57	36.17	6.42	3.49	12	1	87.4	1 5 6
USAEH002	−101.20	27	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
USAEH003	−110.20	27	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
USAEH004	−119.20	27	−96.45	36.21	8.20	3.12	165	1	87.4	1 5 6
USAPSA02	−166.20	27	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
USAPSA03	−175.20	27	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
USAWH101	−148.20	27	−111.02	40.68	4.36	2.15	162	1	87.4	
USAWH102	−157.20	27	−113.07	40.74	3.72	1.78	149	1	87.4	
VENAND03	−115.20	27	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5

17 717.66 MHz (28)

1	2	3	4		5		6	7	8	9
ALS00002	−165.80	28	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
ALS00003	−174.80	28	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
ARGNORT4	−93.80	28	−63.96	−30.01	3.86	1.99	48	2	87.4	
ARGNORT5	−54.80	28	−62.85	−29.80	3.24	2.89	47	2	87.4	
B CE311	−63.80	28	−40.60	−6.07	3.04	2.06	174	2	87.4	8 9/GR7
B CE312	−44.80	28	−40.26	−6.06	3.44	2.09	174	2	87.4	8 9/GR9
B CE411	−63.80	28	−50.97	−15.26	3.86	1.38	49	2	87.4	8 9/GR7
B CE412	−44.80	28	−50.71	−15.30	3.57	1.56	52	2	87.4	8 9/GR9
B CE511	−63.80	28	−53.11	−2.98	2.42	2.15	107	2	87.4	8 9/GR7
B NO611	−73.80	28	−59.60	−11.62	2.86	1.69	165	1	87.4	8 9/GR8
B NO711	−73.80	28	−60.70	−1.78	3.54	1.78	126	1	87.4	8 9/GR8
B NO811	−73.80	28	−68.75	−4.71	2.37	1.65	73	1	87.4	8 9/GR8
B SE911	−101.80	28	−45.99	−19.09	2.22	0.79	62	2	87.4	8
B SU111	−80.80	28	−51.10	−25.64	2.76	1.06	50	2	87.4	8 9/GR6
B SU112	−44.80	28	−50.76	−25.62	2.47	1.48	56	2	87.4	8 9/GR9
B SU211	−80.80	28	−44.51	−16.94	3.22	1.37	60	2	87.4	8 9/GR6
B SU212	−44.80	28	−43.99	−16.97	3.27	1.92	59	2	87.4	8 9/GR9
CAN01101	−137.80	28	−125.60	57.24	3.45	1.27	157	2	87.4	9/GR10
CAN01201	−137.80	28	−111.92	55.89	3.33	0.98	151	2	87.4	9/GR10
CAN01202	−72.30	28	−107.64	55.62	2.75	1.11	32	2	87.4	
CAN01203	−128.80	28	−111.43	55.56	3.07	1.15	151	2	87.4	9/GR12
CAN01303	−128.80	28	−102.39	57.12	3.54	0.92	154	2	87.4	9/GR12
CAN01304	−90.80	28	−99.00	57.33	1.96	1.73	1	2	87.4	9/GR13
CAN01403	−128.80	28	−89.70	52.02	4.67	0.79	148	2	87.4	9/GR12
CAN01404	−90.80	28	−84.78	52.41	3.09	2.06	153	2	87.4	9/GR13
CAN01405	−81.80	28	−84.02	52.34	2.82	2.30	172	2	87.4	9/GR14
CAN01504	−90.80	28	−72.68	53.78	3.57	1.67	157	2	87.4	9/GR13
CAN01505	−81.80	28	−71.76	53.76	3.30	1.89	162	2	87.4	9/GR14
CAN01605	−81.80	28	−61.54	49.50	2.66	1.39	144	2	87.4	9/GR14
CAN01606	−70.30	28	−61.32	49.51	2.41	1.65	148	2	87.4	
CHLCONT4	−105.80	28	−69.59	−23.20	2.21	0.69	68	2	87.4	9/GR16
CHLCONT6	−105.80	28	−73.52	−55.52	3.65	1.31	39	2	87.4	9/GR16
CRBBAH01	−92.30	28	−76.09	24.13	1.83	0.68	141	1	87.4	9/GR18
CRBBER01	−92.30	28	−64.76	32.13	0.60	0.60	90	1	87.4	9/GR18
CRBBLZ01	−92.30	28	−88.61	17.26	0.64	0.64	90	1	87.4	9/GR18
CRBEC001	−92.30	28	−60.07	8.26	4.20	0.86	115	1	87.4	9/GR18
CRBJMC01	−92.30	28	−79.45	17.97	0.99	0.68	151	1	87.4	9/GR18
EQAC0001	−94.80	28	−78.31	−1.52	1.48	1.15	65	1	87.4	9/GR19
EQAG0001	−94.80	28	−90.36	−0.57	0.94	0.89	99	1	87.4	9/GR19
GRD00003	−79.30	28	−61.62	12.34	0.60	0.60	90	2	87.4	
GTMIFRB2	−107.30	28	−90.50	15.64	1.03	0.74	84	1	87.4	
GUFMGG02	−52.80	28	−56.42	8.47	4.16	0.81	123	2	87.4	2 7
HWA00002	−165.80	28	−165.79	23.32	4.20	0.68	160	2	87.4	9/GR1
HWA00003	−174.80	28	−166.10	23.42	4.25	0.68	159	2	87.4	9/GR2
MEX01NTE	−77.80	28	−105.80	25.99	2.88	2.07	155	2	87.4	1
MEX02NTE	−135.80	28	−107.36	26.32	3.80	1.57	149	2	87.4	1
MEX02SUR	−126.80	28	−96.39	19.88	3.19	1.87	158	2	87.4	1
PNRIFRB2	−121.00	28	−80.15	8.46	1.01	0.73	170	1	87.4	
PRU00004	−85.80	28	−74.19	−8.39	3.74	2.45	112	2	87.4	
PTRVIR01	−100.80	28	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
PTRVIR02	−109.80	28	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH001	−61.30	28	−87.53	36.18	6.41	3.49	12	2	87.4	1 5 6
USAEH002	−100.80	28	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
USAEH003	−109.80	28	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH004	−118.80	28	−96.42	36.21	8.20	3.12	165	2	87.4	1 5 6
USAPSA02	−165.80	28	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
USAPSA03	−174.80	28	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
USAWH101	−147.80	28	−111.01	40.67	4.38	2.15	162	2	87.4	
USAWH102	−156.80	28	−113.01	40.71	3.74	1.79	149	2	87.4	
VEN02VEN	−103.80	28	−66.79	6.90	2.50	1.77	122	2	87.4	9/GR22
VEN11VEN	−103.80	28	−66.79	6.90	2.50	1.77	122	2	87.4	9/GR22

17 732.24 MHz (29)

1	2	3	4		5		6	7	8	9
ALS00002	−166.20	29	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
ALS00003	−175.20	29	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
ARGINSU4	−94.20	29	−52.98	−59.81	3.40	0.68	19	1	87.4	9/GR3
ARGINSU5	−55.20	29	−44.17	−59.91	3.77	0.70	13	1	87.4	9/GR4
ARGSUR04	−94.20	29	−65.04	−43.33	3.32	1.50	40	1	87.4	9/GR3
ARGSUR05	−55.20	29	−63.68	−43.01	2.54	2.38	152	1	87.4	9/GR4
B CE311	−64.20	29	−40.60	−6.07	3.04	2.06	174	1	87.4	8 9/GR7
B CE312	−45.20	29	−40.27	−6.06	3.44	2.09	174	1	87.4	8 9/GR9
B CE411	−64.20	29	−50.97	−15.27	3.86	1.38	49	1	87.4	8 9/GR7
B CE412	−45.20	29	−50.71	−15.30	3.57	1.56	52	1	87.4	8 9/GR9
B CE511	−64.20	29	−53.10	−2.90	2.44	2.13	104	1	87.4	8 9/GR7
B NO611	−74.20	29	−59.60	−11.62	2.85	1.69	165	2	87.4	8 9/GR8
B NO711	−74.20	29	−60.70	−1.78	3.54	1.78	126	2	87.4	8 9/GR8
B NO811	−74.20	29	−68.76	−4.71	2.37	1.65	73	2	87.4	8 9/GR8
B SU111	−81.20	29	−51.12	−25.63	2.76	1.05	50	1	87.4	8 9/GR6
B SU112	−45.20	29	−50.75	−25.62	2.47	1.48	56	1	87.4	8 9/GR9
B SU211	−81.20	29	−44.51	−16.95	3.22	1.36	60	1	87.4	8 9/GR6
B SU212	−45.20	29	−44.00	−16.87	3.20	1.96	58	1	87.4	8 9/GR9
BERBERMU	−96.20	29	−64.77	32.32	0.60	0.60	90	2	87.4	
BOLAND01	−115.20	29	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CAN01101	−138.20	29	−125.63	57.24	3.45	1.27	157	1	87.4	9/GR10
CAN01201	−138.20	29	−112.04	55.95	3.35	0.97	151	1	87.4	9/GR10
CAN01202	−72.70	29	−107.70	55.63	2.74	1.12	32	1	87.4	
CAN01203	−129.20	29	−111.48	55.61	3.08	1.15	151	1	87.4	9/GR12
CAN01303	−129.20	29	−102.42	57.12	3.54	0.91	154	1	87.4	9/GR12
CAN01304	−91.20	29	−99.12	57.36	1.98	1.72	2	1	87.4	9/GR13
CAN01403	−129.20	29	−89.75	52.02	4.68	0.78	148	1	87.4	9/GR12
CAN01404	−91.20	29	−84.82	52.42	3.10	2.05	152	1	87.4	9/GR13
CAN01405	−82.20	29	−84.00	52.39	2.84	2.29	172	1	87.4	9/GR14
CAN01504	−91.20	29	−72.66	53.77	3.57	1.67	156	1	87.4	9/GR13
CAN01505	−82.20	29	−71.77	53.79	3.30	1.89	162	1	87.4	9/GR14
CAN01605	−82.20	29	−61.50	49.55	2.65	1.40	143	1	87.4	9/GR14
CAN01606	−70.70	29	−61.30	49.55	2.40	1.65	148	1	87.4	
CHLCONT5	−106.20	29	−72.23	−35.57	2.60	0.68	55	1	87.4	9/GR17
CHLPAC02	−106.20	29	−80.06	−30.06	1.36	0.68	69	1	87.4	9/GR17
CLMAND01	−115.20	29	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CLM00001	−103.20	29	−74.50	5.87	3.98	1.96	118	1	87.4	
EQACAND1	−115.20	29	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
EQAGAND1	−115.20	29	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
HWA00002	−166.20	29	−165.79	23.42	4.20	0.68	160	1	87.4	9/GR1
HWA00003	−175.20	29	−166.10	23.42	4.25	0.68	159	1	87.4	9/GR2
JMC00002	−92.70	29	−77.30	18.12	0.62	0.62	90	2	87.4	
KNA00001	−79.70	29	−62.46	17.44	0.60	0.60	90	1	87.4	
MEX01NTE	−78.20	29	−105.81	26.01	2.89	2.08	155	1	87.4	1
MEX01SUR	−69.20	29	−94.84	19.82	3.05	2.09	4	1	87.4	1
MEX02NTE	−136.20	29	−107.21	26.31	3.84	1.55	148	1	87.4	1
MEX02SUR	−127.20	29	−96.39	19.88	3.18	1.87	157	1	87.4	1
PAQPAC01	−106.20	29	−109.18	−27.53	0.60	0.60	90	1	87.4	9/GR17
PRG00002	−99.20	29	−58.66	−23.32	1.45	1.04	76	1	87.4	
PRUAND02	−115.20	29	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
PTRVIR01	−101.20	29	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
PTRVIR02	−110.20	29	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
SPMFRAN3	−53.20	29	−67.24	47.51	3.16	0.79	7	1	87.4	2 7
SURINAM2	−84.70	29	−55.69	4.35	1.00	0.69	86	1	87.4	
URG00001	−71.70	29	−56.22	−32.52	1.02	0.89	11	1	87.4	
USAEH001	−61.70	29	−87.57	36.17	6.42	3.49	12	1	87.4	1 5 6
USAEH002	−101.20	29	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
USAEH003	−110.20	29	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
USAEH004	−119.20	29	−96.45	36.21	8.20	3.12	165	1	87.4	1 5 6
USAPSA02	−166.20	29	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
USAPSA03	−175.20	29	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
USAWH101	−148.20	29	−111.02	40.68	4.36	2.15	162	1	87.4	
USAWH102	−157.20	29	−113.07	40.74	3.72	1.78	149	1	87.4	
VENAND03	−115.20	29	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5

17 746.82 MHz (30)

1	2	3	4		5		6	7	8	9
ALS00002	−165.80	30	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
ALS00003	−174.80	30	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
ARGNORT4	−93.80	30	−63.96	−30.01	3.86	1.99	48	2	87.4	
ARGNORT5	−54.80	30	−62.85	−29.80	3.24	2.89	47	2	87.4	
ATNBEAM1	−52.80	30	−66.44	14.87	1.83	0.68	39	2	87.4	
B CE311	−63.80	30	−40.60	−6.07	3.04	2.06	174	2	87.4	8 9/GR7
B CE312	−44.80	30	−40.26	−6.06	3.44	2.09	174	2	87.4	8 9/GR9
B CE411	−63.80	30	−50.97	−15.26	3.86	1.38	49	2	87.4	8 9/GR7
B CE412	−44.80	30	−50.71	−15.30	3.57	1.56	52	2	87.4	8 9/GR9
B CE511	−63.80	30	−53.11	−2.98	2.42	2.15	107	2	87.4	8 9/GR7
B NO611	−73.80	30	−59.60	−11.62	2.86	1.69	165	1	87.4	8 9/GR8
B NO711	−73.80	30	−60.70	−1.78	3.54	1.78	126	1	87.4	8 9/GR8
B NO811	−73.80	30	−68.75	−4.71	2.37	1.65	73	1	87.4	8 9/GR8
B SE911	−101.80	30	−45.99	−19.09	2.22	0.79	62	2	87.4	8
B SU111	−80.80	30	−51.10	−25.64	2.76	1.06	50	2	87.4	8 9/GR6
B SU112	−44.80	30	−50.76	−25.62	2.47	1.48	56	2	87.4	8 9/GR9
B SU211	−80.80	30	−44.51	−16.94	3.22	1.37	60	2	87.4	8 9/GR6
B SU212	−44.80	30	−43.99	−16.97	3.27	1.92	59	2	87.4	8 9/GR9
BLZ00001	−115.80	30	−88.68	17.27	0.62	0.62	90	2	87.4	
CAN01101	−137.80	30	−125.60	57.24	3.45	1.27	157	2	87.4	9/GR10
CAN01201	−137.80	30	−111.92	55.89	3.33	0.98	151	2	87.4	9/GR10
CAN01202	−72.30	30	−107.64	55.62	2.75	1.11	32	2	87.4	
CAN01203	−128.80	30	−111.43	55.56	3.07	1.15	151	2	87.4	9/GR12
CAN01303	−128.80	30	−102.39	57.12	3.54	0.92	154	2	87.4	9/GR12
CAN01304	−90.80	30	−99.00	57.33	1.96	1.73	1	2	87.4	9/GR13
CAN01403	−128.80	30	−89.70	52.02	4.67	0.79	148	2	87.4	9/GR12
CAN01404	−90.80	30	−84.78	52.41	3.09	2.06	153	2	87.4	9/GR13
CAN01405	−81.80	30	−84.02	52.34	2.82	2.30	172	2	87.4	9/GR14
CAN01504	−90.80	30	−72.68	53.78	3.57	1.67	157	2	87.4	9/GR13
CAN01505	−81.80	30	−71.76	53.76	3.30	1.89	162	2	87.4	9/GR14
CAN01605	−81.80	30	−61.54	49.50	2.66	1.39	144	2	87.4	9/GR14
CAN01606	−70.30	30	−61.32	49.51	2.41	1.65	148	2	87.4	
CHLCONT4	−105.80	30	−69.59	−23.20	2.21	0.69	68	2	87.4	9/GR16
CHLCONT6	−105.80	30	−73.52	−55.52	3.65	1.31	39	2	87.4	9/GR16
CRBBAH01	−92.30	30	−76.09	24.13	1.83	0.68	141	1	87.4	9/GR18
CRBBER01	−92.30	30	−64.76	32.13	0.60	0.60	90	1	87.4	9/GR18
CRBBLZ01	−92.30	30	−88.61	17.26	0.64	0.64	90	1	87.4	9/GR18
CRBEC001	−92.30	30	−60.07	8.26	4.20	0.86	115	1	87.4	9/GR18
CRBJMC01	−92.30	30	−79.45	17.97	0.99	0.68	151	1	87.4	9/GR18
CTR00201	−130.80	30	−84.33	9.67	0.82	0.68	119	2	87.4	
DMAIFRB1	−79.30	30	−61.30	15.35	0.60	0.60	90	2	87.4	
EQAC0001	−94.80	30	−78.31	−1.52	1.48	1.15	65	1	87.4	9/GR19
EQAG0001	−94.80	30	−90.36	−0.57	0.94	0.89	99	1	87.4	9/GR19
HWA00002	−165.80	30	−165.79	23.32	4.20	0.68	160	2	87.4	9/GR1
HWA00003	−174.80	30	−166.10	23.42	4.25	0.68	159	2	87.4	9/GR2
MEX01NTE	−77.80	30	−105.80	25.99	2.88	2.07	155	2	87.4	1
MEX02NTE	−135.80	30	−107.36	26.32	3.80	1.57	149	2	87.4	1
MEX02SUR	−126.80	30	−96.39	19.88	3.19	1.87	158	2	87.4	1
NCG00003	−107.30	30	−84.99	12.90	1.05	1.01	176	1	87.4	
PRU00004	−85.80	30	−74.19	−8.39	3.74	2.45	112	2	87.4	
PTRVIR01	−100.80	30	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
PTRVIR02	−109.80	30	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH001	−61.30	30	−87.53	36.18	6.41	3.49	12	2	87.4	1 5 6
USAEH002	−100.80	30	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
USAEH003	−109.80	30	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH004	−118.80	30	−96.42	36.21	8.20	3.12	165	2	87.4	1 5 6
USAPSA02	−165.80	30	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
USAPSA03	−174.80	30	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
USAWH101	−147.80	30	−111.01	40.67	4.38	2.15	162	2	87.4	
USAWH102	−156.80	30	−113.01	40.71	3.74	1.79	149	2	87.4	
VEN11VEN	−103.80	30	−66.79	6.90	2.50	1.77	122	2	87.4	

17 761.40 MHz (31)

1	2	3	4		5		6	7	8	9
ALS00002	−166.20	31	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
ALS00003	−175.20	31	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
ARGINSU4	−94.20	31	−52.98	−59.81	3.40	0.68	19	1	87.4	9/GR3
ARGINSU5	−55.20	31	−44.17	−59.91	3.77	0.70	13	1	87.4	9/GR4
ARGSUR04	−94.20	31	−65.04	−43.33	3.32	1.50	40	1	87.4	9/GR3
ARGSUR05	−55.20	31	−63.68	−43.01	2.54	2.38	152	1	87.4	9/GR4
B CE311	−64.20	31	−40.60	−6.07	3.04	2.06	174	1	87.4	8 9/GR7
B CE312	−45.20	31	−40.27	−6.06	3.44	2.09	174	1	87.4	8 9/GR9
B CE411	−64.20	31	−50.97	−15.27	3.86	1.38	49	1	87.4	8 9/GR7
B CE412	−45.20	31	−50.71	−15.30	3.57	1.56	52	1	87.4	8 9/GR9
B CE511	−64.20	31	−53.10	−2.90	2.44	2.13	104	1	87.4	8 9/GR7
B NO611	−74.20	31	−59.60	−11.62	2.85	1.69	165	2	87.4	8 9/GR8
B NO711	−74.20	31	−60.70	−1.78	3.54	1.78	126	2	87.4	8 9/GR8
B NO811	−74.20	31	−68.76	−4.71	2.37	1.65	73	2	87.4	8 9/GR8
B SU111	−81.20	31	−51.12	−25.63	2.76	1.05	50	1	87.4	8 9/GR6
B SU112	−45.20	31	−50.75	−25.62	2.47	1.48	56	1	87.4	8 9/GR9
B SU211	−81.20	31	−44.51	−16.95	3.22	1.36	60	1	87.4	8 9/GR6
B SU212	−45.20	31	−44.00	−16.87	3.20	1.96	58	1	87.4	8 9/GR9
BERBERMU	−96.20	31	−64.77	32.32	0.60	0.60	90	2	87.4	
BOLAND01	−115.20	31	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
BOL00001	−87.20	31	−64.61	−16.71	2.52	2.19	85	1	87.4	
BRB00001	−92.70	31	−59.85	12.93	0.60	0.60	90	2	87.4	
CAN01101	−138.20	31	−125.63	57.24	3.45	1.27	157	1	87.4	9/GR10
CAN01201	−138.20	31	−112.04	55.95	3.35	0.97	151	1	87.4	9/GR10
CAN01202	−72.70	31	−107.70	55.63	2.74	1.12	32	1	87.4	
CAN01203	−129.20	31	−111.48	55.61	3.08	1.15	151	1	87.4	9/GR12
CAN01303	−129.20	31	−102.42	57.12	3.54	0.91	154	1	87.4	9/GR12
CAN01304	−91.20	31	−99.12	57.36	1.98	1.72	2	1	87.4	9/GR13
CAN01403	−129.20	31	−89.75	52.02	4.68	0.78	148	1	87.4	9/GR12
CAN01404	−91.20	31	−84.82	52.42	3.10	2.05	152	1	87.4	9/GR13
CAN01405	−82.20	31	−84.00	52.39	2.84	2.29	172	1	87.4	9/GR14
CAN01504	−91.20	31	−72.66	53.77	3.57	1.67	156	1	87.4	9/GR13
CAN01505	−82.20	31	−71.77	53.79	3.30	1.89	162	1	87.4	9/GR14
CAN01605	−82.20	31	−61.50	49.55	2.65	1.40	143	1	87.4	9/GR14
CAN01606	−70.70	31	−61.30	49.55	2.40	1.65	148	1	87.4	
CHLCONT5	−106.20	31	−72.23	−35.57	2.60	0.68	55	1	87.4	9/GR17
CHLPAC02	−106.20	31	−80.06	−30.06	1.36	0.68	69	1	87.4	9/GR17
CLMAND01	−115.20	31	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
CLM00001	−103.20	31	−74.50	5.87	3.98	1.96	118	1	87.4	
CUB00001	−89.20	31	−79.81	21.62	2.24	0.68	168	1	87.4	
EQACAND1	−115.20	31	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
EQAGAND1	−115.20	31	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
GRD00059	−57.20	31	−61.58	12.29	0.60	0.60	90	1	87.4	
GRLDNK01	−53.20	31	−44.89	66.56	2.70	0.82	173	1	87.4	2
GUY00201	−84.70	31	−59.19	4.78	1.44	0.85	95	1	87.4	
HWA00002	−166.20	31	−165.79	23.42	4.20	0.68	160	1	87.4	9/GR1
HWA00003	−175.20	31	−166.10	23.42	4.25	0.68	159	1	87.4	9/GR2
MEX01NTE	−78.20	31	−105.81	26.01	2.89	2.08	155	1	87.4	1
MEX01SUR	−69.20	31	−94.84	19.82	3.05	2.09	4	1	87.4	1
MEX02NTE	−136.20	31	−107.21	26.31	3.84	1.55	148	1	87.4	1
MEX02SUR	−127.20	31	−96.39	19.88	3.18	1.87	157	1	87.4	1
MSR00001	−79.70	31	−61.73	16.75	0.60	0.60	90	1	87.4	4
PAQPAC01	−106.20	31	−109.18	−27.53	0.60	0.60	90	1	87.4	9/GR17
PRG00002	−99.20	31	−58.66	−23.32	1.45	1.04	76	1	87.4	
PRUAND02	−115.20	31	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5
PTRVIR01	−101.20	31	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
PTRVIR02	−110.20	31	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
URG00001	−71.70	31	−56.22	−32.52	1.02	0.89	11	1	87.4	
USAEH001	−61.70	31	−87.57	36.17	6.42	3.49	12	1	87.4	1 5 6
USAEH002	−101.20	31	−93.94	36.32	8.24	3.56	171	1	87.4	1 6 9/GR20
USAEH003	−110.20	31	−95.23	36.29	8.27	3.37	168	1	87.4	1 6 9/GR21
USAEH004	−119.20	31	−96.45	36.21	8.20	3.12	165	1	87.4	1 5 6
USAPSA02	−166.20	31	−109.94	36.86	6.04	1.11	137	1	87.4	9/GR1
USAPSA03	−175.20	31	−116.23	37.50	5.60	0.75	132	1	87.4	9/GR2
USAWH101	−148.20	31	−111.02	40.68	4.36	2.15	162	1	87.4	
USAWH102	−157.20	31	−113.07	40.74	3.72	1.78	149	1	87.4	
VENAND03	−115.20	31	−71.37	−4.69	6.49	2.57	87	1	87.4	9/GR5

17 775.98 MHz (32)

1	2	3	4		5		6	7	8	9
ALS00002	−165.80	32	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
ALS00003	−174.80	32	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
ARGNORT4	−93.80	32	−63.96	−30.01	3.86	1.99	48	2	87.4	
ARGNORT5	−54.80	32	−62.85	−29.80	3.24	2.89	47	2	87.4	
B CE311	−63.80	32	−40.60	−6.07	3.04	2.06	174	2	87.4	8 9/GR7
B CE312	−44.80	32	−40.26	−6.06	3.44	2.09	174	2	87.4	8 9/GR9
B CE411	−63.80	32	−50.97	−15.26	3.86	1.38	49	2	87.4	8 9/GR7
B CE412	−44.80	32	−50.71	−15.30	3.57	1.56	52	2	87.4	8 9/GR9
B CE511	−63.80	32	−53.11	−2.98	2.42	2.15	107	2	87.4	8 9/GR7
B NO611	−73.80	32	−59.60	−11.62	2.86	1.69	165	1	87.4	8 9/GR8
B NO711	−73.80	32	−60.70	−1.78	3.54	1.78	126	1	87.4	8 9/GR8
B NO811	−73.80	32	−68.75	−4.71	2.37	1.65	73	1	87.4	8 9/GR8
B SE911	−101.80	32	−45.99	−19.09	2.22	0.79	62	2	87.4	8
B SU111	−80.80	32	−51.10	−25.64	2.76	1.06	50	2	87.4	8 9/GR6
B SU112	−44.80	32	−50.76	−25.62	2.47	1.48	56	2	87.4	8 9/GR9
B SU211	−80.80	32	−44.51	−16.94	3.22	1.37	60	2	87.4	8 9/GR6
B SU212	−44.80	32	−43.99	−16.97	3.27	1.92	59	2	87.4	8 9/GR9
CAN01101	−137.80	32	−125.60	57.24	3.45	1.27	157	2	87.4	9/GR10
CAN01201	−137.80	32	−111.92	55.89	3.33	0.98	151	2	87.4	9/GR10
CAN01202	−72.30	32	−107.64	55.62	2.75	1.11	32	2	87.4	
CAN01203	−128.80	32	−111.43	55.56	3.07	1.15	151	2	87.4	9/GR12
CAN01303	−128.80	32	−102.39	57.12	3.54	0.92	154	2	87.4	9/GR12
CAN01304	−90.80	32	−99.00	57.33	1.96	1.73	1	2	87.4	9/GR13
CAN01403	−128.80	32	−89.70	52.02	4.67	0.79	148	2	87.4	9/GR12
CAN01404	−90.80	32	−84.78	52.41	3.09	2.06	153	2	87.4	9/GR13
CAN01405	−81.80	32	−84.02	52.34	2.82	2.30	172	2	87.4	9/GR14
CAN01504	−90.80	32	−72.68	53.78	3.57	1.67	157	2	87.4	9/GR13
CAN01505	−81.80	32	−71.76	53.76	3.30	1.89	162	2	87.4	9/GR14
CAN01605	−81.80	32	−61.54	49.50	2.66	1.39	144	2	87.4	9/GR14
CAN01606	−70.30	32	−61.32	49.51	2.41	1.65	148	2	87.4	
CHLCONT4	−105.80	32	−69.59	−23.20	2.21	0.69	68	2	87.4	9/GR16
CHLCONT6	−105.80	32	−73.52	−55.52	3.65	1.31	39	2	87.4	9/GR16
CRBBAH01	−92.30	32	−76.09	24.13	1.83	0.68	141	1	87.4	9/GR18
CRBBER01	−92.30	32	−64.76	32.13	0.60	0.60	90	1	87.4	9/GR18
CRBBLZ01	−92.30	32	−88.61	17.26	0.64	0.64	90	1	87.4	9/GR18
CRBEC001	−92.30	32	−60.07	8.26	4.20	0.86	115	1	87.4	9/GR18
CRBJMC01	−92.30	32	−79.45	17.97	0.99	0.68	151	1	87.4	9/GR18
EQAC0001	−94.80	32	−78.31	−1.52	1.48	1.15	65	1	87.4	9/GR19
EQAG0001	−94.80	32	−90.36	−0.57	0.94	0.89	99	1	87.4	9/GR19
GRD00003	−79.30	32	−61.62	12.34	0.60	0.60	90	2	87.4	
GTMIFRB2	−107.30	32	−90.50	15.64	1.03	0.74	84	1	87.4	
GUFMGG02	−52.80	32	−56.42	8.47	4.16	0.81	123	2	87.4	2 7
HWA00002	−165.80	32	−165.79	23.32	4.20	0.68	160	2	87.4	9/GR1
HWA00003	−174.80	32	−166.10	23.42	4.25	0.68	159	2	87.4	9/GR2
MEX01NTE	−77.80	32	−105.80	25.99	2.88	2.07	155	2	87.4	1
MEX02NTE	−135.80	32	−107.36	26.32	3.80	1.57	149	2	87.4	1
MEX02SUR	−126.80	32	−96.39	19.88	3.19	1.87	158	2	87.4	1
PNRIFRB2	−121.00	32	−80.15	8.46	1.01	0.73	170	1	87.4	
PRU00004	−85.80	32	−74.19	−8.39	3.74	2.45	112	2	87.4	
PTRVIR01	−100.80	32	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
PTRVIR02	−109.80	32	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH001	−61.30	32	−87.53	36.18	6.41	3.49	12	2	87.4	1 5 6
USAEH002	−100.80	32	−93.85	36.31	8.26	3.55	171	2	87.4	1 6 9/GR20
USAEH003	−109.80	32	−95.47	36.38	8.10	3.45	168	2	87.4	1 6 9/GR21
USAEH004	−118.80	32	−96.42	36.21	8.20	3.12	165	2	87.4	1 5 6
USAPSA02	−165.80	32	−109.83	36.82	6.03	1.12	137	2	87.4	9/GR1
USAPSA03	−174.80	32	−116.10	37.47	5.60	0.76	132	2	87.4	9/GR2
USAWH101	−147.80	32	−111.01	40.67	4.38	2.15	162	2	87.4	
USAWH102	−156.80	32	−113.01	40.71	3.74	1.79	149	2	87.4	
VEN02VEN	−103.80	32	−66.79	6.90	2.50	1.77	122	2	87.4	9/GR22
VEN11VEN	−103.80	32	−66.79	6.90	2.50	1.77	122	2	87.4	9/GR22

ARTICLE 9A (REV.WRC-23)

Plan for feeder links for the broadcasting-satellite service in the fixed-satellite service in the frequency bands 14.5-14.8 GHz and 17.3-18.1 GHz in Regions 1 and 3

9A.1 COLUMN HEADINGS OF THE PLAN

Col. 1 *Notifying administration symbol*.

Col. 2 *Beam identification* (Column 2, normally, contains the symbol designating the administration or the geographical area taken from Table B1 of the Preface to the International Frequency Information Circular (BR IFIC), followed by the symbol designating the service area).

Col. 3 *Nominal orbital position*, in degrees and hundredths of a degree from the Greenwich meridian (negative values indicate longitudes which are west of the Greenwich meridian; positive values indicate longitudes which are east of the Greenwich meridian).

Col. 4 *Nominal intersection of the beam axis with the Earth* (boresight or aim point in the case of a non-elliptical beam), longitude and latitude, in degrees and hundredths of a degree.

Col. 5 *Space station receiving antenna characteristics* (elliptical beams). This Column contains three numerical values corresponding to the major axis, the minor axis and the major axis orientation respectively of the elliptical cross-section half-power beam, in degrees and hundredths of a degree. Orientation of the ellipse determined as follows: in a plane normal to the beam axis, the direction of a major axis of the ellipse is specified as the angle measured anticlockwise from a line parallel to the equatorial plane to the major axis of the ellipse, to the nearest degree.

Col. 6 S*pace station receiving antenna pattern code*.

The codes used for the antenna pattern of the receiving space station (feeder link) antenna are defined as follows:

R13RSS	Figure B (Curves A, B and C) and § 3.7.3 in Annex 3
R123FR	Figure C and § 3.7.3 in Annex 3
R123SS	Figure 7 and § 4.6.3 in Annex 3
MODRSS	Figure B (Curves A′, B′ and C) and § 3.7.3 in Annex 3 (Recommendation ITU-R BO.1296)

In cases where the “Space station receiving antenna pattern code” field is blank, the necessary antenna pattern data are provided by shaped beam data submitted by the administration. These data are stored in Column 7. A particular shaped beam is identified by the combination of Column 1, Column 7 and Column 14. In such cases the maximum cross-polar gain is given in Column 8, Cross-polar gain field.

In cases where the "Space station receiving antenna pattern code" field contains a code which starts with "CB_" characters, it is a composite beam. Any composite beam consists of two or more elliptical beams. Each composite beam is described in the special composite beam file having the same name plus a GXT extension (e.g. the description of the CB_COMP_BM1 composite beam is stored in the CB_COMP_BM1.GXT file).

Col. 7 *Space station receiving antenna shaped (non-elliptical, non-composite) beam identification.*

Col. 8 *Maximum space station receiving antenna co-polar and cross-polar (in the case of shaped beam) isotropic gain* (dBi).

Col. 9 *Earth station transmitting antenna pattern code and maximum gain* (dBi).

The codes used for transmitting earth station (feeder-link) antenna patterns are defined as follows:

R13TES	Figure A (Curves A and B) and § 3.5.3 in Annex 3
MODTES	Figure A (Curves A′ and B′) and § 3.5.3 in Annex 3 (Recommendation ITU-R BO.1295)

Col. 10 *Polarization* (CL – circular left, CR – circular right, LE – linear referenced to the equatorial plane) and polarization angle in degrees and hundredths of a degree (in the case of linear polarization only).

Col. 11 *e.i.r.p.* in the direction of maximum radiation (dBW).

Col. 12 *Permitted increase in earth station e.i.r.p.* (dB) for the purpose of power control (see § 3.11 of Annex 3). (WRC-15)

Col. 13 *Designation of emission.*

Col. 14 *Identity of the space station.*

Col. 15 *Group code* (an identification code which indicates that all assignments with the same group identification code will be treated as a group).

Group code: if an assignment is part of the group:

a) the equivalent protection margin to be used for the application of Article 4 shall be calculated on the following basis:

– for the calculation of interference to assignments that are part of a group, only the interference contributions from assignments that are not part of the same group are to be included, *and*

[32] (SUP – WRC-15)

– for the calculation of interference from assignments belonging to a group to assignments that are not part of that same group, only the worst interference contribution from that group shall be used on a test point to test point basis.

b) If an administration notifies the same frequency in more than one beam of a group for use at the same time, the aggregate *C*/*I* ratio produced by all emissions from that group shall not exceed the *C*/*I* ratio calculated on the basis of § *a)* above.

Col. 16 *Assignment status*.

The assignment status codes used for beams are defined as follows:

P	Assignment in the Regions 1 and 3 feeder-link Plan which has not been brought into use and/or the date of bringing into use has not been confirmed to the Bureau. For this category of assignments, WRC-2000 protection ratios are applied (27 dB co-channel and 22 dB adjacent channel).
PE	Assignment in the Regions 1 and 3 feeder-link Plan, which is in conformity with Appendix **30A**, has been notified, brought into use and the date of bringing into use has been confirmed to the Bureau before 12 May 2000. For this category of assignments, WRC-97 protection ratios are applied (30 dB co-channel and 22 dB adjacent channel).

Col. 17 *Remarks*.

9A.2 TEXT FOR NOTES IN THE REMARKS COLUMN OF THE REGIONS 1 AND 3 FEEDER-LINK PLAN (WRC-19)

1 (Not used.)

2 (Not used.)

3 (Not used.)

4 (Not used.)

5 This assignment shall be brought into use only when the limits given in § 5 of Annex 1 are not exceeded, or with the agreement of the administrations identified in Table 1A, whose networks or beams listed in this Table may be affected with respect to assignments which are in conformity with the Region 2 feeder-link Plan on 12 May 2000 (see also Note to § 9A.2).

6 This assignment shall not claim protection from interference caused by the assignments which pertain to networks or beams identified in Table 1B which are in conformity with the Region 2 feeder-link Plan on 12 May 2000 (see also Note to § 9A.2).

7 This assignment shall not claim protection from interference caused by the assignments which pertain to networks or beams identified in Table 1B which are recorded in the Master Register with a favourable finding prior to 12 May 2000 (see also Note to § 9A.2).

The methodology and criteria for this analysis shall be those contained in § 1 of Annex 4, modified to take into consideration the system noise temperature of the received space station to be 600 K and to apply a $\Delta T/T$ criterion of 6%.

8 Provisional beam. These assignments have been included in the Regions 1 and 3 feeder-link Plan by WRC-97. These assignments are for exclusive use by Palestine, subject to the Israeli-Palestinian Interim Agreement of 28 September 1995, Resolution 741 of the Council notwithstanding and Resolution 99 (Minneapolis, 1998) of the Plenipotentiary Conference.

9 (Not used.)

10 (SUP - WRC-12)

11 Affected administrations and corresponding networks are included in the relevant AP30A/P Special Section. (WRC-23)

NOTE – In cases where assignments from the WRC-97 Plans without Remarks were included in the WRC-2000 Regions 1 and 3 feeder-link Plan without change, or with conversion of modulation from analogue to digital, or a change from normal roll-off to fast roll-off antenna characteristics, the coordination status afforded by the WRC-97 Plans shall be preserved.

In cases where assignments from the WRC-97 Plans with Remarks were included in the WRC-2000 Regions 1 and 3 feeder-link Plan without change, or with conversion of modulation from analogue to digital, or a change from normal roll-off to fast roll-off antenna pattern, the compatibility will be reassessed using the revised criteria and methodology of WRC-2000 and the Remarks of the WRC-97 Plans assignment will either be maintained or reduced on the basis of the results of this analysis.

In other cases, the methodology described in Notes 5 to 7 shall be applied.

TABLE 1A (WRC-07)

Affected administrations and corresponding networks/beams identified based on Note 5 in § 9A.2 of Article 9A

Beam name	Channels	Affected administrations*	Affected networks/beams*
CPV30100	2, 4, 8, 10, 12	GUY JMC	GUY00302, JMC00005
CPV30100	6	JMC	JMC00005
G 02700	2, 4, 8, 10, 12	GUY JMC	GUY00302, JMC00005
G 02700	6	JMC	JMC00005
LBR24400	1	GUY	GUY00302
LBR24400	3, 9, 13	JMC	JMC00005
LBR24400	5, 7, 11	GUY JMC	GUY00302, JMC00005

* Administrations and corresponding networks or beams whose assignment(s) may receive interference from the beam shown in the left-hand column.

TABLE 1B (WRC-15)

Affecting administrations and corresponding networks/beams identified based on Notes 6 and 7 in § 9A.2 of Article 9A

Beam name	Channels	Note	Affecting administrations*	Affecting networks/beams*
CPV30100	2, 4, 8, 10, 12	6	GUY JMC	GUY00302, JMC00005
CPV30100	6	6	JMC	JMC00005
E___100	1, 3, 5, 7, 9, 11, 13	6	G	BERBER02
G 02700	2, 4, 8, 10, 12	6	GUY JMC	GUY00302, JMC00005
G 02700	6	6	JMC	JMC00005
LBR24400	1	6	GUY	GUY00302
LBR24400	3, 9, 13	6	JMC	JMC00005
LBR24400	5, 7, 11	6	GUY JMC	GUY00302, JMC00005

* Administrations and corresponding networks or beams whose assignment(s) may cause interference to the beam shown in the left-hand column.

TABLE 2A

Table showing correspondence between channel numbers and assigned frequencies[1] for the feeder links in the frequency band 14.5-14.8 GHz

Channel No.	Assigned feeder-link frequency (MHz)
1	14 525.30
2	14 544.48
3	14 563.66
4	14 582.84
5	14 602.02
6	14 621.20
7	14 640.38
8	14 659.56
9	14 678.74
10	14 697.92
11	14 717.10
12	14 736.28
13	14 755.46
14	14 774.64

[1] Assigned frequency = 14 506.12 + 19.18 *n*, where *n* is the channel number.

TABLE 2B

Table showing correspondence between channel numbers and assigned frequencies[1] for the feeder links in the frequency band 17.3-18.1 GHz

Channel No.	Assigned feeder-link frequency (MHz)	Channel No.	Assigned feeder-link frequency (MHz)
1	17 327.48	21	17 711.08
2	17 346.66	22	17 730.26
3	17 365.84	23	17 749.44
4	17 385.02	24	17 768.62
5	17 404.20	25	17 787.80
6	17 423.38	26	17 806.98
7	17 442.56	27	17 826.16
8	17 461.74	28	17 845.34
9	17 480.92	29	17 864.52
10	17 500.10	30	17 883.70
11	17 519.28	31	17 902.88
12	17 538.46	32	17 922.06
13	17 557.64	33	17 941.24
14	17 576.82	34	17 960.42
15	17 596.00	35	17 979.60
16	17 615.18	36	17 998.78
17	17 634.36	37	18 017.96
18	17 653.54	38	18 037.14
19	17 672.72	39	18 056.32
20	17 691.90	40	18 075.50

[1] Assigned frequency = 17 308.3 + 19.18 *n*, where *n* is the channel number.

TABLE 3A1 (REV.WRC-23)

Basic characteristics of the Regions 1 and 3 feeder-link Plan in the frequency band 14.5-14.8 GHz (sorted by administration)

1	2	3	4		5			6	7	8		9		10		11	12	13	14	15	16	17
Admin. symbol	Beam identification	Orbital position	Boresight		Space station antenna characteristics			Space station antenna code	Shaped beam	Space station antenna gain		Earth station antenna		Polarization		e.i.r.p.	Power control	Designation of emission	Identity of the space station	Group code	Status	Remarks
			Long.	Lat.	Major axis	Minor axis	Orien-tation			Co-polar	Cross-polar	Code	Gain	Type	Angle							
CHN	CHN19001	122.00	114.17	23.32	0.91	0.60	2.88	MODRSS		47.08		MODTES	57.00	CL		84.0		27M0G7W		4C	P	
CHN	CHN19002	122.00	114.17	23.32	0.91	0.60	2.88	MODRSS		47.08		MODTES	57.00	CR		84.0		27M0G7W		4C	P	
CME	CME30001	−13.00	12.70	6.20	2.54	1.68	87.00	MODRSS		38.15		MODTES	57.00	CL		84.0		27M0G7W		4I	P	
CME	CME30002	−13.00	12.70	6.20	2.54	1.68	87.00	MODRSS		38.15		MODTES	57.00	CR		84.0		27M0G7W		4I	P	
ETH	ETH09201	36.00	40.49	9.20	2.83	2.26	174.44	MODRSS		36.40		MODTES	57.00	CL		82.0		27M0G7W		4P	P	
ETH	ETH09202	36.00	40.49	9.20	2.83	2.26	174.44	MODRSS		36.40		MODTES	57.00	CR		82.0		27M0G7W		4P	P	
GHA	GHA10801	−25.00	−1.20	7.90	1.48	1.06	102.00	MODRSS		42.49		MODTES	57.00	CR		83.0		27M0G7W		4F	P	
GHA	GHA10802	−25.00	−1.20	7.90	1.48	1.06	102.00	MODRSS		42.49		MODTES	57.00	CL		83.0		27M0G7W		4F	P	
IND	INDA_101	55.80	76.16	14.72				CB_RSS_INDA		45.66		MODTES	57.00	CR		82.0		27M0G7W		4U	P	
IND	INDA_102	55.80	76.16	14.72				CB_RSS_INDA		45.66		MODTES	57.00	CL		82.0		27M0G7W		4U	P	
IRN	IRN10901	34.00	54.20	32.40	3.82	1.82	149.00	MODRSS		36.03		MODTES	57.00	CR		82.0		27M0G7W		4S	P	
IRN	IRN10902	34.00	54.20	32.40	3.82	1.82	149.00	MODRSS		36.03		MODTES	57.00	CL		82.0		27M0G7W		4S	P	
KOR	KO11201D	116.00	127.50	36.00	1.24	1.02	168.00	R13RSS		43.40		R13TES	57.30	CL		82.0		27M0G7W	KOREASAT-1	03	PE	
KOR	KOR11201	116.00	127.50	36.00	1.24	1.02	168.00	R13RSS		43.40		R13TES	57.30	CL		82.0		27M0G7W	KOREASAT-1	03	PE	
NPL	NPL12201	50.00	83.70	28.30	1.72	0.60	163.00	MODRSS		44.31		MODTES	57.00	CR		82.0		27M0G7W		4N	P	
NPL	NPL12202	50.00	83.70	28.30	1.72	0.60	163.00	MODRSS		44.31		MODTES	57.00	CL		82.0		27M0G7W		4N	P	
PAK	PAK12701	38.20	69.60	29.50	2.30	2.16	14.00	MODRSS		37.49		MODTES	57.00	CR		82.0		27M0G7W		4R	P	
PAK	PAK12702	38.20	69.60	29.50	2.30	2.16	14.00	MODRSS		37.49		MODTES	57.00	CL		82.0		27M0G7W		4R	P	
PNG	PNG13101	134.00	148.07	−6.65	3.13	2.30	168.32	MODRSS		38.87		MODTES	57.00	CR		89.0		27M0G7W		4B	P	
PNG	PNG13102	134.00	148.07	−6.65	3.13	2.30	168.32	MODRSS		38.87		MODTES	57.00	CL		89.0		27M0G7W		4B	P	
SEN	SEN22201	−37.00	−14.40	13.80	1.46	1.04	139.00	MODRSS		42.63		MODTES	57.00	CL		82.0		27M0G7W		4D	P	
SEN	SEN22202	−37.00	−14.40	13.80	1.46	1.04	139.00	MODRSS		42.63		MODTES	57.00	CR		82.0		27M0G7W		4D	P	
SEY	SEY00001	42.50	51.86	−7.23	2.43	1.04	27.51	MODRSS		40.44		MODTES	57.00	CL		84.0		27M0G7W		4T	P	
SEY	SEY00002	42.50	51.86	−7.23	2.43	1.04	27.51	MODRSS		40.44		MODTES	57.00	CR		84.0		27M0G7W		4T	P	
TGO	TGO22601	−30.00	0.68	8.57	1.13	0.60	108.43	MODRSS		46.14		MODTES	57.00	CL		82.0		27M0G7W		4E	P	
TGO	TGO22602	−30.00	0.68	8.57	1.13	0.60	108.43	MODRSS		46.14		MODTES	57.00	CR		82.0		27M0G7W		4E	P	
USA	USAC_101	140.00	177.50	16.35				CB_RSS_USAC		44.06		MODTES	57.00	CL		87.0		27M0G7W		4A	P	
USA	USAC_102	140.00	177.50	16.35				CB_RSS_USAC		44.06		MODTES	57.00	CR		87.0		27M0G7W		4A	P	
YEM	YEM__101	11.00	48.29	14.53				CB_RSS_YEMA		47.78		MODTES	57.00	CR		82.0		27M0G7W		4O	P	
YEM	YEM__102	11.00	48.29	14.53				CB_RSS_YEMA		47.78		MODTES	57.00	CL		82.0		27M0G7W		4O	P	

TABLE 3A2 (REV.WRC-23)

Basic characteristics of the Regions 1 and 3 feeder-link Plan in the frequency band 17.3-18.1 GHz (sorted by administration)

1	2	3	4		5			6	7	8		9		10		11	12	13	14	15	16	17
Admin. symbol	Beam identification	Orbital position	Boresight		Space station antenna characteristics			Space station antenna code	Shaped beam	Space station antenna gain		Earth station antenna		Polarization		e.i.r.p.	Power control	Designation of emission	Identity of the space station	Group code	Status	Remarks
			Long.	Lat.	Major axis	Minor axis	Orien-tation			Co-polar	Cross-polar	Code	Gain	Type	Angle							
AFG	AFG24501	50.00	67.00	34.30	1.89	1.19	18.00	MODRSS		40.93		MODTES	57.00	CL		84.0		27M0G7W		7I	P	
AFG	AFG24502	50.00	67.00	34.30	1.89	1.19	18.00	MODRSS		40.93		MODTES	57.00	CR		84.0		27M0G7W		7I	P	
AFS	AFS_SASAT3	−8.20	24.11	−28.06	2.70	1.36	36.92	R123SS		38.80		MODTES	57.00	CL		86.0		27M0G7W			P	
AGL	AGL29500	−24.80	16.43	−12.37	2.66	1.75	77.43	MODRSS		37.77		MODTES	57.00	CR		84.0		27M0G7W			P	
ALB	ALB_SAT	−33.60	19.87	41.11	0.65	0.60	130.56	R123SS		48.54		MODTES	57.00	CL		86.0		27M0G7W			P	11
ALG	ALG25152	−24.80	1.50	27.60	3.65	2.94	135.00	MODRSS		34.14		MODTES	57.00	CL		84.0		27M0G7W			P	
AND	AND34100	−37.00	1.60	42.50	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		83.0		27M0G7W			P	
ARM	ARM06400	22.80	44.99	39.95	0.73	0.60	148.17	MODRSS		48.02		MODTES	57.00	CR		84.0		27M0G7W			P	
ARS	ARS_BSS	7.90	44.04	23.34	3.63	1.84	137.74	R123SS		36.20		MODTES	57.00	CR		86.0		27M0G7W			P	
ARS	ARS34000	17.00	44.60	23.40	4.21	2.48	145.00	MODRSS		34.28		MODTES	57.00	CL		84.0		27M0G7W		54	P	
AUS	AUS00400	152.00	135.00	−24.20	7.19	5.20	140.00	MODRSS		28.71		MODTES	57.00	CL		87.0		27M0G7W		30	P	
AUS	AUS00401	152.00	96.83	−12.19	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		30	P	
AUS	AUS00402	152.00	105.69	−10.45	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		30	P	
AUS	AUS00403	152.00	110.52	−66.28	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		30	P	
AUS	AUS00404	152.00	158.94	−54.50	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		30	P	
AUS	AUS00405	152.00	159.06	−31.52	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		30	P	
AUS	AUS00406	152.00	167.93	−29.02	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		30	P	
AUS	AUS0040A	152.00	135.36	−23.95	6.89	4.83	141.15	R123FR		29.23		MODTES	57.00	CL		87.0		27M0G7W		30	P	
AUS	AUS00500	152.00	135.00	−24.20	7.19	5.20	140.00	MODRSS		28.71		MODTES	57.00	CR		87.0		27M0G7W		41	P	
AUS	AUS00501	152.00	96.83	−12.19	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		41	P	
AUS	AUS00502	152.00	105.69	−10.45	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		41	P	
AUS	AUS00503	152.00	110.52	−66.28	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		41	P	
AUS	AUS00504	152.00	158.94	−54.50	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		41	P	
AUS	AUS00505	152.00	159.06	−31.52	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		41	P	
AUS	AUS00506	152.00	167.93	−29.02	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		41	P	
AUS	AUS00600	152.00	135.50	−24.20	7.19	5.20	140.00	MODRSS		28.71		MODTES	57.00	CR		87.0		27M0G7W		42	P	
AUS	AUS00601	152.00	96.83	−12.19	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		42	P	
AUS	AUS00602	152.00	105.69	−10.45	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		42	P	
AUS	AUS00603	152.00	110.52	−66.28	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		42	P	
AUS	AUS00604	152.00	158.94	−54.50	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		42	P	
AUS	AUS00605	152.00	159.06	−31.52	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		42	P	
AUS	AUS00606	152.00	167.93	−29.02	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		42	P	

1	2	3	4		5			6	7	8		9		10		11	12	13	14	15	16	17
Admin. symbol	Beam identification	Orbital position	Boresight		Space station antenna characteristics			Space station antenna code	Shaped beam	Space station antenna gain		Earth station antenna		Polarization		e.i.r.p.	Power control	Designation of emission	Identity of the space station	Group code	Status	Remarks
			Long.	Lat.	Major axis	Minor axis	Orien-tation			Co-polar	Cross-polar	Code	Gain	Type	Angle							
AUS	AUS00700	164.00	136.00	−23.90	7.26	4.48	132.00	MODRSS		29.32		MODTES	57.00	CR		87.0		27M0G7W		31	P	
AUS	AUS00701	164.00	96.83	−12.19	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		31	P	
AUS	AUS00702	164.00	105.69	−10.45	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		31	P	
AUS	AUS00703	164.00	110.52	−66.28	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		31	P	
AUS	AUS00704	164.00	158.94	−54.50	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		31	P	
AUS	AUS00705	164.00	159.06	−31.52	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		31	P	
AUS	AUS00706	164.00	167.93	−29.02	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		31	P	
AUS	AUS0070A	164.00	136.62	−24.16	6.82	4.20	134.19	R123FR		29.87		MODTES	57.00	CR		87.0		27M0G7W		31	P	
AUS	AUS00800	164.00	136.00	−23.90	7.26	4.48	132.00	MODRSS		29.32		MODTES	57.00	CL		87.0		27M0G7W		44	P	
AUS	AUS00801	164.00	96.83	−12.19	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		44	P	
AUS	AUS00802	164.00	105.69	−10.45	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		44	P	
AUS	AUS00803	164.00	110.52	−66.28	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		44	P	
AUS	AUS00804	164.00	158.94	−54.50	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		44	P	
AUS	AUS00805	164.00	159.06	−31.52	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		44	P	
AUS	AUS00806	164.00	167.93	−29.02	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		44	P	
AUS	AUS00900	164.00	136.00	−23.90	7.26	4.48	132.00	MODRSS		29.32		MODTES	57.00	CR		87.0		27M0G7W		32	P	
AUS	AUS00901	164.00	96.83	−12.19	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		32	P	
AUS	AUS00902	164.00	105.69	−10.45	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		32	P	
AUS	AUS00903	164.00	110.52	−66.28	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		32	P	
AUS	AUS00904	164.00	158.94	−54.50	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		32	P	
AUS	AUS00905	164.00	159.06	−31.52	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		32	P	
AUS	AUS00906	164.00	167.93	−29.02	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		87.0		27M0G7W		32	P	
AUS	AUS0090A	164.00	136.62	−24.16	6.82	4.20	134.19	R123FR		29.87		MODTES	57.00	CR		87.0		27M0G7W		32	P	
AUS	AUSA0000	152.00	135.36	−23.95	6.89	4.83	141.15	R123FR		29.23		MODTES	57.00	CL		87.0		27M0G7W		40	P	
AUS	AUSA0001	152.00	96.83	−12.19	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		40	P	
AUS	AUSA0002	152.00	105.69	−10.45	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		40	P	
AUS	AUSA0003	152.00	110.52	−66.28	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		40	P	
AUS	AUSA0004	152.00	158.94	−54.50	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		40	P	
AUS	AUSA0005	152.00	159.06	−31.52	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		40	P	
AUS	AUSA0006	152.00	167.93	−29.02	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		40	P	
AUS	AUSB0000	164.00	136.62	−24.16	6.82	4.20	134.19	R123FR		29.87		MODTES	57.00	CL		87.0		27M0G7W		43	P	
AUS	AUSB0001	164.00	96.83	−12.19	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		43	P	
AUS	AUSB0002	164.00	105.69	−10.45	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		43	P	
AUS	AUSB0003	164.00	110.52	−66.28	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		43	P	
AUS	AUSB0004	164.00	158.94	−54.50	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		43	P	
AUS	AUSB0005	164.00	159.06	−31.52	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		43	P	
AUS	AUSB0006	164.00	167.93	−29.02	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		87.0		27M0G7W		43	P	

1	2	3	4		5			6	7	8		9		10		11	12	13	14	15	16	17
Admin. symbol	Beam identification	Orbital position	Boresight		Space station antenna characteristics			Space station antenna code	Shaped beam	Space station antenna gain		Earth station antenna		Polarization		e.i.r.p.	Power control	Designation of emission	Identity of the space station	Group code	Status	Remarks
			Long.	Lat.	Major axis	Minor axis	Orien-tation			Co-polar	Cross-polar	Code	Gain	Type	Angle							
AUT	AUT01600	−18.80	10.31	49.47	1.82	0.92	151.78	MODRSS		42.19		MODTES	57.00	CR		84.0		27M0G7W			P	
AZE	AZERSAT-BSS-10E	10.00	46.95	39.93	0.84	0.60	145.64	R123SS		47.42		MODTES	57.00	CR		86.0		27M0G7W			P	
BDI	BDI_SAT	−26.80	29.79	−3.19	0.60	0.60	0.00	R123SS		48.88		MODTES	57.00	CR		86.0		27M0G7W			P	11
BEL	BEL01800	38.20	5.12	51.96	1.00	1.00	0.00	MODRSS		44.44		MODTES	57.00	CR		85.5		27M0G7W			P	
BEN	BEN_SAT	−30.60	2.25	9.47	1.30	0.60	94.63	R123SS		45.53		MODTES	57.00	CR		86.0		27M0G7W			P	
BFA	BFA10700	−30.00	−1.50	12.20	1.45	1.14	29.00	MODRSS		42.26		MODTES	57.00	CL		84.0		27M0G7W			P	
BGD	BGD22000	74.00	90.30	23.60	1.46	0.84	135.00	MODRSS		43.56		MODTES	57.00	CR		84.0		27M0G7W			P	
BHR	BHR25500	34.00	50.50	26.10	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		83.0		27M0G7W			P	
BIH	BIH_SAT	−26.50	17.10	43.85	0.73	0.60	143.98	R123SS		48.03		MODTES	57.00	CR		86.0		27M0G7W			P	11
BLR	BLR06200	37.80	28.04	53.18	1.17	0.60	9.68	MODRSS		45.96		MODTES	57.00	CL		84.0		27M0G7W			P	
BOT	BOT_001	−26.60	23.16	−22.38	1.80	0.96	59.49	R123SS		42.07		MODTES	57.00	CR		86.0		27M0G7W			P	11
BRM	BRM29800	104.00	96.97	18.68	3.33	1.66	91.63	MODRSS		37.02		MODTES	57.00	CR		84.0		27M0G7W			P	
BRU	BRU3300A	74.00	114.70	4.40	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		84.0		27M0G7W			P	
BTN	BTN03100	86.00	90.44	27.05	0.72	0.60	175.47	MODRSS		48.11		MODTES	57.00	CR		84.0		27M0G7W			P	
BUL	BUL02000	1.90	19.00	45.50					E001	36.5	0	MODTES	57.00	LE	*	75.8		33M0G7W			P	
CAF	CAF25800	−13.20	21.00	6.30	2.25	1.68	31.00	MODRSS		38.67		MODTES	57.00	CR		84.0		27M0G7W			P	
CBG	CBG29900	86.00	104.89	12.79	1.12	0.94	32.89	MODRSS		44.22		MODTES	57.00	CR		84.0		27M0G7W			P	
CHN	CHN15400	62.00	101.90	33.50	5.10	2.80	143.00	MODRSS		32.90		MODTES	57.00	CR		84.0		27M0G7W		45	P	
CHN	CHN15500	62.00	101.90	33.50	5.10	2.80	143.00	MODRSS		32.90		MODTES	57.00	CL		84.0		27M0G7W		45	P	
CHN	CHN15800	134.00	113.21	34.27	6.40	3.16	10.74	MODRSS		31.39		MODTES	57.00	CL		84.0		27M0G7W		46	P	
CHN	CHN15900	134.00	113.21	34.27	6.40	3.16	10.74	MODRSS		31.39		MODTES	57.00	CR		84.0		27M0G7W		46	P	
CHN	CHN16000	92.20	108.10	33.70	5.00	4.00	148.00	MODRSS		31.44		MODTES	57.00	CR		84.0		27M0G7W		47	P	
CHN	CHN16100	92.20	108.10	33.70	5.00	4.00	148.00	MODRSS		31.44		MODTES	57.00	CL		84.0		27M0G7W		47	P	
CHN	CHN20000	122.00	113.55	22.20	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		84.0		27M0G7W			P	
CLN	CLN21900	50.00	80.60	7.70	1.18	0.60	106.00	MODRSS		45.95		MODTES	57.00	CL		84.0		27M0G7W			P	
COD	COD_SAT1	−23.50	22.28	−4.21	3.37	2.32	84.81	R123SS		35.52		MODTES	57.00	CL		86.0		27M0G7W			P	
COG	COG_SAT	−37.30	14.66	−0.76	1.82	0.72	74.62	R123SS		43.27		MODTES	57.00	CR		86.0		27M0G7W			P	11
COM	COM_BSS	−3.70	43.73	−11.88	0.60	0.60	0.00	R123SS		48.88		MODTES	57.00	LE	90	86.0		27M0G7W			P	
CPV	CPV30100	−33.50	−24.12	16.09	0.77	0.63	94.46	MODRSS		47.56		MODTES	57.00	CL		84.0		27M0G7W			P	5, 6
CTI	CTI23700	−24.80	−5.66	7.39	1.45	1.29	126.59	MODRSS		41.73		MODTES	57.00	CR		84.0		27M0G7W			P	
CVA	CVA_BSS	−33.60	12.47	41.90	0.60	0.60	0.00	R123SS		48.88		MODTES	57.00	CL		86.0		27M0G7W			P	11
CYP	CYP08600	−1.20	33.45	35.12	0.60	0.60	90.00	MODRSS		48.88		MODTES	57.00	CL		84.0		27M0G7W			P	
CZE	CZE14401	−12.80	16.77	46.78	1.71	0.89	149.15	MODRSS		42.64		MODTES	57.00	CR		84.0		27M0G7W			P	
CZE	CZE14402	−12.80	16.77	46.78	1.71	0.89	149.15	MODRSS		42.64		MODTES	57.00	CL		84.0		27M0G7W			P	
CZE	CZE14403	−12.80	16.77	46.78	1.71	0.89	149.15	MODRSS		42.64		MODTES	57.00	CL		84.0		27M0G7W		37	P	
D	D_08700	−18.80	10.31	49.47	1.82	0.92	151.78	MODRSS		42.19		MODTES	57.00	CR		84.0		27M0G7W			P	

1	2	3	4		5			6	7	8		9		10		11	12	13	14	15	16	17
Admin. symbol	Beam identification	Orbital position	Boresight		Space station antenna characteristics			Space station antenna code	Shaped beam	Space station antenna gain		Earth station antenna		Polarization		e.i.r.p.	Power control	Designation of emission	Identity of the space station	Group code	Status	Remarks
			Long.	Lat.	Major axis	Minor axis	Orien-tation			Co-polar	Cross-polar	Code	Gain	Type	Angle							
DJI	DJI_SAT	−17.46	42.58	11.72	0.60	0.60	0.00	R123SS		48.88		MODTES	57.00	CR		86.0		27M0G7W			P	11
DNK	DNK__100	−25.20	5.28	61.83				CB_RSS_DNKA		48.88		MODTES	57.00	CL		79.5		27M0G7W			P	
DNK	DNK09000	−33.50	14.34	61.72	1.83	0.60	151.50	MODRSS		44.05		MODTES	57.00	CR		84.0		27M0G7W			P	
DNK	DNK09100	−33.50	−14.94	63.79	1.52	0.60	168.57	MODRSS		44.86		MODTES	57.00	CR		84.0		27M0G7W			P	
E	E____100	−30.00	−9.40	34.15				CB_RSS_E__A		44.79		MODTES	57.00	CR		84.0		27M0G7W		01	P	6
E	HISP27D4	−30.00	−3.10	39.90					ECO	43.00	18.70	R13TES	55.00	CR		82.5		27M0G7W--	HISPASAT-1	01	PE	
E	HISP27D6	−30.00	−3.10	39.90					ECO	43.00	18.70	R13TES	58.50	CR		83.5		27M0G7W--	HISPASAT-1	01	PE	
E	HISP33D4	−30.00	−3.10	39.90					ECO	43.00	18.70	MODTES	55.00	CR		82.5		33M0G7W--	HISPASAT-1	01	PE	
E	HISP33D6	−30.00	−3.10	39.90					ECO	43.00	18.70	MODTES	58.50	CR		83.5		33M0G7W--	HISPASAT-1	01	PE	
E	HISPASA4	−30.00	−3.10	39.90					ECO	43.00	18.70	R13TES	55.00	CR		82.5		27M0G7W	HISPASAT-1	01	PE	
E	HISPASA6	−30.00	−3.10	39.90					ECO	43.00	18.70	R13TES	58.50	CR		83.5		27M0G7W	HISPASAT-1	01	PE	
EGY	EGY02600	−7.00	29.70	26.80	2.33	1.72	136.00	MODRSS		38.42		MODTES	57.00	CR		84.0		27M0G7W		12	P	
ERI	ERI09200	22.80	39.41	14.98	1.67	0.95	145.49	MODRSS		42.44		MODTES	57.00	CL		84.0		27M0G7W			P	
EST	EST06100	44.50	25.40	59.18	0.67	0.60	5.99	MODRSS		48.42		MODTES	57.00	CR		84.0		27M0G7W			P	
F	F_09300	−7.00	3.30	45.37	2.18	1.20	156.36	MODRSS		40.27		MODTES	57.00	CR		84.0		27M0G7W		21	P	
F	F____100	−7.00	29.16	13.43				CB_RSS_F__A		48.88		MODTES	57.00	CL		84.0		27M0G7W		12	P	
F	F____200	140.00	174.50	−17.30				CB_RSS_F__B		45.80		MODTES	57.00	CL		84.0		27M0G7W		7F	P	
F	F____300	140.00	174.65	−17.65				CB_RSS_F__C		47.97		MODTES	57.00	CR		84.0		27M0G7W		7F	P	
F	OCE10100	−160.00	−145.00	−16.30	4.34	3.54	4.00	MODRSS		32.58		MODTES	57.00	CL		84.0		27M0G7W			P	
FIN	FIN10300	22.80	17.61	61.54	2.18	0.90	11.59	MODRSS		41.53		MODTES	57.00	CL		84.0		27M0G7W		52	P	
FIN	FIN10400	22.80	17.61	61.54	2.18	0.90	11.59	MODRSS		41.53		MODTES	57.00	CL		84.0		27M0G7W		52	P	
FJI	FJI19300	−178.00	179.62	−17.87	1.16	0.92	155.22	MODRSS		44.16		MODTES	57.00	CR		84.0		27M0G7W			P	
FSM	FSM00000	158.00	151.90	5.48	5.15	1.57	167.00	MODRSS		35.38		MODTES	57.00	CR		84.0		27M0G7W			P	
G	G_02700	−33.50	−3.50	53.80	1.84	0.72	142.00	MODRSS		43.23		MODTES	57.00	CR		84.0		27M0G7W			P	5, 6
GAB	GAB_37.3W	−37.30	11.63	−0.69	1.22	0.71	82.94	R123SS		45.07		MODTES	57.00	CL		86.0		27M0G7W			P	11
GEO	GEO_BSS	−4.10	43.22	42.30	0.96	0.60	153.15	R123SS		46.84		MODTES	57.00	LE	90	86.0		27M0G7W			P	
GMB	GMB30200	−37.20	−15.10	13.40	0.79	0.60	4.00	MODRSS		47.69		MODTES	57.00	CL		83.0		27M0G7W			P	
GNB	GNB30400	−30.00	−15.00	12.00	0.90	0.60	172.00	MODRSS		47.12		MODTES	57.00	CL		84.0		27M0G7W			P	
GNE	GNE30300	−18.80	10.30	1.50	0.68	0.60	10.00	MODRSS		48.34		MODTES	57.00	CR		84.0		27M0G7W			P	
GRC	GRC10500	−1.20	24.52	38.11	1.70	0.95	152.55	MODRSS		42.37		MODTES	57.00	CR		84.0		27M0G7W			P	
GUI	GUI19200	−37.00	−11.00	10.20	1.58	1.04	147.00	MODRSS		42.29		MODTES	57.00	CR		85.0		27M0G7W			P	
HNG	HNG10601	−12.80	16.77	46.78	1.71	0.89	149.15	MODRSS		42.64		MODTES	57.00	CR		84.0		27M0G7W			P	
HNG	HNG10602	−12.80	16.77	46.78	1.71	0.89	149.15	MODRSS		42.64		MODTES	57.00	CL		84.0		27M0G7W			P	
HNG	HNG10603	−12.80	16.77	46.78	1.71	0.89	149.15	MODRSS		42.64		MODTES	57.00	CL		84.0		27M0G7W		37	P	
HOL	HOL21300	38.20	5.12	51.96	1.00	1.00	0.00	MODRSS		44.44		MODTES	57.00	CL		85.5		27M0G7W			P	
HRV	HRV14801	−12.80	16.77	46.78	1.71	0.89	149.15	MODRSS		42.64		MODTES	57.00	CR		84.0		27M0G7W			P	
HRV	HRV14802	−12.80	16.77	46.78	1.71	0.89	149.15	MODRSS		42.64		MODTES	57.00	CL		84.0		27M0G7W			P	

1	2	3	4		5			6	7	8		9		10		11	12	13	14	15	16	17
Admin. symbol	Beam identification	Orbital position	Boresight		Space station antenna characteristics			Space station antenna code	Shaped beam	Space station antenna gain		Earth station antenna		Polarization		e.i.r.p.	Power control	Designation of emission	Identity of the space station	Group code	Status	Remarks
			Long.	Lat.	Major axis	Minor axis	Orien-tation			Co-polar	Cross-polar	Code	Gain	Type	Angle							
HRV	HRV14803	−12.80	16.77	46.78	1.71	0.89	149.15	MODRSS		42.64		MODTES	57.00	CL		84.0		27M0G7W		37	P	
I	I 08200	9.00	12.67	40.74	1.99	1.35	144.20	MODRSS		40.14		MODTES	57.00	CR		84.0		27M0G7W			P	
IND	IND03700	68.00	93.00	25.50	1.46	1.13	40.00	MODRSS		42.27		MODTES	57.00	CL		84.0		27M0G7W			P	
IND	IND04701	68.00	93.30	11.10	1.92	0.60	96.00	MODRSS		43.83		MODTES	57.00	CR		84.0		27M0G7W		7E	P	
IND	IND04702	68.00	93.30	11.10	1.92	0.60	96.00	MODRSS		43.83		MODTES	57.00	CL		84.0		27M0G7W		7E	P	
IND	INDA_101	55.80	76.16	14.72				CB_RSS_INDA		45.66		MODTES	57.00	CR		84.0		27M0G7W		7G	P	
IND	INDA_102	55.80	76.16	14.72				CB_RSS_INDA		45.66		MODTES	57.00	CL		84.0		27M0G7W		7G	P	
IND	INDB_101	55.80	83.67	23.73				CB_RSS_INDB		43.13		MODTES	57.00	CR		84.0		27M0G7W		7H	P	
IND	INDB_102	55.80	83.67	23.73				CB_RSS_INDB		43.13		MODTES	57.00	CL		84.0		27M0G7W		7H	P	
IND	INDD_100	68.00	74.37	29.16				CB_RSS_INDD		41.79		MODTES	57.00	CR		84.0		27M0G7W			P	
INS	INS02800	80.20	113.60	−1.40	6.73	3.33	160.00	MODRSS		30.94		MODTES	57.00	CR		84.0		27M0G7W			P	
INS	INS03501	104.00	115.20	−1.70	9.14	3.43	170.00	MODRSS		29.48		MODTES	57.00	CL		84.0		27M0G7W		7D	P	
INS	INS03502	104.00	115.20	−1.70	9.14	3.43	170.00	MODRSS		29.48		MODTES	57.00	CR		84.0		27M0G7W		7D	P	
IRL	IRL21100	−37.20	−8.25	53.22	0.72	0.60	157.56	MODRSS		48.08		MODTES	57.00	CR		84.0		27M0G7W			P	
IRN	IRN10900	34.00	54.20	32.40	3.82	1.82	149.00	MODRSS		36.03		MODTES	57.00	CL		83.0		27M0G7W			P	
IRQ	IRQ_SAT	-9.60	43.48	33.16	1.76	0.64	135.09	R123SS		43.93		MODTES	57.00	CL		86.0		27M0G7W			P	11
ISL	ISL04900	−33.50	−19.00	64.90	1.00	0.60	177.00	MODRSS		46.67		MODTES	57.00	CL		83.0		27M0G7W			P	
ISL	ISL05000	−33.50	−14.94	63.79	1.52	0.60	168.57	MODRSS		44.86		MODTES	57.00	CR		84.0		27M0G7W			P	
ISR	ISR11000	−4.00	34.95	31.32	0.73	0.60	110.02	MODRSS		48.03		MODTES	57.00	CR		84.0		27M0G7W			P	
J	000BS−3N	109.85	134.50	31.50	3.52	3.30	68.00	MODRSS		33.80		MODTES	57.00	CR		87.0		27M0G7W	BS-3N	02	PE	
J	J 10985	109.85	134.50	31.50	3.52	3.30	68.00	MODRSS		33.80		MODTES	57.00	CR		87.0		34M5G7W		02	P	
J	J 11100	110.00	134.50	31.50	3.52	3.30	68.00	MODRSS		33.80		MODTES	57.00	CR		87.0		34M5G7W		02	P	
J	J 1110E	110.00	134.50	31.50	3.52	3.30	68.00	MODRSS		33.80		MODTES	57.00	CR		87.0		27M0G7W	BS-3M	02	PE	
JOR	JOR22400	11.00	37.55	34.02	1.47	0.91	73.16	MODRSS		43.19		MODTES	57.00	CL		85.0		27M0G7W			P	
KAZ	KAZ06600	56.40	65.73	46.40	4.58	1.76	177.45	MODRSS		35.38		MODTES	57.00	CL		84.0		27M0G7W			P	
KEN	KEN_SAT_001	−9.20	37.82	1.02	1.98	1.02	97.23	R123SS		41.39		MODTES	57.00	CL		86.0		27M0G7W			P	11
KGZ	KGZ07000	50.00	73.91	41.32	1.47	0.64	5.05	MODRSS		44.75		MODTES	57.00	CR		84.0		27M0G7W			P	
KIR	KIR__100	176.00	−170.31	−0.56				CB_RSS_KIRA		42.60		MODTES	57.00	CL		84.0		27M0G7W			P	
KOR	KOR11201	116.00	127.50	36.00	1.24	1.02	168.00	MODRSS		43.43		MODTES	57.00	CL		89.0		27M0G7W		03	P	
KOR	KOR11202	116.00	127.50	36.00	1.24	1.02	168.00	MODRSS		43.43		MODTES	57.00	CR		89.0		27M0G7W		03	P	
KRE	KRE28600	140.00	128.45	40.32	1.63	0.68	18.89	MODRSS		44.00		MODTES	57.00	CL		87.0		27M0G7W			P	
KWT	KWT11300	11.00	47.48	29.12	0.60	0.60	90.00	MODRSS		48.88		MODTES	57.00	CR		83.0		27M0G7W			P	
LAO	LAO28400	122.20	103.71	18.17	1.87	1.03	123.99	MODRSS		42.18		MODTES	57.00	CR		84.0		33M0G7W			P	
LBN	LBN27900	11.00	37.55	34.02	1.47	0.91	73.16	MODRSS		43.19		MODTES	57.00	CR		84.0		27M0G7W			P	
LBR	LBR24400	−33.50	−9.30	6.60	1.22	0.70	133.00	MODRSS		45.13		MODTES	57.00	CR		84.0		27M0G7W			P	5, 6
LBY	LBY28021	−24.80	17.50	26.30	3.68	1.84	130.00	MODRSS		36.14		MODTES	57.00	CL		84.0		27M0G7W			P	
LIE	LIE25300	−18.80	10.31	49.47	1.82	0.92	151.78	MODRSS		42.19		MODTES	57.00	CL		84.0		27M0G7W			P	

1	2	3	4		5			6	7	8		9		10		11	12	13	14	15	16	17
Admin. symbol	Beam identification	Orbital position	Boresight		Space station antenna characteristics			Space station antenna code	Shaped beam	Space station antenna gain		Earth station antenna		Polarization		e.i.r.p.	Power control	Designation of emission	Identity of the space station	Group code	Status	Remarks
			Long.	Lat.	Major axis	Minor axis	Orien-tation			Co-polar	Cross-polar	Code	Gain	Type	Angle							
LSO	LSO_SAT	−16.00	28.25	−29.57	0.60	0.60	0.00	R123SS		48.88		MODTES	57.00	CL		86.0		27M0G7W			P	
LTU	LTU06100	23.20	24.52	56.11				CB_RSS_LTUA		47.92		MODTES	57.00	CR		84.0		27M0G7W			P	
LUX	LUX11400	28.20	5.21	49.20	0.60	0.60	90.00	MODRSS		48.88		MODTES	57.00	CL		84.0		27M0G7W		09	P	
LVA	LVA06100	23.20	24.52	56.11				CB_RSS_LVAA		47.92		MODTES	57.00	CR		84.0		27M0G7W			P	
MAU	MAU_300	68.40	59.06	−15.94	2.70	1.78	135.44	R123SS		37.63		MODTES	57.00	CL		86.0		27M0G7W			P	11
MCO	MCO11600	34.20	7.40	43.70	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		81.0		27M0G7W			P	
MDA	MDA_SAT	−16.30	27.63	46.93	0.69	0.60	141.49	R123SS		48.28		MODTES	57.00	CL		86.0		27M0G7W			P	11
MDG	MDG_SAT	69.50	46.55	−18.07	2.47	1.36	90.92	R123SS		39.18		MODTES	57.00	LE	0	86.0		27M0G7W			P	11
MHL	MHL00000	146.00	167.64	9.83	2.07	0.90	157.42	MODRSS		41.75		MODTES	57.00	CR		84.0		27M0G7W			P	
MKD	MKD_BSS	−16.70	21.79	41.62	0.60	0.60	0.00	R123SS		48.88		MODTES	57.00	CR		86.0		27M0G7W			P	11
MLA	MLA__100	91.50	108.07	3.92				CB_RSS_MLAA		41.75		MODTES	57.00	CR		84.0		27M0G7W			P	
MLD	MLD30600	50.00	73.10	6.00	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		84.0		27M0G7W			P	
MLI	MLI_SAT_100	−42.00	−4.84	17.52	2.61	2.04	115.30	R123SS		37.18		MODTES	57.00	CR		86.0		27M0G7W			P	
MLT	MLT14700	22.80	14.40	35.90	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CR		84.0		27M0G7W			P	
MNG	MNG24800	74.00	101.95	46.79	3.32	1.04	169.27	MODRSS		39.07		MODTES	59.92	CL		86.9		27M0G7W			P	
MRC	MRC20900	−25.20	−8.90	28.90	3.96	1.55	50.00	MODRSS		36.57		MODTES	57.00	CR		80.0		27M0G7W			P	
MTN	MTN__100	−36.80	−11.24	20.91				CB_RSS_MTNA		37.55		MODTES	57.00	CR		86.0		27M0G7W			P	
MOZ	MOZ_SAT	-8.20	34.22	-17.64	3.37	1.20	62.10	R123SS		38.38		MODTES	57.00	CL		86.0		27M0G7W			P	
MWI	MWI_SAT	−23.50	34.03	−13.26	1.37	0.60	83.29	R123SS		45.30		MODTES	57.00	CR		86.0		27M0G7W			P	
NGR	NGR11500	−37.20	7.63	16.97	2.20	1.80	100.58	MODRSS		38.47		MODTES	57.00	CL		84.0		27M0G7W			P	
NIG	NIG11903	−42.00	7.68	9.84	2.02	1.28	93.89	R123SS		40.32		MODTES	57.00	CL		86.0		27M0G7W			P	11
NMB	NMB_SAT	−34.00	17.47	−21.14	2.53	1.29	65.23	R123SS		39.31		MODTES	57.00	CR		86.0		27M0G7W			P	
NOR	NOR12000	−0.80	16.70	61.58	1.84	0.95	177.31	MODRSS		42.02		MODTES	57.00	CR		84.0		27M0G7W		06	P	
NOR	NOR12100	−0.80	16.70	61.58	1.84	0.95	177.31	MODRSS		42.02		MODTES	57.00	CL		84.0		27M0G7W		06	P	
NRU	NRU30900	134.00	167.00	−0.50	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		84.0		27M0G7W			P	
NZL	NZL__100	158.00	−174.35	−24.30				CB_RSS_NZLA		48.88		MODTES	57.00	CL		84.0		27M0G7W			P	
OMA	OMA12300	17.20	55.60	21.00	1.88	1.02	100.00	MODRSS		41.62		MODTES	57.00	CL		85.0		27M0G7W			P	
PHL	PHL28500	98.00	121.30	11.10	3.46	1.76	99.00	MODRSS		36.60		MODTES	57.00	CL		84.0		27M0G7W			P	
PLW	PLW00000	140.00	132.98	5.51	1.30	0.60	55.41	MODRSS		45.53		MODTES	57.00	CR		84.0		27M0G7W			P	
POL	POL-BSS-4.2W	−4.20	19.52	51.88	1.43	0.65	160.25	R123SS		44.76		MODTES	57.00	LE	90	86.0		27M0G7W			P	
POR	POR__100	−37.00	−15.92	37.65				CB_RSS_PORA		47.17		MODTES	57.00	CR		84.0		27M0G7W			P	
PSE	YYY00001	−13.20	34.99	31.86	0.60	0.60	90.00	MODRSS		48.88		MODTES	57.00	CL		80.5		27M0G7W			P	8
QAT	QAT24700	20.00	51.59	25.35	0.60	0.60	90.00	MODRSS		48.88		MODTES	57.00	CL		84.0		27M0G7W			P	
ROU	ROU_SAT	−23.40	25.03	45.59	1.13	0.60	149.23	R123SS		46.13		MODTES	57.00	CL		86.0		27M0G7W			P	
RRW	BSS-RRW	−9.20	29.78	−2.10	0.60	0.60	0.00	R123SS		48.88		MODTES	57.00	CR		86.0		27M0G7W			P	
RUS	RSTREA11	36.00	38.00	53.00					COP	38.40	8.40	MODTES	57.00	CR		84.0		27M0G7W	RST-1	05	PE	
RUS	RSTREA12	36.00	38.00	53.00					COP	38.40	8.40	MODTES	57.00	CL		84.0		27M0G7W	RST-1	05	PE	

1	2	3	4		5			6	7	8		9		10		11	12	13	14	15	16	17
Admin. symbol	Beam identification	Orbital position	Boresight		Space station antenna characteristics			Space station antenna code	Shaped beam	Space station antenna gain		Earth station antenna		Polarization		e.i.r.p.	Power control	Designation of emission	Identity of the space station	Group code	Status	Remarks
			Long.	Lat.	Major axis	Minor axis	Orien-tation			Co-polar	Cross-polar	Code	Gain	Type	Angle							
RUS	RSTRED11	36.00	38.00	53.00					COP	38.40	8.40	MODTES	57.00	CR		84.0		27M0G7W	RST-1	05	PE	
RUS	RSTRED12	36.00	38.00	53.00					COP	38.40	8.40	MODTES	57.00	CL		84.0		27M0G7W	RST-1	05	PE	
RUS	RSTRSD11	36.00	38.00	53.00					COP	38.40	8.40	MODTES	57.00	CR		84.0		27M0G7W	RST-1	05	P	
RUS	RSTRSD12	36.00	38.00	53.00					COP	38.40	8.40	MODTES	57.00	CL		84.0		27M0G7W	RST-1	05	P	
RUS	RSTRSD21	56.00	65.00	63.00					COP	38.40	8.40	MODTES	57.00	CR		84.0		27M0G7W	RST-2	14	P	
RUS	RSTRSD22	56.00	65.00	63.00					COP	38.40	8.40	MODTES	57.00	CL		84.0		27M0G7W	RST-2	14	P	
RUS	RSTRSD31	86.00	97.00	62.00					COP	38.40	8.40	MODTES	57.00	CR		84.0		27M0G7W	RST-3	33	P	
RUS	RSTRSD32	86.00	97.00	62.00					COP	38.40	8.40	MODTES	57.00	CL		84.0		27M0G7W	RST-3	33	P	
RUS	RSTRSD51	140.00	158.00	56.00					COP	38.40	8.40	MODTES	57.00	CR		84.0		27M0G7W	RST-5	35	P	
RUS	RSTRSD52	140.00	158.00	56.00					COP	38.40	8.40	MODTES	57.00	CL		84.0		27M0G7W	RST-5	35	P	
RUS	RUS00401	110.00	118.22	51.52					COP	38.40	8.40	MODTES	57.00	CR		84.0		27M0G7W	RUS-4	34	P	
RUS	RUS00402	110.00	118.22	51.52					COP	38.40	8.40	MODTES	57.00	CL		84.0		27M0G7W	RUS-4	34	P	
S	S_13800	5.00	17.00	61.50	2.00	1.00	10.00	MODRSS		41.44		MODTES	57.00	CL		84.0		27M0G7W		04	P	
S	S_13900	5.00	17.00	61.50	2.00	1.00	10.00	MODRSS		41.44		MODTES	57.00	CL		84.0		27M0G7W		04	P	
SDN	SUDANBSS	-16.00	28.52	15.33	2.86	1.86	101.59	R123SS		37.19		MODTES	57.00	CL		86.0		27M0G7W			P	
SEY	SEY00000	42.50	51.86	−7.23	2.43	1.04	27.51	MODRSS		40.44		MODTES	57.00	CR		84.0		27M0G7W			P	
SLM	SLM00000	128.00	159.27	−8.40	1.35	1.08	118.59	MODRSS		42.81		MODTES	57.00	CL		84.0		27M0G7W			P	
SMO	SMO05700	−178.00	−171.70	−13.87	0.60	0.60	90.00	MODRSS		48.88		MODTES	57.00	CL		84.0		27M0G7W			P	
SMR	SMR31100	−36.80	12.50	43.90	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		83.0		27M0G7W			P	
SNG	SNG15100	88.00	103.86	1.42	0.92	0.72	175.12	MODRSS		46.25		MODTES	57.00	CL		84.0		27M0G7W			P	
SOM	SOM001	-4.40	44.56	6.57	2.92	1.06	80.43	R123SS		39.54		MODTES	57.00	LE	90	86.0		27M0G7W			P	
SRB	SRB_BSS	−26.70	20.57	44.07	0.90	0.60	143.40	R123SS		47.12		MODTES	57.00	CL		86.0		27M0G7W			P	11
SRL	SRL25900	−33.50	−11.80	8.60	0.78	0.68	114.00	MODRSS		47.20		MODTES	57.00	CR		84.0		27M0G7W			P	
SSD	SSUD_SAT	-23.90	30.25	8.06	1.73	1.18	110.06	R123SS		41.35		MODTES	57.00	CR		86.0		27M0G7W			P	11
STP	STP24100	−7.00	7.00	0.80	0.60	0.60	0.00	MODRSS		48.88		MODTES	57.00	CL		84.0		27M0G7W			P	
SUI	SUI14000	−18.80	10.31	49.47	1.82	0.92	151.78	MODRSS		42.19		MODTES	57.00	CL		84.0		27M0G7W			P	
SVK	SVK14401	−12.80	16.77	46.78	1.71	0.89	149.15	MODRSS		42.64		MODTES	57.00	CR		84.0		27M0G7W			P	
SVK	SVK14402	−12.80	16.77	46.78	1.71	0.89	149.15	MODRSS		42.64		MODTES	57.00	CL		84.0		27M0G7W			P	
SVK	SVK14403	−12.80	16.77	46.78	1.71	0.89	149.15	MODRSS		42.64		MODTES	57.00	CL		84.0		27M0G7W		37	P	
SVN	SVN14800	33.80	15.01	46.18	0.60	0.60	90.00	MODRSS		48.88		MODTES	57.00	CR		82.0		27M0G7W			P	
SWZ	SWZ_SAT	−23.90	31.51	−26.57	0.60	0.60	0.00	R123SS		48.88		MODTES	57.00	CR		86.0		27M0G7W			P	
SYR	SYR22900	11.00	37.55	34.02	1.47	0.91	73.16	MODRSS		43.19		MODTES	57.00	CL		84.0		27M0G7W		53	P	
SYR	SYR33900	11.00	37.60	34.20	1.32	0.88	74.00	MODRSS		43.80		MODTES	57.00	CL		84.0		27M0G7W		53	P	
TCD	TOUMAI	−34.00	17.20	15.50	3.10	1.15	104.19	R123SS		38.93		MODTES	57.00	CL		86.0		27M0G7W			P	
THA	THA14200	98.00	100.75	12.88	2.80	1.82	93.77	MODRSS		37.38		MODTES	57.00	CR		84.0		27M0G7W			P	
TJK	TJK06900	38.00	71.14	38.41	1.21	0.73	155.31	MODRSS		45.00		MODTES	57.00	CL		82.0		27M0G7W			P	
TKM	TKM06800	50.00	59.24	38.83	2.26	1.02	166.64	MODRSS		40.81		MODTES	57.00	CL		85.7		27M0G7W			P	

1	2	3	4		5			6	7	8		9		10		11	12	13	14	15	16	17
Admin. symbol	Beam identification	Orbital position	Boresight		Space station antenna characteristics			Space station antenna code	Shaped beam	Space station antenna gain		Earth station antenna		Polarization		e.i.r.p.	Power control	Designation of emission	Identity of the space station	Group code	Status	Remarks
			Long.	Lat.	Major axis	Minor axis	Orien-tation			Co-polar	Cross-polar	Code	Gain	Type	Angle							
TLS	TLS00000	128.00	126.03	−8.72	0.66	0.60	13.92	MODRSS		48.50		MODTES	57.00	CR		84.0		27M0G7W			P	
TON	TON21500	170.75	−175.23	−18.19	1.59	0.60	71.33	MODRSS		44.64		MODTES	57.00	CR		84.0		27M0G7W			P	
TUN	TUN_BSS	−37.30	9.01	33.79	1.31	0.60	121.24	R123SS		45.49		MODTES	57.00	CR		86.0		27M0G7W			P	11
TUN	TUN27200	−25.20	2.50	32.00	3.59	1.75	175.00	MODRSS		36.47		MODTES	57.00	CR		84.0		27M0G7W		55	P	
TUR	TUR14500	42.00	35.14	38.99	3.19	1.10	0.03	MODRSS		39.00		MODTES	57.00	CL		84.0		27M0G7W		36	P	
TUV	TUV00000	176.00	177.61	−7.11	0.94	0.60	137.58	MODRSS		46.93		MODTES	57.00	CR		84.0		27M0G7W			P	
TZA	TANSAT1	−16.00	34.43	−5.95	2.13	1.13	96.91	R123SS		40.63		MODTES	57.00	CR		86.0		27M0G7W			P	
UAE	UAE27400	52.50	53.98	24.37	1.23	0.84	6.62	MODRSS		44.31		MODTES	57.00	CR		84.0		27M0G7W			P	
UGA	UGASAT	−26.60	31.94	1.15	1.25	0.60	83.71	R123SS		45.70		MODTES	57.00	CL		86.0		27M0G7W			P	11
UKR	UKR06300	38.20	31.82	48.19	2.32	0.95	177.32	MODRSS		41.01		MODTES	57.00	CR		84.0		27M0G7W			P	
USA	GUM33101	122.00	155.56	13.21				CB_RSS_GUMA		43.61		MODTES	57.00	CR		87.0		27M0G7W		7C	P	
USA	GUM33102	122.00	155.56	13.21				CB_RSS_GUMA		43.61		MODTES	57.00	CL		87.0		27M0G7W		7C	P	
USA	MRA33200	121.80	155.56	13.21				CB_RSS_MRAA		43.61		MODTES	57.00	CR		91.0		27M0G7W			P	
USA	PLM33200	170.00	−145.55	19.50				CB_RSS_PLMA		39.35		MODTES	57.00	CL		87.0		27M0G7W			P	
USA	USAA_101	170.00	−145.55	19.50				CB_RSS_USAA		39.35		MODTES	57.00	CR		87.0		27M0G7W		7A	P	
USA	USAA_102	170.00	−145.55	19.50				CB_RSS_USAA		39.35		MODTES	57.00	CL		87.0		27M0G7W		7A	P	
UZB	UZB07100	33.80	63.80	41.21	2.56	0.89	159.91	MODRSS		40.84		MODTES	57.00	CR		82.0		27M0G7W			P	
VTN	VTN32500	107.00	106.84	14.21	3.43	1.76	109.43	MODRSS		36.64		MODTES	57.00	CR		84.0		27M0G7W			P	
VUT	VUT12801	140.00	168.00	−16.40	1.52	0.68	87.00	MODRSS		44.30		MODTES	57.00	CL		84.0		27M0G7W		7B	P	
VUT	VUT12802	140.00	168.00	−16.40	1.52	0.68	87.00	MODRSS		44.30		MODTES	57.00	CR		84.0		27M0G7W		7B	P	
ZMB	ZMB_2020	−23.90	27.29	−13.08	2.01	1.03	58.48	R123SS		41.29		MODTES	57.00	CL		86.0		27M0G7W			P	
ZWE	ZWE_2020	−16.00	29.59	−18.92	1.32	1.05	60.86	R123SS		43.03		MODTES	57.00	CR		86.0		27M0G7W			P	

* Channels 1,3,5,7,17: 0; channels 2, 4, 6, 8, 18: 90.

COLUMN HEADINGS OF TABLES 3B1 AND 3B2

Col. 1 *Nominal orbital position*, in degrees and hundredths of a degree from the Greenwich meridian (negative values indicate longitudes which are west of the Greenwich meridian; positive values indicate longitudes which are east of the Greenwich meridian).

Col. 2 *Notifying administration symbol*.

Col. 3 *Beam identification* (Column 2, normally, contains the symbol designating the administration or the geographical area taken from Table B1 of the Preface to the International Frequency Information Circular (BR IFIC), followed by the symbol designating the service area).

Col. 4 Polarization (CL – circular left, CR – circular right).

Col. 5 *Channel number/indication of minimum equivalent protection margin (EPM) for a given assignment derived from the set of values for all test points belonging to the given beam.*

TABLE 3B1 (REV.WRC-23)

Minimum equivalent protection margin in the Regions 1 and 3 feeder-link Plan in the frequency band 14.5-14.8 GHz (sorted by orbital position)

1	2	3	4	5												
				Channel number												
Orbital position	Admin. symbol	Beam Identification	Polarization type	2	3	4	5	6	7	8	9	10	11	12	13	14
				Minimum equivalent protection margin												
−37.00	SEN	SEN22201	CL				40.8		39.6		39.6		39.6		39.6	
−37.00	SEN	SEN22202	CR					39.6		39.6		39.6		39.6		40.7
−30.00	TGO	TGO22601	CL				15.0		14.1		14.1		14.1		14.1	
−30.00	TGO	TGO22602	CR					14.1		14.1		14.1		14.1		15.0
−25.00	GHA	GHA10801	CR				14.9		14.1		14.1		14.1		14.1	
−25.00	GHA	GHA10802	CL					14.1		14.1		14.1		14.1		14.9
−19.20	NIG	NIG11901*	CR				6.4		4.2		4.2		4.2		4.2	
−19.20	NIG	NIG11902*	CL					4.2		4.2		4.2		4.2		6.4
−18.80	NMB	NMB02501*	CL				6.9		4.5		4.5		4.5		4.5	
−18.80	NMB	NMB02502*	CR					4.5		4.5		4.5		4.5		6.9
−13.00	CME	CME30001	CL				17.2		16.3		16.3		16.3		16.3	
−13.00	CME	CME30002	CR					16.3		16.3		16.3		16.3		17.2
−7.00	SDN	SDN__101*	CL				27.1		26.1		26.1		26.1		26.1	
−7.00	SDN	SDN__102*	CR					26.1		26.1		26.1		26.1		27.1
−1.00	MOZ	MOZ30701*	CL				16.6		15.7		15.7		15.7		15.7	
−1.00	MOZ	MOZ30702*	CR					15.7		15.7		15.7		15.7		16.6
4.80	AFS	AFS02101*	CL				11.9		11.0		11.0		11.0		11.0	
4.80	AFS	AFS02102*	CR					11.0		11.0		11.0		11.0		11.9
11.00	YEM	YEM__101	CR				47.8		47.3		47.3		47.3		47.3	
11.00	YEM	YEM__102	CL					47.3		47.3		47.3		47.3		47.8
34.00	IRN	IRN10901	CR		15.2		13.9		13.9		13.9		13.9		13.9	
34.00	IRN	IRN10902	CL			14.3		13.9		13.9		13.9		13.9		14.8

1	2	3	4	5												
Orbital position	Admin. symbol	Beam Identification	Polarization type	Channel number												
				2	3	4	5	6	7	8	9	10	11	12	13	14
				Minimum equivalent protection margin												
36.00	ETH	ETH09201	CL				2.3		1.4		1.4		1.4		1.4	
36.00	ETH	ETH09202	CR					1.4		1.4		1.4		1.4		2.3
37.80	SOM	SOM31201*	CL				0.0		−0.3		−0.3		−0.3		−0.3	
37.80	SOM	SOM31202*	CR					−0.3		−0.3		−0.3		−0.3		1.6
38.20	PAK	PAK12701	CR		14.2		3.2		0.9		0.9		0.9		0.9	
38.20	PAK	PAK12702	CL			4.2		0.9		0.9		0.9		0.9		3.3
42.50	SEY	SEY00001	CL				36.3		35.3		35.3		35.3		35.3	
42.50	SEY	SEY00002	CR					35.3		35.3		35.3		35.3		36.4
50.00	IRQ	IRQ25601*	CL				−0.1		−0.1		−0.1		−0.1		−0.1	
50.00	IRQ	IRQ25602*	CR					−0.1		−0.1		−0.1		−0.1		2.4
50.00	NPL	NPL12201	CR		38.2		3.9		1.2		1.2		1.2		1.2	
50.00	NPL	NPL12202	CL			4.6		1.2		1.2		1.2		1.2		3.9
55.80	IND	INDA_101	CR		25.7		24.7		24.7		24.7		24.7		24.7	
55.80	IND	INDA_102	CL			24.7		24.7		24.7		24.7		24.7		25.6
116.00	KOR	KO11201D	CL	7.5		7.5		7.5		7.5		7.5		7.5		
116.00	KOR	KOR11201	CL	7.5		7.5		7.5		7.5		7.5		7.5		
122.00	CHN	CHN19001	CL		47.7		47.7		47.7		47.7		47.7		50.7	
122.00	CHN	CHN19002	CR			42.0		42.0		42.0		42.0		42.0		999.9
134.00	PNG	PNG13101	CR		26.1		25.2		25.2		25.2		25.2		25.2	
134.00	PNG	PNG13102	CL			25.2		25.2		25.2		25.2		25.2		26.1
140.00	USA	USAC_101	CL		19.4		18.6		18.6		18.6		18.6		18.6	
140.00	USA	USAC_102	CR			18.6		18.6		18.6		18.6		18.6		19.4

* This beam was replaced at WRC-23. The new beam is contained in Table 3A2.

TABLE 3B2 (REV.WRC-23)

Minimum equivalent protection margin in the Regions 1 and 3 feeder-link Plan in the frequency band 17.3-18.1 GHz (sorted by orbital position)

1	2	3	4	5																																											
				Channel number																																											
Orbital Position	Admin. symbol	Beam Identification	Polarization type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
				Minimum equivalent protection margin																																											
−178.00	FJI	FJI19300	CR	3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3																			
−178.00	SMO	SMO05700	CL	12.2		12.2		12.2		12.2		12.2		12.2		12.2		12.2		12.2		12.2		12.2		12.2																			
−160.00	F	OCE10100	CL		999.9		999.9		999.9		999.9		999.9		999.9		999.9		999.9		999.9		999.9		999.9		999.9																	
−37.20	GMB	GMB30200	CL																					1.3		3.2		3.2		3.2		3.2		3.2		3.2		3.2		3.2		3.2	
−37.20	IRL	IRL21100	CR																					9.2		10.2		10.2		10.2		10.2		10.3		10.2		10.2		10.3		10.3	
−37.20	NGR	NGR11500	CL	1.8		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4																					
−37.00	AND	AND34100	CL																						10.6		10.6		10.6		10.6		10.6		10.6		10.6		10.6		10.6		13.3
−37.00	GUI	GUI19200	CR		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		1.5																				
−37.00	POR	POR_100	CR	2.4		0.0		−0.1		0.0		−0.1		0.0		−0.1		0.0		−0.1		0.0																					
−36.80	MTN	MTN__100	CR																						0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		2.0
−36.80	SMR	SMR31100	CL		10.6		10.6		10.6		10.6		10.6		10.6		10.6		10.6		10.6		12.0																				
−33.50	CPV	CPV30100	CL		14.3		14.3		14.3		14.3		14.3		14.3		14.3		14.3		14.3		11.6																				
−33.50	DNK	DNK09000	CR																												5.1						5.1						
−33.50	DNK	DNK09100	CR																																1.1				1.1				
−33.50	G	G 02700	CR		6.4		6.4		6.4		6.4		6.4		6.4		6.4		6.4		6.4		4.2																				
−33.50	ISL	ISL04900	CL																					1.5		−0.1		−0.1		1.8		7.5		2.8		1.8		1.8		2.8		14.1	
−33.50	ISL	ISL05000	CR																						1.1		1.1		1.1														
−33.50	LBR	LBR24400	CR	10.6		7.7		7.7		7.7		7.7		7.7		7.7		7.7		7.7		7.7																					
−33.50	SRL	SRL25900	CR																					9.7		11.8		11.8		11.4		13.1		13.7		11.4		11.4		13.7		17.1	
−30.00	BFA	BFA10700	CL																						12.0		12.0		12.0		12.0		12.0		12.0		12.0		12.0		12.0		14.9
−30.00	E	E____100	CR	7.9		7.6		7.6		7.6		7.6		7.6		7.6		7.6		7.6		7.6																					
−30.00	E	HISP27D4	CR	10.2				10.1				10.1				10.1				10.1																							
−30.00	E	HISP27D6	CR	11.2				11.1				11.1				11.1				11.1																							
−30.00	E	HISP33D4	CR	10.1				10.1				10.1				10.1				10.1																							
−30.00	E	HISP33D6	CR	11.1				11.1				11.1				11.1				11.1																							
−30.00	E	HISPASA4	CR	10.2				10.1				10.1				10.1				10.1																							

1	2	3	4	5																																											
				Channel number																																											
Orbital Position	Admin. symbol	Beam Identification	Polarization type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
				Minimum equivalent protection margin																																											
−30.00	E	HISPASA6	CR	11.2				11.1				11.1				11.1				11.1																											
−30.00	GNB	GNB30400	CL	15.6		16.9		15.2		16.9		15.2		16.9		15.2		16.9		15.2		16.9																									
−25.20	DNK	DNK__100	CL	1.2		−0.6		−0.6		−0.6		−0.6		−0.6		−0.6		−0.6		−0.6		−0.9																									
−25.20	MRC	MRC20900	CR		1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1		−1.1																								
−25.20	TUN	TUN15000***	CR																						−0.4		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4		−0.2
−25.20	TUN	TUN27200	CR																																		−1.2				−1.2				
−24.80	AGL	AGL29500	CR	9.2		6.8		6.8		6.8		6.8		6.8		6.8		6.8		6.8		6.8																									
−24.80	ALG	ALG25152	CL																						−1.0		−1.0		−1.0		−1.0		−1.0		−1.0		−1.1		−1.0		−1.1		0.0
−24.80	CTI	CTI23700	CR																					6.5		5.5		5.5		5.5		5.5		5.5		5.3		5.2		5.3		5.2	
−24.80	LBY	LBY28021	CL		−0.9		−0.9		−0.9		−0.9		−0.9		−0.9		−0.9		−0.9		−0.9		0.6																						
−19.20	BEN	BEN23300***	CL																					4.4		9.4		9.4		9.4		9.4		9.4		9.4		9.4		9.4		9.4	
−19.20	COD	COD__100***	CL	4.5		2.1		2.1		2.1		2.1		2.1		2.1		2.1		2.1		2.1																									
−19.20	MLI	MLI__100***	CR		4.2		4.2		4.2		4.2		4.2		4.2		4.2		4.2		4.2		2.4																						
−18.80	AUT	AUT01600	CR																					−0.3		−0.2		−0.2		−0.2		−0.2		−0.2		−0.2		−0.2		−0.2		−0.2	
−18.80	D	D 08700	CR	2.5		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4																									
−18.80	GNE	GNE30300	CR																						13.0		13.0		13.0		13.0		13.0		13.0		13.0		13.0		13.0		14.7
−18.80	LIE	LIE25300	CL																						0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		2.5
−18.80	SUI	SUI14000	CL		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3																						
−13.20	CAF	CAF25800	CR		1.1		−0.4		1.1		−0.4		1.1		−0.4		1.1		−0.4		1.1		1.0																						
−13.20	COG	COG23500***	CR																						9.8		9.8		9.8		9.8		9.8		9.8		9.8		9.8		9.8		11.7
−13.20	GAB	GAB26000***	CL	4.9		1.7		1.7		1.7		1.7		1.7		1.7		1.7		1.7		1.7																									
−13.20	PSE	YYY00001	CL																					8.6		10.1		10.1		10.1		10.1		10.1		10.1		10.1		10.1		10.1	
−12.80	CZE	CZE14401	CR	2.8								0.8								0.8								0.0								0.0								
−12.80	CZE	CZE14402	CL														0.1														−0.7								−0.7					
−12.80	CZE	CZE14403	CL		0.1*																				−0.7*		−0.7*																	
−12.80	HNG	HNG10601	CR			0.8								0.8								0.8								0.0								0.0						
−12.80	HNG	HNG10602	CL						0.1																								−0.7									−0.7		
−12.80	HNG	HNG10603	CL		0.1*																				−0.7*		−0.7*																	
−12.80	HRV	HRV14801	CR					0.8								0.8								0.8								0.0								0.0				

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1	2	3	4	5																																										
				Channel number																																										
Orbital Position	Admin. symbol	Beam Identification	Polarization type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
				Minimum equivalent protection margin																																									
−12.80	HRV	HRV14802	CL										0.1																						−0.7									2.1
−12.80	HRV	HRV14803	CL		0.1*																				−0.7*		−0.7*																
−12.80	SVK	SVK14401	CR							0.8								0.8								0.0								0.0								0.0	
−12.80	SVK	SVK14402	CL																		0.1								−0.7								−0.7						
−12.80	SVK	SVK14403	CL		0.1*																				−0.7*		−0.7*																
−7.00	EGY	EGY02600	CR		27.4		28.1		27.4		28.1		27.4		28.1		27.4		28.7		27.8		9.2																				
−7.00	F	F 09300	CR																						−0.4		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4		−0.4
−7.00	F	F____100	CL	17.3		16.4		16.4		16.4		16.4		16.4		16.4		17.1		17.9		17.9																					
−7.00	SRB	SRB14800***	CL																						1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		2.0
−7.00	STP	STP24100	CL																						14.0		14.0		14.0		14.0		14.0		14.0		14.0		14.0		14.0		14.1
−4.00	ISR	ISR11000	CR																						18.2		18.2		18.2		18.2		18.2		18.2		18.2		18.2		18.2		20.9
−1.20**	BUL	BUL02000	CL	3.5		1.6		1.6		1.6		1.6		1.6		1.6		3.2		5.6		5.5																					
−1.20	CVA	CVA08300***	CR		1.7		2.3		1.7		2.3		1.7		2.3																												
−1.20	CVA	CVA08500***	CR														1.7																										
−1.20	CYP	CYP08600	CL																					7.7		4.6		4.7		4.6		4.7		4.6		4.7		4.6		4.7		4.6	
−1.20	GRC	GRC10500	CR																						0.2		−0.6		0.2		−0.6		0.2		−0.6		0.2		−0.6		0.2		0.6
−0.80	BOT	BOT29700***	CL																					3.2		−0.4		0.8		−0.4		0.8		−0.4		0.8		−0.4		0.8		−0.4	
−0.80	KEN	KEN24900***	CR		1.4		2.4		1.4		2.5		1.4		2.5		1.4		3.3		1.9		5.3																				
−0.80	NOR	NOR12000	CR	1.7		−0.7		−0.7		−0.7		−0.7		−0.7		−0.9		0.9		4.2		4.6																					
−0.80	NOR	NOR12100	CL																								4.4				4.4												
−0.80	ZMB	ZMB31400***	CR																						0.2		−1.0		0.2		−1.0		0.2		−1.0		0.2		−1.0		0.2		0.7
−0.80	ZWE	ZWE13500***	CL	8.6		7.6		7.6		7.6		7.6		7.6		7.6		7.8		7.9		7.9																					
4.80	LSO	LSO30500***	CL		6.3		6.2		6.3		6.2		6.3		6.2		6.1		6.1		5.8		8.0																				
4.80	MWI	MWI30800***	CR																					10.6		11.1		11.1		11.1		6.9		6.9		6.9		6.9		6.9		5.4	
4.80	SWZ	SWZ31300***	CR	6.9		3.9		3.9		3.9		3.9		3.9		3.8		3.8		3.8		3.4																					
5.00	S	S 13800	CL																					7.5		7.2		8.2		7.2		8.2		7.2		8.2		7.2		8.2		7.2	
5.00	S	S 13900	CL																														9.8										

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** The current entry is at 1.90° E (WRC-23)

*** This beam was replaced at WRC-23. The new beam is contained in Table 3A2. (WRC-23)

1	2	3	4	5																																										
				Channel number																																										
Orbital Position	Admin. symbol	Beam Identification	Polarization type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
				Minimum equivalent protection margin																																									
9.00	I	I 08200	CR																						12.2		12.0		12.2		11.6		11.1		11.2		11.2		11.2		11.2		11.4
11.00	BDI	BDI27000***	CL	3.2		0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4		0.4																						
11.00	JOR	JOR22400	CL																						5.8		5.8		5.8		5.8		5.8		5.8		5.8		5.8		5.8		7.6
11.00	KWT	KWT11300	CR																					8.0		7.1		7.1		7.1		7.1		7.1		7.1		7.1		7.1		7.1	
11.00	LBN	LBN27900	CR	2.0		−0.8		−0.8		−0.8		−0.8		−0.8		−0.8		−0.8		−0.8		−0.8																						
11.00	RRW	RRW31000***	CR		0.2		0.2		0.2		0.2		0.2		0.2		0.2		0.2		0.2		2.6																					
11.00	SYR	SYR22900	CL		−0.7		−0.7		−0.7		−0.7		−0.7		−0.7		−0.7		−0.7		−0.7		1.4																					
11.00	SYR	SYR33900	CL		−0.7																																							
11.00	TZA	TZA22500***	CR																						0.1		0.1		0.1		0.1		0.1		0.1		0.1		0.1		0.1		2.0
16.80	DJI	DJI09900***	CL	8.7		6.0		6.0		6.0		6.0		6.0		6.0		6.0		6.0		6.0																						
17.00	ARS	ARS00375***	CL																						4.3		4.3		4.3		4.3		4.3		4.3		4.3		4.3		4.3		6.8
17.00	ARS	ARS34000	CL																																									6.8
17.00	TCD	TCD14300***	CR	4.3		4.0		4.0		4.0		4.0		4.0		4.0		4.0		4.0		4.1																						
17.00	UGA	UGA05100***	CR																					11.5		10.7		10.7		10.7		10.7		10.7		10.7		10.7		10.7		10.7	
17.20	OMA	OMA12300	CL		2.0		2.0		2.0		2.0		2.0		2.0		2.0		2.0		2.0		4.4																					
20.00	QAT	QAT24700	CL		13.7		13.7		13.7		13.7		13.7		13.7		13.7		13.7		13.7		15.5																					
22.80	ARM	ARM06400	CR																						2.4		2.4		2.4		2.4		2.4		2.4		2.4		2.4		2.4		5.1
22.80	ERI	ERI09200	CL																						1.3		1.3		1.3		1.3		1.3		1.3		1.3		1.3		1.3		1.7
22.80	FIN	FIN10300	CL																						0.2		0.2		0.2		0.2		0.2		0.2		0.2		0.2		0.2		1.7
22.80	FIN	FIN10400	CL																																				0.2				1.7
22.80	MKD	MKD14800***	CL		8.7		8.7		8.7		8.7		8.7		8.7		8.7		8.7		8.7		10.6																					
22.80	MLT	MLT14700	CR	9.1		7.7		7.7		7.7		7.7		7.7		7.7		7.7		7.7		7.8																						
23.20	AZE	AZE06400***	CL																					4.7		2.5		2.5		2.5		2.5		2.5		2.5		2.5		2.5		2.5	
23.20	GEO	GEO06400***	CL	8.1		6.0		6.0		6.0		6.0		6.0		6.0		6.0		6.0		6.0																						
23.20	LTU	LTU06100	CR																					5.6		3.0		3.0		3.0		3.0		3.0		3.0		3.0		3.0		3.0	
23.20	LVA	LVA06100	CR	6.4		6.3		6.2		6.2		6.2		6.2		6.2		6.2		6.2		6.4																						
28.20	LUX	LUX11400	CL	18.5		18.2		17.7		18.2		17.7		18.2		17.7		18.2		18.2		18.3																						
29.00	COM	COM20700***	CR																					12.9		9.9		9.9		9.9		9.9		9.9		9.9		9.9		9.9		9.9	
29.00	MAU	MAU__100***	CL																						2.6		2.6		2.6		2.6		2.6		2.6		2.6		2.6		2.6		5.6
29.00	MDG	MDG23600***	CL	28.0		27.5		27.5		27.5		27.5		27.5		27.5		27.5		27.5		27.9																						
33.80	SVN	SVN14800	CR		5.9		5.9		5.9		5.9		5.9		5.9		5.9		6.0		6.0		6.1																					

1	2	3	4	5																																													
				Channel number																																													
Orbital Position	Admin. symbol	Beam Identification	Polarization type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
				Minimum equivalent protection margin																																													
33.80	UZB	UZB07100	CR																						0.3		2.5		5.8		4.7		5.8		4.7		5.8		4.7		5.8		5.0
34.00	BHR	BHR25500	CR		6.6		6.6		6.6		6.6		6.6		6.6		6.6		6.6		6.6		6.7																						
34.00	IRN	IRN10900	CL	2.4		−0.2		−0.2		−0.2		−0.3		−0.2		−0.3		−0.2		−0.2		−0.2		0.6		1.9																			
34.20	MCO	MCO11600	CR																						2.3		8.7		17.2		17.2		17.2		17.2		17.2		17.2		17.2		17.7
36.00	RUS	RSTREA11	CR																											−0.8				−0.8				−0.8				−0.8	
36.00	RUS	RSTREA12	CL																												−1.2				−1.2				−1.2				−0.4
36.00	RUS	RSTRED11	CR																											−0.8				−0.8				−0.8				−0.8	
36.00	RUS	RSTRED12	CL																												−1.2				−1.2				−1.2				−0.4
36.00	RUS	RSTRSD11	CR																									−0.5		−0.5		−0.5		−0.5		−0.5		−0.5		−0.5		−0.5	
36.00	RUS	RSTRSD12	CL																										−0.7		−0.7		−0.7		−0.7		−0.7		−0.7		−0.7		0.2
37.80	BLR	BLR06200	CL	2.1		0.4		0.2		0.4		0.2		0.4		0.2		0.4		0.4		0.4																						
38.00	TJK	TJK06900	CL		1.9		1.9		1.9		1.9		1.9		1.9		1.9		1.9		1.9		4.4																					
38.20	BEL	BEL01800	CR																						−1.2		0.6		1.3		1.3		1.3		1.3		1.3		1.3		1.3		4.2
38.20	HOL	HOL21300	CL																					−0.1		−0.8		1.3		1.3		1.3		1.3		1.3		1.3		1.3		1.3	
38.20	UKR	UKR06300	CR		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.6		0.6		0.3																					
42.00	TUR	TUR14500	CL		7.9		7.9		7.9		7.9		7.9		7.9		7.9		7.9		7.9		7.9																					
42.50	SEY	SEY00000	CR																						19.9		20.1		20.2		20.2		20.2		20.2		20.2		20.2		20.2		21.0
44.50	EST	EST06100	CR	14.4		13.8		13.8		13.8		13.8		13.8		13.8		13.8		13.8		13.8																						
50.00	AFG	AFG24501	CL																													1.5		1.5		1.5		1.5		1.5		1.5	
50.00	AFG	AFG24502	CR																														1.5		1.5		1.5		1.5		1.5		4.0
50.00	CLN	CLN21900	CL	1.0		0.9		0.9		0.9		0.9		0.9		0.8		0.8		0.8		0.8		4.9		4.9																		
50.00	KGZ	KGZ07000	CR		−1.0		−1.0		−1.0		−1.0		−1.0		−1.0		−1.0		−1.0		−1.0		0.4																					
50.00	MDA	MDA06300	CR																					3.2		0.8		1.0		1.0		0.7		0.5		0.5		0.5		0.5		0.5	
50.00	MLD	MLD30600	CR	5.5		5.3		5.3		5.3		5.3		5.3		5.2		5.2		5.2		5.2		5.6		5.8																		
50.00	POL	POL13200***	CR	5.9		4.5		4.5		4.5		4.5		4.5		4.5		4.5		4.5		4.5																						
50.00	ROU	ROU13600***	CL																						0.4		0.5		0.7		−0.1		−0.9		−0.9		−0.9		−0.9		−0.9		2.0
50.00	TKM	TKM06800	CL	−0.2		−1.0		−1.0		−1.0		−1.0		−1.0		−1.0		−1.0		−1.0		−1.0																						
52.50	UAE	UAE27400	CR																					28.1		28.6		34.6		35.0		26.8		26.2		26.2		26.2		26.2		26.2	
55.80	IND	INDA_101	CR													0.5		4.7		4.7		4.7		15.0		15.0																		
55.80	IND	INDA_102	CL														9.3		9.3		9.3		11.7		17.4		14.2																	
55.80	IND	INDB_101	CR	5.3		5.3		5.3		5.3		5.3		5.3																														

1	2	3	4	5																																										
				Channel number																																										
Orbital Position	Admin. symbol	Beam Identification	Polarization type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
				Minimum equivalent protection margin																																									
55.80	IND	INDB_102	CL		7.3		7.3		7.3		7.3		7.3		−0.2																														
56.00	BIH	BIH14800***	CR	13.0		12.6		12.6		12.6		12.6		12.6		12.3		12.3		12.3		12.3																							
56.00	RUS	RSTRSD21	CR																									11.0		17.6		17.2		17.1		17.1		17.1		17.1		17.1	
56.00	RUS	RSTRSD22	CL																										17.7		17.6		17.2		17.2		17.2		17.2		17.2		18.2
56.40	KAZ	KAZ06600	CL	3.2		1.2		1.2		1.2		1.2		1.2		3.1		6.0		6.0		6.0																							
62.00	ALB	ALB29600***	CL																						12.8		14.1		46.6		46.5		46.3		46.3		46.3		46.3		46.3		47.4
62.00	CHN	CHN15400	CR		13.5		13.5		13.5		13.5		13.5		13.7		15.1		15.1		15.1		15.5		2.6		2.6																	
62.00	CHN	CHN15500	CL	14.5		13.6		13.6		13.6		13.6		13.6		15.0		15.4		15.4		15.4		2.5		−0.5																			
68.00	IND	IND03700	CL		5.2		5.2		5.2		5.2		5.2		5.2		5.2		5.2		5.2		5.2		5.2		8.2																		
68.00	IND	IND04701	CR																													40.8		40.8		40.8		40.8		40.8		40.8	
68.00	IND	IND04702	CL																														44.2		44.2		44.2		44.2		44.2		47.1
68.00	IND	INDD_100	CR	6.0		3.0		3.0		3.0		3.0		3.0		3.0		3.0		3.0		3.0		3.0		3.0																			
74.00	BGD	BGD22000	CR	4.7		1.7		1.7		1.7		1.7		1.7		1.7		1.7		1.7		1.7		0.9		0.9																			
74.00	BRU	BRU3300A	CR		12.1		12.1		12.1		12.1		12.1		12.1		12.1		12.1		12.1		11.7		11.3		13.6																		
74.00	MNG	MNG24800	CL																					8.1		8.1		15.8		999.9		48.6		48.1		48.1		48.1		48.1		48.1	
80.20	INS	INS02800	CR	16.0		14.6		14.6		14.6		14.6		14.6		14.6		14.6		14.6		14.6		14.5		14.5																			
86.00	BTN	BTN03100	CR	8.6		5.6		5.6		5.6		5.6		5.6		5.6		5.6		5.6		5.6		5.6		5.6																			
86.00	CBG	CBG29900	CR		2.1		2.1		2.1		2.1		2.1		2.1		2.1		2.1		2.1		2.1		2.1		4.0																		
86.00	RUS	RSTRSD31	CR																									1.9		999.9		999.9		999.9		999.9		999.9		999.9		999.9	
86.00	RUS	RSTRSD32	CL																									999.9		999.9		999.9		999.9		999.9		999.9		999.9		999.9	
88.00	SNG	SNG15100	CL	15.4		13.0		13.0		13.0		13.0		13.0		13.0		13.0		13.0		13.0		13.0		13.0																			
91.50	MLA	MLA__100	CR		11.4		11.4		11.4		11.4		11.4		11.4		11.4		11.4		11.4		11.4		11.4		13.7																		
92.20	CHN	CHN16000	CR	7.7		4.9		4.9		4.9		4.9		4.9		4.9		4.9		4.9		4.9		4.9		4.9																			
92.20	CHN	CHN16100	CL		11.1		11.1		11.1		11.1		11.1		11.1		11.1		11.1		11.1		11.1		11.1		11.2																		
98.00	PHL	PHL28500	CL		5.1		5.1		5.1		5.1		5.1		5.1		5.1		5.1		5.1		5.1		5.1		7.9																		
98.00	THA	THA14200	CR	8.1		5.3		5.3		5.3		5.3		5.3		5.3		5.3		5.3		5.3		5.3		5.3																			
104.00	BRM	BRM29800	CR	15.4		13.8		13.8		13.8		13.8		13.8		13.8		13.8		13.8		13.8		13.8		13.8																			
104.00	INS	INS03501	CL																													36.4		37.0		37.0		37.0		37.0		37.0	
104.00	INS	INS03502	CR																														42.1		42.1		42.1		42.1		42.1		45.1
107.00	VTN	VTN32500	CR		14.2		14.2		14.2		14.2		14.2		14.2		14.2		14.2		14.2		14.3		14.4		17.1																	
109.85	J	000BS−3N	CR	21.6		19.4		19.2		19.2		19.2		19.2		19.9		21.0																											

1	2	3	4	5																																										
				Channel number																																										
Orbital Position	Admin. symbol	Beam Identification	Polarization type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
				Minimum equivalent protection margin																																										
109.85	J	J 10985	CR	23.9		21.6		21.4		21.4		21.4		21.4		22.1		23.1		21.7		21.4		21.4		21.4																			
110.00	J	J 11100	CR	23.7		21.4		21.2		21.2		21.2		21.2		22.0		23.0		21.6		21.2		21.3		21.3																			
110.00	J	J 1110E	CR	21.4		19.2		19.0		19.0		19.0		19.0		19.8		20.8																											
110.00	RUS	RUS00401	CR																									29.2		999.9		14.1		13.2		13.2		13.2		13.2		13.2	
110.00	RUS	RUS00402	CL																										999.9		20.8													
116.00	KOR	KOR11201	CL																													28.2		29.2		29.2		29.2		29.2		29.2	
116.00	KOR	KOR11202	CR																														31.8		31.8		31.8		31.8		31.8		34.7
121.80	USA	MRA33200	CR	3.2		0.2		0.2		0.2		0.2		0.2		0.2		0.2		0.2		0.2		0.2		0.2																			
122.00	CHN	CHN20000	CL		13.8		13.8		13.8		13.8		13.8		13.8		13.9		13.9		13.8		13.8		13.8		15.9																		
122.00	USA	GUM33101	CR																													29.3		28.6		28.6		28.6		28.6		28.6	
122.00	USA	GUM33102	CL																														28.6		28.6		28.6		28.6		28.6		29.3
122.20	LAO	LAO28400	CR		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.4		0.4		1.6																	
128.00	SLM	SLM00000	CL	16.4		13.4		13.4		13.4		13.4		13.4		13.4		13.4		13.4		13.4		13.4		13.4																			
128.00	TLS	TLS00000	CR		19.6		19.6		19.6		19.6		19.6		19.6		19.6		19.6		19.6		19.6		19.6		22.6																	
134.00	CHN	CHN15800	CL		0.6		0.6		0.6		0.6		0.6		0.6		0.6		0.6		0.6		0.6		0.6		3.6																	
134.00	CHN	CHN15900	CR	2.0		2.0		2.0		2.0		2.0		2.0		2.0		2.0		2.0		2.0		2.0		2.0																			
134.00	NRU	NRU30900	CL	18.8		17.6		17.6		17.6		17.6		17.6		17.6		17.6		17.6		17.6		17.6		17.6																			
140.00	F	F___200	CL		10.2		10.2		10.2		10.2		10.2		10.2		10.2		10.2		10.2		10.2		10.2		11.2																	
140.00	F	F___300	CR	8.5		6.7		6.7		6.7		6.7		6.7		6.7		6.7		6.7		6.7		6.7		6.7																			
140.00	KRE	KRE28600	CL	13.6		12.2		12.2		12.2		12.2		12.2		12.2		12.2		12.2		12.2		12.2		12.2																			
140.00	PLW	PLW00000	CR		9.7		9.7		9.7		9.7		9.7		9.7		9.7		9.7		9.7		9.7		9.7		7.9																	
140.00	RUS	RSTRSD51	CR																									0.1		999.9		3.0		1.6		1.6		1.6		1.6		1.6	
140.00	RUS	RSTRSD52	CL																										999.9		7.3		1.6		1.6		1.6		1.6		1.6		3.0
140.00	VUT	VUT12801	CL																													8.9		8.9		8.9		8.9		8.9		8.9	
140.00	VUT	VUT12802	CR																														8.9		8.9		8.9		8.9		8.9		10.4
146.00	MHL	MHL00000	CR		41.3		40.8		41.3		40.8		41.3		41.1		41.6		41.1		41.6		41.1		41.6		41.8																	
152.00	AUS	AUS00400	CL			−0.3				−0.3				−0.3				−0.3				−0.3				−0.3																	
152.00	AUS	AUS00401	CL			6.0				6.0				6.0				6.0				6.0				6.0																	
152.00	AUS	AUS00402	CL			6.0				6.0				6.0				6.0				6.0				6.0																	
152.00	AUS	AUS00403	CL			6.0				6.0				6.0				6.0				6.0				6.0																	
152.00	AUS	AUS00404	CL			6.0				6.0				6.0				6.0				6.0				6.0																	

1	2	3	4	5																																									
				Channel number																																										
Orbital Position	Admin. symbol	Beam Identification	Polarization type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
				Minimum equivalent protection margin																																									
152.00	AUS	AUS00405	CL			6.0				6.0				6.0				6.0				6.0				6.0																			
152.00	AUS	AUS00406	CL			6.0				6.0				6.0				6.0				6.0				6.0																			
152.00	AUS	AUS0040A	CL			−0.4				−0.4				−0.4				−0.4				−0.4				−0.4																			
152.00	AUS	AUS00500	CR				−3.3				−3.3				−0.3				−0.3				−0.3				−0.3																		
152.00	AUS	AUS00501	CR				3.0				3.0				6.0				6.0				6.0				6.0																		
152.00	AUS	AUS00502	CR				3.0				3.0				6.0				6.0				6.0				6.0																		
152.00	AUS	AUS00503	CR				3.0				3.0				6.0				6.0				6.0				6.0																		
152.00	AUS	AUS00504	CR				3.0				3.0				6.0				6.0				6.0				6.0																		
152.00	AUS	AUS00505	CR				3.0				3.0				6.0				6.0				6.0				6.0																		
152.00	AUS	AUS00506	CR				3.0				3.0				6.0				6.0				6.0				6.0																		
152.00	AUS	AUS00600	CR																										999.9		999.9		999.9		999.9				999.9				999.9
152.00	AUS	AUS00601	CR																										999.9		999.9		999.9		999.9				999.9				999.9
152.00	AUS	AUS00602	CR																										999.9		999.9		999.9		999.9				999.9				999.9
152.00	AUS	AUS00603	CR																										999.9		999.9		999.9		999.9				999.9				999.9
152.00	AUS	AUS00604	CR																										999.9		999.9		999.9		999.9				999.9				999.9
152.00	AUS	AUS00605	CR																										999.9		999.9		999.9		999.9				999.9				999.9
152.00	AUS	AUS00606	CR																										999.9		999.9		999.9		999.9				999.9				999.9
152.00	AUS	AUSA0000	CL	39.7				−0.4				−0.4																																
152.00	AUS	AUSA0001	CL	61.2				6.0				6.0																																
152.00	AUS	AUSA0002	CL	60.5				6.0				6.0																																
152.00	AUS	AUSA0003	CL	61.5				6.0				6.0																																
152.00	AUS	AUSA0004	CL	53.4				6.0				6.0																																
152.00	AUS	AUSA0005	CL	55.9				6.0				6.0																																
152.00	AUS	AUSA0006	CL	48.3				6.0				6.0																																
158.00	FSM	FSM00000	CR	8.8		5.7		5.7		5.7		5.7		5.7		5.7		5.7		5.7		5.7		5.7		5.7																			
158.00	NZL	NZL__100	CL		8.5		8.4		8.5		8.4		8.5		8.4		8.6		8.6		8.6		8.6		8.6		11.2																		
164.00	AUS	AUS00700	CR			−2.9				−2.9				−2.9				0.1				0.1				0.1																			
164.00	AUS	AUS00701	CR			3.0				3.0				3.0				6.0				6.0				6.0																			
164.00	AUS	AUS00702	CR			3.0				3.0				3.0				6.0				6.0				6.0																			
164.00	AUS	AUS00703	CR			3.0				3.0				3.0				6.0				6.0				6.0																			
164.00	AUS	AUS00704	CR			3.0				3.0				3.0				6.0				6.0				6.0																			

1	2	3	4	5																																										
				Channel number																																										
Orbital Position	Admin. symbol	Beam Identification	Polarization type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
				Minimum equivalent protection margin																																									
164.00	AUS	AUS00705	CR			3.0				3.0				3.0				6.0				6.0				6.0																		
164.00	AUS	AUS00706	CR			3.0				3.0				3.0				6.0				6.0				6.0																		
164.00	AUS	AUS0070A	CR			−3.1				−3.1				−3.1				−0.1				−0.1				−0.1																		
164.00	AUS	AUS00800	CL		0.2				0.2				0.2				0.2				0.2				0.2																			
164.00	AUS	AUS00801	CL		6.0				6.0				6.0				6.0				6.0				6.0																			
164.00	AUS	AUS00802	CL		6.0				6.0				6.0				6.0				6.0				6.0																			
164.00	AUS	AUS00803	CL		6.0				6.0				6.0				6.0				6.0				6.0																			
164.00	AUS	AUS00804	CL		6.0				6.0				6.0				6.0				6.0				6.0																			
164.00	AUS	AUS00805	CL		6.0				6.0				6.0				6.0				6.0				6.0																			
164.00	AUS	AUS00806	CL		6.0				6.0				6.0				6.0				6.0				6.0																			
164.00	AUS	AUS00900	CR																								31.9		999.9		38.1		36.8				36.8				36.8	
164.00	AUS	AUS00901	CR																								65.2		999.9		63.1		61.7				61.7				61.7	
164.00	AUS	AUS00902	CR																								65.4		999.9		63.3		61.9				61.9				61.9	
164.00	AUS	AUS00903	CR																								60.5		999.9		62.1		60.8				60.8				60.8	
164.00	AUS	AUS00904	CR																								50.2		999.9		60.8		59.5				59.5				59.5	
164.00	AUS	AUS00905	CR																								56.4		999.9		59.4		58.1				58.1				58.1	
164.00	AUS	AUS00906	CR																								48.1		999.9		57.0		55.8				55.8				55.8	
164.00	AUS	AUS0090A	CR																								42.0		999.9		40.3		38.9				38.9				38.9	
164.00	AUS	AUSB0000	CL				−0.1				−0.1				−0.1																												
164.00	AUS	AUSB0001	CL				6.0				6.0				6.0																												
164.00	AUS	AUSB0002	CL				6.0				6.0				6.0																												
164.00	AUS	AUSB0003	CL				6.0				6.0				6.0																												
164.00	AUS	AUSB0004	CL				6.0				6.0				6.0																												
164.00	AUS	AUSB0005	CL				6.0				6.0				6.0																												
164.00	AUS	AUSB0006	CL				6.0				6.0				6.0																												
170.00	USA	PLM33200	CL		10.2		10.2		10.2		10.2		10.2		10.2		10.2		10.2		10.2		10.2		10.2		10.2																	
170.00	USA	USAA_101	CR																												45.5		45.5		999.9		45.5		999.9		45.5	
170.00	USA	USAA_102	CL																													45.5		48.5		48.5		48.5		48.5		48.5
170.75	TON	TON21500	CR		11.6		11.6		11.6		11.6		11.6		11.6		11.6		11.6		11.6		11.6		11.6		11.6																	
176.00	KIR	KIR__100	CL	4.2		1.2		1.2		1.2		1.2		1.2		1.2		1.2		1.2		1.2		1.2		1.2																		
176.00	TUV	TUV00000	CR		4.7		4.7		4.7		4.7		4.7		4.7		4.7		4.7		4.7		4.7		4.7		7.7																	

ARTICLE 10

Interference

10.1 The Member States shall endeavour to agree on the action required to reduce harmful interference which might be caused by the application of these provisions and the associated Plans.

ARTICLE 11

Period of validity of the provisions and associated Plans

11.1 The provisions and associated Plans have been prepared in order to meet the requirements for feeder-links for the broadcasting-satellite service in the bands concerned for a period extending until at least 1 January 1994.

11.2 In any event, the provisions and associated Plans shall remain in force until their revision by a competent administrative radio conference convened in accordance with the relevant provisions of the Convention in force.

ANNEX 1 (REV.WRC-19)

Limits for determining whether a service of an administration is considered to be affected by a proposed modification to the Region 2 feeder-link Plan or by a proposed new or modified assignment in the Regions 1 and 3 feeder-link List or when it is necessary under this Appendix to seek the agreement of any other administration (Rev.WRC-03)

1 (SUP - WRC-2000)

2 (SUP - WRC-2000)

3 Limits to the change in the overall equivalent protection margin with respect to frequency assignments in conformity with the Region 2 feeder-link Plan[33] (WRC-2000)

With respect to the modification to the Region 2 feeder-link Plan and when it is necessary under this Appendix to seek the agreement of any other administration of Region 2, except in cases covered by Resolution **42 (Rev.WRC-19)**, an administration is considered as being affected if the overall

[33] With respect to § 3 the limit specified relates to the overall equivalent protection margin calculated in accordance with § 1.12 of Annex 3.

equivalent protection margin[34] corresponding to a test point of its entry in that Plan, including the cumulative effect of any previous modification to that Plan or any previous agreement, falls more than 0.25 dB below 0 dB, or, if already negative, more than 0.25 dB below the value resulting from:

– the feeder-link Plan as established by the 1983 Conference; *or*

– a modification of the assignment in accordance with this Appendix; *or*

– a new entry in the feeder-link Plan under Article 4; *or*

– any agreement reached in accordance with this Appendix except for Resolution **42 (Rev.WRC-19)**. (WRC-19)

4 Limits to the interference into frequency assignments in conformity with the Regions 1 and 3 feeder-link Plan or with the Regions 1 and 3 feeder-link List or proposed new or modified assignments in the Regions 1 and 3 feeder-link List (WRC-03)

Under assumed free-space propagation conditions, the power flux-density of a proposed new or modified assignment in the feeder-link List shall not exceed the value of −76 dB(W/(m^2 · 27 MHz)) at any point in the geostationary-satellite orbit, and the relative off-axis e.i.r.p. of the associated feeder-link antenna shall be in compliance with Fig. A (WRC-97 curves) of Annex 3. (WRC-03)

With respect to § 4.1.1 *a)* or *b)* of Article 4, an administration in Region 1 or 3 is considered by the Bureau as being affected if the minimum orbital spacing between the wanted and interfering space stations, under worst-case station-keeping conditions, is less than 9°. (WRC-03)

However, an administration is not considered as being affected if, under assumed free-space propagation conditions, the effect of the proposed new or modified assignments in the feeder-link List is that the feeder-link equivalent protection margin[35] corresponding to a test point of its assignment in the feeder-link Plan or the feeder-link List or for which the procedure of Article 4 has been initiated, including the cumulative effect of any previous modification to the feeder-link List or any previous agreement, does not fall more than 0.45 dB below 0 dB, or, if already negative, more than 0.45 dB below the value resulting from:

– the Regions 1 and 3 feeder-link Plan and List as established by WRC-2000; *or*

– a proposed new or modified assignment to the feeder-link List in accordance with this Appendix; *or*

– a new entry in the Regions 1 and 3 feeder-link List as a result of the successful application of Article 4 procedures. (WRC-03)

For a proposed new or modified assignment to the feeder-link List, in the interference analysis, for each test point, the antenna characteristics described in § 3.5 of Annex 3 shall apply. (WRC-03)

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[34] For the definition of the overall equivalent protection margin, see § 1.11 of Annex 5 to Appendix **30**.

[35] For the definition of the equivalent protection margin, see § 1.7 of Annex 3.

5 Limits applicable to protect a frequency assignment in the frequency bands 17.3-18.1 GHz (Regions 1 and 3) and 17.3-17.8 GHz (Region 2) to a receiving space station in the fixed-satellite service (Earth-to-space)

An administration in Region 1 or 3 is considered as being affected by a proposed modification in Region 2, with respect to § 4.2.2 *a)* or 4.2.2 *b)* of Article 4, or an administration in Region 2 is considered as being affected by a proposed new or modified assignment in the Regions 1 and 3 feeder-link List, with respect to § 4.1.1 *c)* of Article 4, when the power flux-density arriving at the receiving space station of a broadcasting-satellite feeder-link would cause an increase in the noise temperature of the feeder-link space station which exceeds the threshold value of $\Delta T/T$ corresponding to 6%, where $\Delta T/T$ is calculated in accordance with the method given in Appendix **8**, except that the maximum power densities per hertz averaged over the worst 1 MHz are replaced by power densities per hertz averaged over the necessary bandwidth of the feeder-link carriers. (WRC-03)

Interim systems of Region 2 in accordance with Resolution **42 (Rev.WRC-19)** shall not be taken into consideration when applying the above paragraph to proposed new or modified assignments in the Regions 1 and 3 feeder-link List. However, the above paragraph shall be applied to Region 2 interim systems with respect to Regions 1 and 3 administrations, referred to in § 5.2 *b)* of Resolution **42 (Rev.WRC-19)**. (WRC-19)

6 Limits applicable to protect a frequency assignment in the frequency bands 14.5-14.8 GHz and 17.8-18.1 GHz (Region 2) to a receiving feeder-link space station in the fixed-satellite service (Earth-to-space) or a frequency assignment in the frequency bands 14.5-14.75 GHz (in countries listed in Resolution 163 (WRC-15)) and 14.5-14.8 GHz (in countries listed in Resolution 164 (WRC-15)) to a receiving space station in the fixed-satellite service (Earth-to-space) not subject to a Plan (WRC-19)

With respect to § 4.1.1 *d)* of Article 4, an administration is considered affected by a proposed new or modified assignment in the Regions 1 and 3 feeder-link List when the power flux-density arriving at the receiving space station of a broadcasting-satellite feeder link in Region 2 or the receiving space station of the fixed-satellite service uplinks not subject to a Plan in all Regions of that administration would cause an increase in the noise temperature of the receiving uplink space station which exceeds the threshold value of $\Delta T/T$ corresponding to 6%, where $\Delta T/T$ is calculated in accordance with the method given in Appendix **8**, except that the maximum power densities per hertz averaged over the worst 1 MHz are replaced by power densities per hertz averaged over the necessary bandwidth of the feeder-link carriers. (WRC-15)

ANNEX 2 (REV.WRC-03)

Basic characteristics to be furnished in notices relating to feeder-link stations in the fixed-satellite service operating in the frequency bands 14.5-14.8 GHz and 17.3-18.1 GHz

These data are listed in Appendix **4**.

ANNEX 3 (REV.WRC-23)

Technical data used in establishing the provisions and associated Plans and Regions 1 and 3 feeder-link List, which should be used for their application[36] (Rev.WRC-03)

1 Definitions

1.1 Feeder link

The term feeder link, as defined in No. **1.115**, is further qualified to indicate a fixed-satellite service link in the frequency band 17.3-17.8 GHz in the Region 2 broadcasting-satellite service Plan and in the frequency bands 14.5-14.8 GHz for countries outside Europe, and 17.3-18.1 GHz in the Regions 1 and 3 Plan, from any earth station within the feeder-link service area to the associated space station in the broadcasting-satellite service.

1.2 Feeder-link beam area

The area delineated by the intersection of the half-power beam of the satellite receiving antenna with the surface of the Earth.

1.3 Feeder-link service area

The area on the surface of the Earth within the feeder-link beam area within which the administration responsible for the service has the right to locate transmitting earth stations for the purpose of providing feeder-links to broadcasting-satellite space stations.

1.4 Nominal orbital position

The longitude of a position in the geostationary-satellite orbit associated with a frequency assignment to a space station in a space radiocommunication service. The position is given in degrees from the Greenwich meridian.

[36] In revising this Annex at WRC-97 and at WRC-2000, no changes were made to the technical data applicable to the Region 2 feeder-link Plan. However, for all three Regions it should be noted that some of the parameters of networks proposed as modifications to the Region 2 feeder-link Plan and the Regions 1 and 3 feeder-link Lists may differ from the technical data presented herein. (WRC-2000)

1.5 Adjacent channel

The RF channel in the broadcasting-satellite service frequency Plan, or in the associated feeder-link frequency Plan, which is situated immediately higher or lower in frequency with respect to the reference channel.

1.6 Second adjacent channel

The RF channel in the broadcasting-satellite service frequency Plan, or in the associated feeder-link frequency Plan, which is situated immediately beyond either of the adjacent channels, with respect to the reference channel.

1.7 Feeder-link equivalent protection margin for Regions 1 and 3[37] (WRC-2000)

The feeder-link equivalent protection margin (M_u) is given by the formula:

$$M_u = -10 \log \left(10^{-M_1/10} + 10^{-M_2/10} + 10^{-M_3/10}\right) \qquad \text{dB}$$

where:

M_1: is the value in dB of the protection margin for the same channel, i.e.:

$$M_1 = \left[\frac{\text{wanted power}}{\text{sum of the co-channel interfering powers}}\right] - \text{co-channel protection ratio}$$

M_2 and M_3: are the values in dB of the protection margin for the upper and lower adjacent channels, respectively, i.e.:

$$M_2 = \left[\frac{\text{wanted power}}{\text{sum of the upper adjacent channel interfering powers}}\right] - \text{adjacent channel protection ratio}$$

$$M_3 = \left[\frac{\text{wanted power}}{\text{sum of the lower adjacent channel interfering powers}}\right] - \text{adjacent channel protection ratio}$$

All powers are evaluated at the receiver input. All protection ratios are given in § 3.3.

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[37] This quantity is used in the alternative formula for the overall equivalent protection margin given in § 1.12. However, in certain cases (e.g. when the channel spacing and/or bandwidth are different from the values given in § 3.5 and 3.8 of Annex 5 to Appendix **30**) the Bureau will use the worst-case approach until a relevant ITU-R Recommendation is incorporated in this Annex by reference. (WRC-2000)

1.8 Overall carrier-to-interference (*C*/*I*) ratio

The overall *C*/*I* ratio is the ratio of the wanted carrier power to the sum of all interfering RF powers in a given channel including both feeder-links and downlinks. The overall *C*/*I* ratio due to interference from the given channel is calculated as the reciprocal of the sum of the reciprocals of the feeder-link *C*/*I* ratio and the downlink *C*/*I* ratio referred to the satellite receiver input and earth station receiver input, respectively[38].

1.9 Overall co-channel protection margin

The overall co-channel protection margin in a given channel is the difference (dB) between the overall co-channel *C*/*I* ratio and the co-channel protection ratio.

1.10 Overall adjacent channel protection margin

The overall adjacent channel protection margin is the difference (dB) between the overall adjacent channel *C*/*I* ratio and the adjacent channel protection ratio.

1.11 Overall second adjacent channel protection margin

The overall second adjacent channel protection margin is the difference (dB) between the overall second adjacent channel *C*/*I* ratio and the second adjacent channel protection ratio.

1.12 Overall equivalent protection margin

The overall equivalent protection margin *M* is given in dB by the expression[39]:

$$M = -10 \log \left(\sum_{i=1}^{n} 10^{\left(-M_i/10\right)} \right)$$

where:

n: is generally equal to 3 for Regions 1 and 3, n is equal to 5 for Region 2

M_1: overall co-channel protection margin (dB) (as defined in § 1.9)

M_2, M_3: overall adjacent channel protection margins for the upper and lower adjacent channels, respectively (dB) (as defined in § 1.10)

M_4, M_5: overall second adjacent channel protection margins for the upper and lower second adjacent channels, respectively (dB) as defined in § 1.11).[40]

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[38] In Region 2, there are a total of five overall *C*/*I* ratios used in the analysis of the Plan, namely, co-channel, upper and lower adjacent channels and upper and lower second adjacent channels. In Regions 1 and 3, three ratios are used, namely, co-channel and upper and lower adjacent channels.

[39] This formula is also used to calculate the overall equivalent protection margin of the assignments notified, which are in conformity with this Appendix, brought into use, and for which the date of bringing into use has been confirmed to the Bureau before 27 October 1997.

[40] M_4 and M_5 are applicable only for Region 2. (WRC-2000)

The adjective "equivalent" indicates that the protection margins for all interference sources from the adjacent and second adjacent as well as co-channel interference sources have been included.

The following alternative formula for overall equivalent protection margin was used at the 1988 Conference (WARC Orb-88) in developing the original feeder-link Plan for Regions 1 and 3. It may be used as a tool to assess the relative contributions of the feeder link and downlink to the overall equivalent protection margin defined above.

$$M = -10 \log \left(10^{-(M_u + R_{cu})/10} + 10^{-(M_d + R_{cd})/10} \right) - R_{co}$$

where:

M_u: equivalent protection margin for the feeder link (as defined in § 1.7)

M_d: equivalent protection margin for the downlink (as defined in § 3.4, Annex 5 to Appendix **30**

R_{cu}: co-channel feeder-link protection ratio

R_{cd}: co-channel downlink protection ratio

R_{co}: co-channel overall protection ratio.

The values of the protection ratios used for the 1988 feeder-link Plan were as follows:

R_{cu} = 40 dB

R_{cd} = 31 dB

R_{co} = 30 dB

The adjective "equivalent" indicates that the protection margins for all interference sources from the adjacent channels as well as co-channel interference sources have been included.

The corresponding values for analysing the 1997 feeder-link Plan are:

R_{cu} = 30 dB

R_{cd} = 24 dB

R_{co} = 23 dB

However, the latter values are restricted to the case of channels having the standard channel spacing and necessary bandwidth given in § 3.5 and 3.8, respectively, of Annex 5 to Appendix **30**.

WRC-2000 generally applied the following protection ratio values for development of the WRC-2000 Regions 1 and 3 feeder-link Plan:

R_{cu} = 27 dB

R_{cd} = 21 dB (WRC-2000)

These values were used for all assignments in WRC-2000 planning except those for which WRC-2000 adopted different values (see § 3.3). The planning at WRC-2000 was based on use of the equivalent protection margin criterion. (WRC-2000)

2 Radio propagation factors

The propagation loss on an Earth-to-space path is equal to the free-space path loss plus the atmospheric absorption loss plus the rain attenuation exceeded for 1% of the worst month in Region 2. In Regions 1 and 3, the atmospheric absorption loss is not included.

2.1 Atmospheric absorption

For Region 2 (see Fig. 2)

The loss due to atmospheric absorption (i.e. clear-sky attenuation) is given by:

$$A_a = \frac{92.20}{\cos\theta}\left(0.020F_o + 0.008\rho F_w\right) \quad \text{dB} \qquad \text{for } \theta < 5°$$

where:

$$F_o = \left\{24.88 \tan\theta + 0.339\sqrt{1\,416.77 \tan^2\theta + 5.51}\right\}^{-1}$$

$$F_w = \left\{40.01 \tan\theta + 0.339\sqrt{3\,663.79 \tan^2\theta + 5.51}\right\}^{-1}$$

and:

$$A_a = \frac{0.0478 + 0.0118\rho}{\sin\theta} \quad \text{dB} \qquad \text{for } \theta \geq 5°$$

where:

θ: elevation angle (degrees)

ρ: surface water vapour concentration, g/m^3, with

ρ = 10 g/m^3 for rain climatic zones A to K and

ρ = 20 g/m^3 for rain climatic zones M to P.

For Regions 1 and 3 (see Figs. 1 and 3 taken from Recommendation ITU-R P.837-1)

In the Regions 1 and 3 feeder-link Plan, the atmospheric absorption loss is not included for the calculation of margins.

2.2 Rain attenuation

The propagation model for feeder links using circularly polarized signals is based on the value of rain attenuation for 1% of the worst month.

Figures 1, 2 and 3 give the rain climatic zones for Regions 1, 2 and 3.

Figure 4 presents a plot of rain attenuation of circularly polarized signals exceeded for 1% of the worst month at 17.5 GHz as a function of earth station latitude and elevation angle for each of the rain climatic zones in Region 2.

For calculation, the following data are needed:

$R_{0.01}$: point rainfall rate for the location exceeded for 0.01% of an average year (mm/h)

h_0: height above mean sea level of the earth station (km)

θ: elevation angle (degrees)

f: frequency (GHz)

ζ: latitude of earth station (degrees).

Mean frequencies will be used for calculations for the frequency bands, i.e. 17.7 GHz and 14.65 GHz for Regions 1 and 3, 17.5 GHz for Region 2.

The calculation procedure used for the Region 2 feeder-link Plan and for the original 1988 Regions 1 and 3 feeder-link Plan consists of the following seven steps:

Step 1: the mean zero-degree isotherm height h_F is:

$$h_F = 5.1 - 2.15 \log \left[1 + 10^{\frac{(|\zeta| - 27)}{25}} \right] \quad \text{km}$$

Step 2: the rain height h_R is:

$$h_R = C \cdot h_F \quad \text{km}$$

where:

$C = 0.6$ for $0° \leq |\zeta| < 20°$

$C = 0.6 + 0.02\,(|\zeta| - 20)$ for $20° \leq |\zeta| < 40°$

$C = 1$ for $|\zeta| \geq 40°$

Step 3: the slant-path length, L_s, below the rain height is:

$$L_s = \frac{2(h_R - h_0)}{\left[\sin^2 \theta + 2\frac{(h_R - h_0)}{R_e} \right]^{1/2} + \sin \theta} \quad \text{km}$$

where R_e is the effective radius of the Earth (8 500 km).

Step 4: the horizontal projection, L_G, of the slant-path is:

$$L_G = L_s \cos \theta \quad \text{km}$$

Step 5: the rain path reduction factor $r_{0.01}$, for 0.01% of the time is:

$$r_{0.01} = \frac{90}{90 + 4L_G}$$

Step 6: the specific attenuation γ_R is determined from:

$$\gamma_R = k\left(R_{0.01}\right)^{\alpha} \qquad \text{dB/km}$$

where $R_{0.01}$ is given in Table 1 for each rain climatic zone. The frequency dependent coefficients k and α are given in Table 2 and the rain climatic zones are given in Figs. 1, 2 and 3 for Regions 1, 2 and 3.

TABLE 1

Rainfall intensity (R) for the rain climatic zones (exceeded for 0.01% of an average year)

Rain climatic zone	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**P**	**Q**
Rainfall intensity (mm/h)	8	12	15	19	22	28	30	32	35	42	60	63	95	145	115

TABLE 2

Frequency dependent coefficients

Frequency (GHz)	***k***	**α**	
14.65	0.0327	1.149	For Regions 1 and 3
17.5	0.0521	1.114	For Region 2
17.7	0.0531	1.110	For Regions 1 and 3

Step 7: the attenuation exceeded for 1% of the worst month is:

$$A_{1\%} = 0.223\,\gamma_R\,L_s\,r_{0.01} \quad \text{dB} \quad \text{for Regions 1 and 3}$$

$$A_{1\%} = 0.21\,\gamma_R\,L_s\,r_{0.01} \quad \text{dB} \quad \text{for Region 2.}$$

For calculation of the permissible increase in e.i.r.p. to overcome rain fading (power control, see § 3.11.1) in the Regions 1 and 3 Plan revised by WRC-97, the same calculation procedure is used with the following changes to conform to Recommendation ITU-R P.618-5.

To calculate the rain height h_R, Steps 1 and 2 are replaced by:

$$h_R = \begin{cases} 5 - 0.075\left(\zeta - 23\right) & \text{for} \quad \zeta > 23^\circ \quad \text{Northern Hemisphere} \\ 5 & \text{for} \quad 0^\circ \le \zeta \le 23^\circ \quad \text{Northern Hemisphere} \\ 5 & \text{for} \quad 0^\circ \ge \zeta \ge -21^\circ \quad \text{Southern Hemisphere} \\ 5 + 0.1\left(\zeta + 21\right) & \text{for} \quad -71^\circ \le \zeta < -21^\circ \quad \text{Southern Hemisphere} \\ 0 & \text{for} \quad \zeta < -71^\circ \quad \text{Southern Hemisphere} \end{cases}$$

Steps 3 and 4 remain the same. However, to calculate the rain path reduction factor $r_{0.01}$, for 0.01% of the time, the equation of Step 5 is replaced by:

$$r_{0.01} = \frac{1}{1 + L_G/L_0}$$

where:

$$L_0 = 35 \exp(-0.015\, R_{0.01})$$

and $R_{0.01}$ is given in Table 1 for each rain climatic zone.

Step 6 remains the same except the frequency dependent coefficients k and α shall be obtained from Recommendation ITU-R P.838-3. (WRC-07)

Step 7 should be replaced as follows:

$$\frac{A_p}{A_{0.01}} = 0.12\, p^{-(0.546 + 0.043 \log p)}$$

where:

$$p\,(\%) = 0.30\, p_w\,(\%)^{1.15} \qquad \text{(Recommendation ITU-R P.841)}$$

p is the average annual time percentage of excess corresponding to desired worst-month time percentage of excess p_w.

2.3 Rain attenuation limit

In the analysis of the Plan for Region 2, a maximum rain attenuation on the feeder link of 13 dB was considered assuming that other means would be used at the implementation stage to compensate for larger rain attenuation on the feeder link.

In the analysis of the Regions 1 and 3 Plan, no rain attenuation is included in the margins.

2.4 Depolarization

Rain and ice can cause depolarization of radio frequency signals. The level of the co-polar component relative to the depolarized component is given by the cross-polarization discrimination (XPD) ratio. For the feeder link, the XPD ratio (dB) not exceeded for 1% of the worst month, is given by:

$$XPD = 30 \log f - 40 \log(\cos\theta) - V \log A_p \qquad \text{for } 5° \le \theta \le 60°$$

where:

$$V = 20 \qquad \text{for 14.5-14.8 GHz}$$

and

$$V = 23 \qquad \text{for 17.3-18.1 GHz}$$

where:

A_p : co-polar rain attenuation exceeded for 1% of the worst month

f : frequency (GHz)

θ : elevation angle (degrees).

To calculate the depolarization value to be used for power control in the Regions 1 and 3 Plan, the following algorithm (Steps 1 to 8), which was obtained from Recommendation ITU-R P.618-5, shall be used.

To calculate long-term statistics of depolarization from rain attenuation statistics the following parameters are needed:

A_p: rain attenuation (dB) exceeded for the required percentage of time, p, for the path in question, commonly called co-polar attenuation (CPA)

τ: tilt angle of the linearly-polarized electric field vector with respect to the horizontal (for circular polarization use $\tau = 45°$)

f: frequency (GHz)

θ: path elevation angle (degrees).

The method described below to calculate XPD statistics from rain attenuation statistics for the same path is valid for 8 GHz $\leq f \leq$ 35 GHz and $\theta \leq 60°$.

Step 1: calculate the frequency-dependent term:

$$C_f = 30 \log f \qquad \text{for} \qquad 8 \text{ GHz} \leq f \leq 35 \text{ GHz}$$

Step 2: calculate the rain attenuation dependent term:

$$C_A = V(f) \log A_p$$

where:

$$V(f) = 12.8 f^{0.19} \qquad \text{for} \qquad 8 \text{ GHz} \leq f \leq 20 \text{ GHz}$$

$$V(f) = 22.6 \qquad \text{for} \qquad 20 \text{ GHz} < f \leq 35 \text{ GHz}$$

Step 3: calculate the polarization improvement factor:

$$C_\tau = -10 \log [1 - 0.484 (1 + \cos 4\tau)]$$

The improvement factor $C_\tau = 0$ for $\tau = 45°$ and reaches a maximum value of 15 dB for $\tau = 0°$ or 90°.

Step 4: calculate the elevation angle dependent term:

$$C_\theta = -40 \log (\cos \theta) \qquad \text{for} \qquad \theta \leq 60°$$

Step 5: calculate the canting angle dependent term:

$$C_\sigma = 0.0052\, \sigma^2$$

σ is the effective standard deviation of the raindrop canting angle distribution, expressed in degrees; σ takes the value 0°, 5°, 10° and 15° for 1%, 0.1%, 0.01% and 0.001% of the time, respectively.

Step 6: calculate rain XPD not exceeded for p% of the time:

$$XPD_{rain} = C_f - C_A + C_\tau + C_\theta + C_\sigma \qquad \text{dB}$$

Step 7: calculate the ice crystal dependent term:

$$C_{ice} = XPD_{rain} (0.3 + 0.1 \log p)/2 \qquad \text{dB}$$

Step 8: calculate the XPD not exceeded for p% of the time, including the effects of ice:

$$XPD_p = XPD_{rain} - C_{ice} \qquad \text{dB}$$

For values of θ greater than 60°, use $\theta = 60°$ in the above equations.

FIGURE 1

Rain-climatic zones for Regions 1 and 3 between longitudes 45° W and 105° E

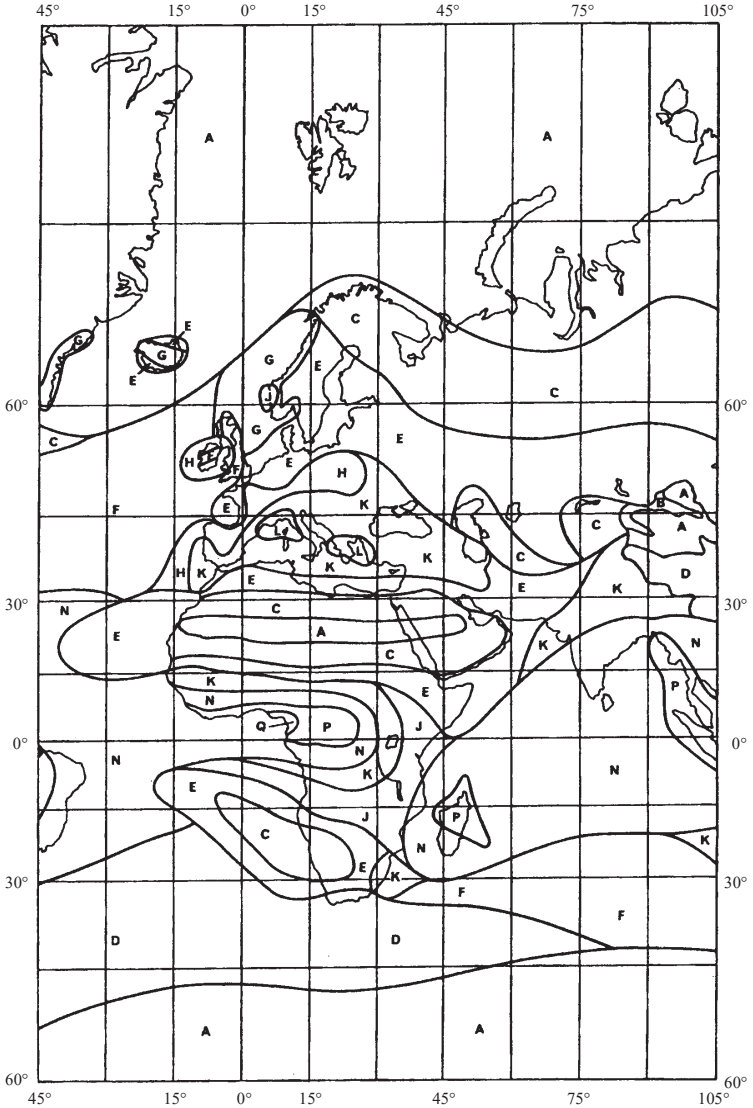


FIGURE 2

Rain-climatic zones (Region 2)

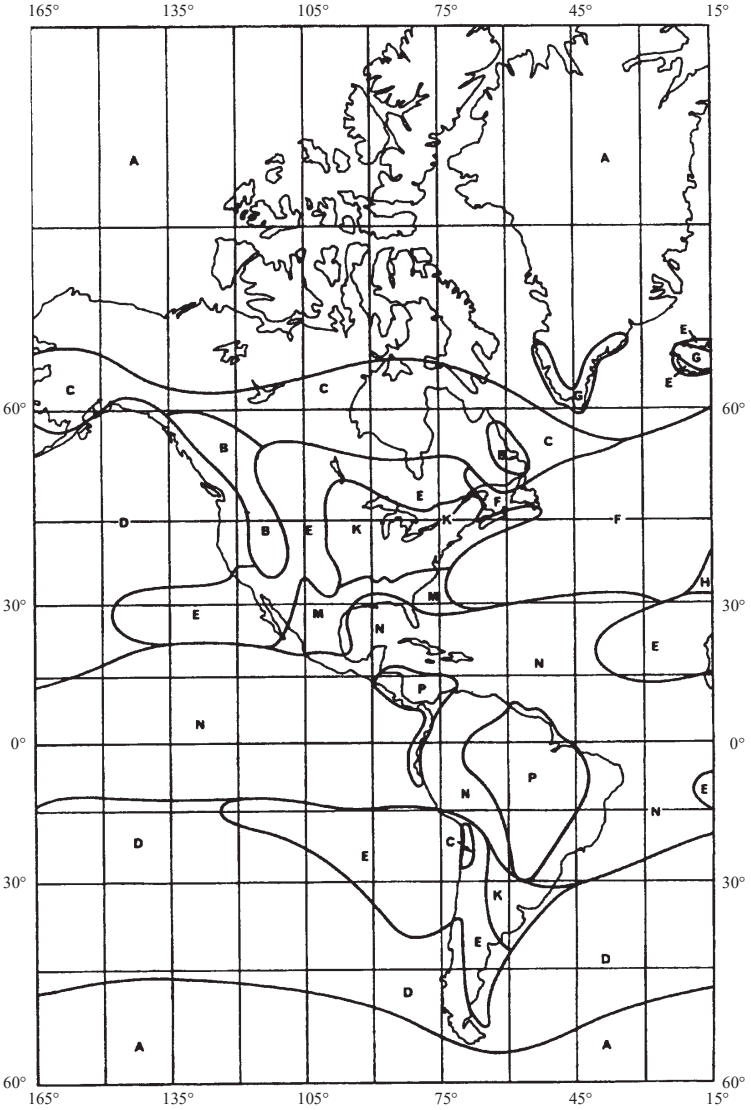


FIGURE 3

Rain-climatic zones for Regions 1 and 3 between longitudes 60° E and 150° W

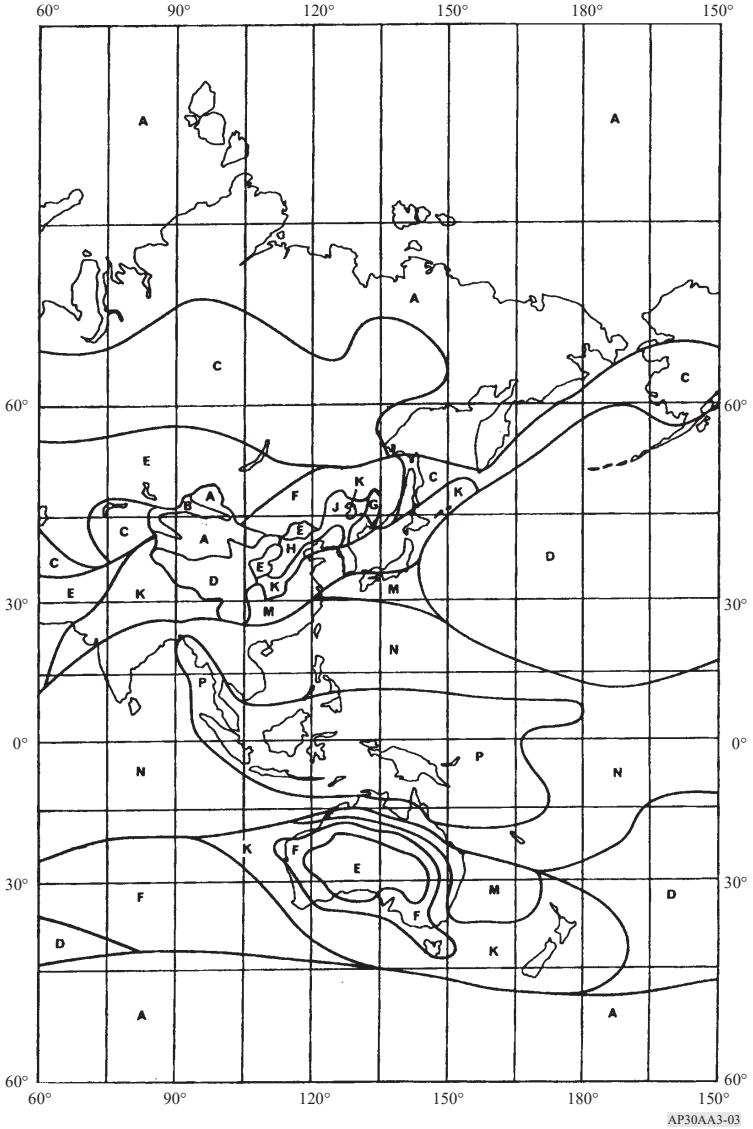


FIGURE 4

Rain attenuation values exceeded for 1% of the worst month (sea level) for Region 2 rain-climatic zones

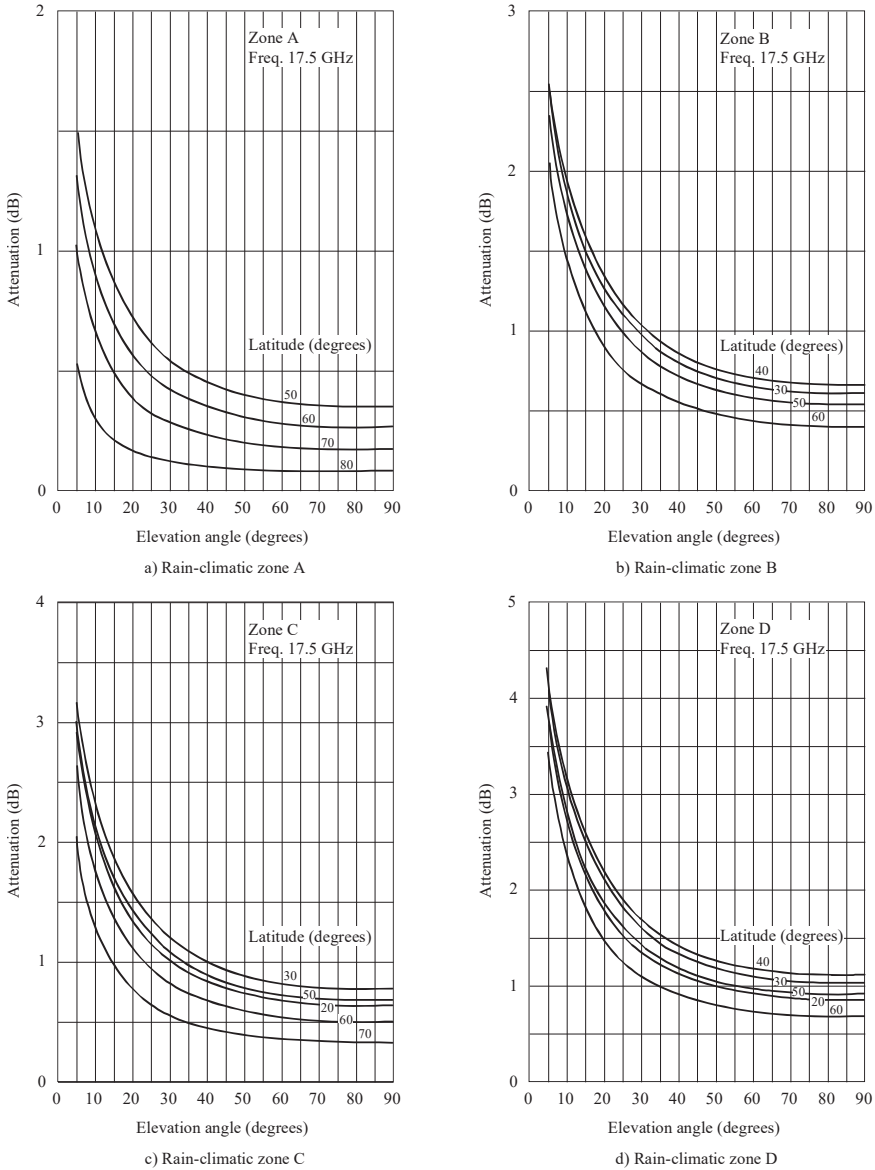
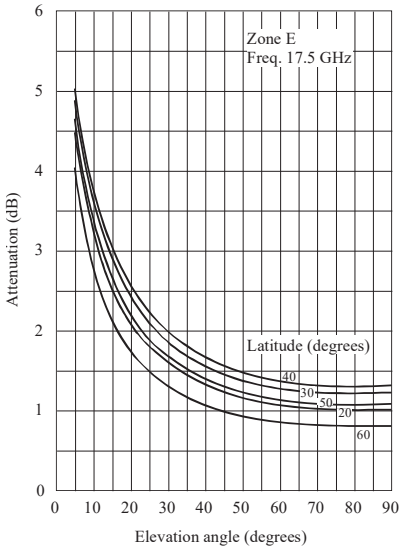
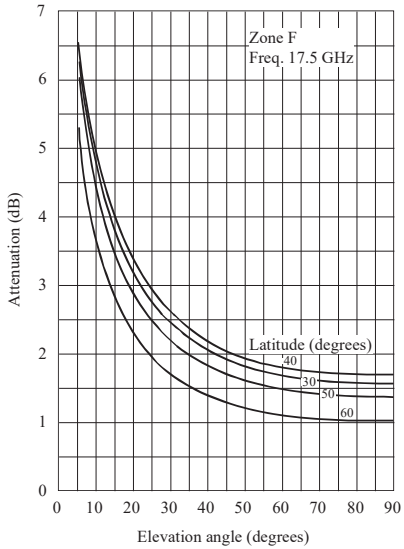


FIGURE 4 (*continued*)

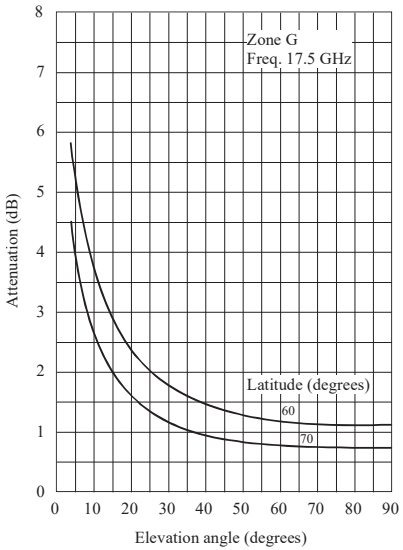
Rain attenuation values exceeded for 1% of the worst month (sea level) for Region 2 rain-climatic zones



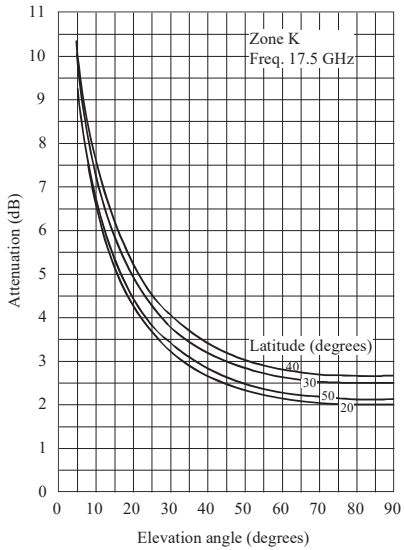
e) Rain-climatic zone E



f) Rain-climatic zone F



g) Rain-climatic zone G



h) Rain-climatic zone K

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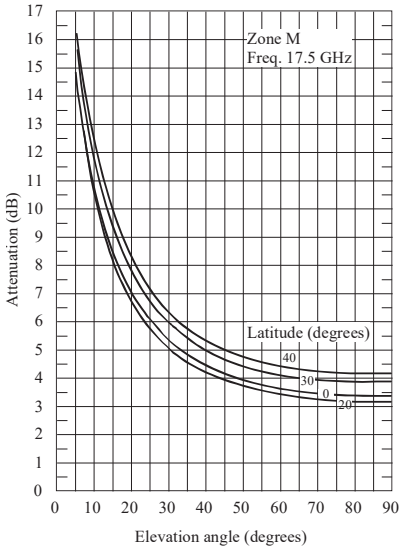
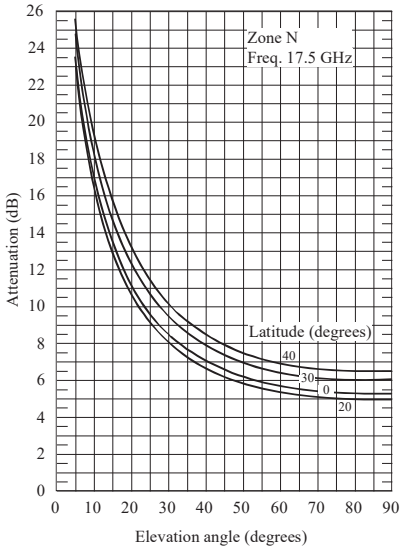
FIGURE 4 (*continued*)

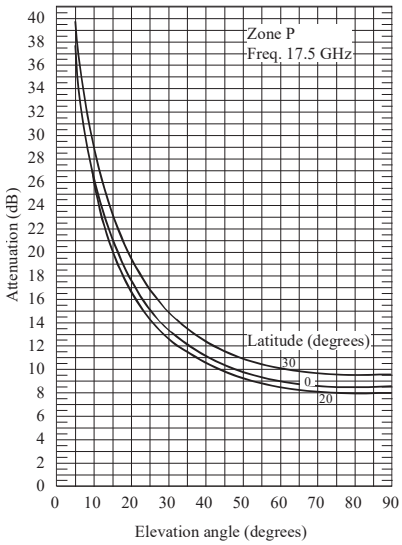
Rain attenuation values exceeded for 1% of the worst month (sea level) for Region 2 rain-climatic zones



i) Rain-climatic zone M



j) Rain-climatic zone N



k) Rain-climatic zone P

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2.5 Procedure for calculating the *C*/*I* ratio at a space station receiver input

In Region 2, the calculation of the feeder-link *C*/*I* ratio (exceeded for 99% of the worst month) at a space station receiver input used to obtain the overall equivalent protection margin at a test point assumes a rain attenuation value not exceeded for 99% of the worst month on the wanted feeder-link path. For the interfering feeder-link signal path, clear sky propagation (i.e., including atmospheric absorption only) is assumed.

In Regions 1 and 3, the calculation of the feeder-link *C*/*I* ratio at a space station receiver input used to obtain the feeder-link equivalent protection margin at a test point assumes free space conditions on the wanted feeder-link path and on the interfering feeder-link path.

3 Basic technical characteristics for Regions 1 and 3

3.1 Translation frequency and guardbands

a) 17 GHz feeder-links

The feeder-link Plan generally uses a frequency translation of 5.6 GHz between the 17 GHz feeder-link channels and the 12 GHz downlink channels. Other values of the translation frequency may be used, provided that the corresponding channels have been assigned to the space station of the administration concerned.

With the value of frequency translation between the feeder-link frequency band (17.3-18.1 GHz in Regions 1 and 3) and the downlink frequency band (11.7-12.5 GHz in Region 1 and 11.7-12.2 GHz in Region 3), the guardbands specified in § 3.9 of Annex 5 to Appendix **30** for the downlink Plan result in corresponding guardband bandwidths of 11 MHz at the upper and 14 MHz at the lower feeder-link band edges. These feeder-link guardbands may be used to provide space operation functions in accordance with No. **1.23** in support of the operation of geostationary-satellite networks in the broadcasting-satellite service. (WRC-03)

b) 14 GHz feeder-links

As the maximum available bandwidth for the feeder-link band 14.5-14.8 GHz is only 300 MHz divided into fourteen 27 MHz channels, against 800 MHz (40 channels) and 500 MHz (24 channels) in the downlink Plan for Regions 1 and 3, respectively, several translation frequencies must be considered to allow any channel in the Plan to be used. Consequently, a particular feeder-link channel has been assigned to several broadcasting-satellite service Plan channels simultaneously.

Generally, the translation frequencies from the feeder-link channels are:

2 797.82 MHz to downlink broadcasting-satellite service channels 1 to 14;

2 529.30 MHz to downlink broadcasting-satellite service channels 15 to 28;

2 260.78 MHz to downlink broadcasting-satellite service channels 29 to 40.

The guardband bandwidths are 11.80 MHz at the lower band edge and 11.86 MHz at the upper band edge.

c) Frequency translation rules

Specific rules for selecting appropriate frequency translations are given in § 6.2.1.2.2 and 6.2.1.3.3 of the 1985 Conference (WARC Orb-85) Report to the 1988 Conference (WARC Orb-88). These rules permit the derivation of simple-to-use tables that define the channel translations that were avoided in revising the Regions 1 and 3 feeder-link Plan for both the 14 GHz and 17 GHz bands (see Tables 3 and 4).

TABLE 3

14.5-14.8 GHz/11.7-12.5 GHz channel translations that should be avoided (as far as possible) according to the 1985 Conference frequency translation rules

14 GHz feeder-link channel number	Downlink channel numbers to be avoided (as far as possible)				
1	7	8	9	19	20
2	8	9	10	20	21
3	9	10	11	21	22
4	10	11	12	22	23
5	11	12	13	23	24
6	12	13	14	24	25
7	13	14	15	25	26
8	14	15	16	26	27
9	15	16	17	27	28
10	16	17	18	28	29
11	17	18	19	29	30
12	18	19	20	30	31
13	19	20	21	31	32
14	20	21	22	32	33

TABLE 4

17.3-18.1 GHz/11.7-12.5 GHz channel translations that should be avoided (as far as possible) according to the 1985 Conference frequency translation rules

17 GHz feeder-link channel number	Downlink channel numbers to be avoided (as far as possible)																													
1			10	11	12	13	14	15	16	17	18	19	20	21	22															
2			11	12	13	14	15	16	17	18	19	20	21	22	23															
3			12	13	14	15	16	17	18	19	20	21	22	23	24															
4			13	14	15	16	17	18	19	20	21	22	23	24	25															
5			14	15	16	17	18	19	20	21	22	23	24	25	26															
6			15	16	17	18	19	20	21	22	23	24	25	26	27															
7			16	17	18	19	20	21	22	23	24	25	26	27	28															
8			17	18	19	20	21	22	23	24	25	26	27	28	29															
9			18	19	20	21	22	23	24	25	26	27	28	29	30															
10	1			19	20	21	22	23	24	25	26	27	28	29	30	31														
11	1	2			20	21	22	23	24	25	26	27	28	29	30	31	32													
12	1	2	3			21	22	23	24	25	26	27	28	29	30	31	32	33												
13	1	2	3	4			22	23	24	25	26	27	28	29	30	31	32	33	34											
14	1	2	3	4	5			23	24	25	26	27	28	29	30	31	32	33	34	35										
15	1	2	3	4	5	6			24	25	26	27	28	29	30	31	32	33	34	35	36									
16	1	2	3	4	5	6	7			25	26	27	28	29	30	31	32	33	34	35	36	37								
17	1	2	3	4	5	6	7	8			26	27	28	29	30	31	32	33	34	35	36	37	38							
18	1	2	3	4	5	6	7	8	9			27	28	29	30	31	32	33	34	35	36	37	38	39						
19	1	2	3	4	5	6	7	8	9	10			28	29	30	31	32	33	34	35	36	37	38	39	40					
20	1	2	3	4	5	6	7	8	9	10	11			29	30	31	32	33	34	35	36	37	38	39	40					
21	1	2	3	4	5	6	7	8	9	10	11	12			30	31	32	33	34	35	36	37	38	39	40					
22	1	2	3	4	5	6	7	8	9	10	11	12	13			31	32	33	34	35	36	37	38	39	40					
23	1	2	3	4	5	6	7	8	9	10	11	12	13	14			32	33	34	35	36	37	38	39	40					
24		2	3	4	5	6	7	8	9	10	11	12	13	14	15			33	34	35	36	37	38	39	40					
25			3	4	5	6	7	8	9	10	11	12	13	14	15	16			34	35	36	37	38	39	40					
26				4	5	6	7	8	9	10	11	12	13	14	15	16	17			35	36	37	38	39	40					
27					5	6	7	8	9	10	11	12	13	14	15	16	17	18			36	37	38	39	40					
28						6	7	8	9	10	11	12	13	14	15	16	17	18	19			37	38	39	40					
29							7	8	9	10	11	12	13	14	15	16	17	18	19	20			38	39	40					
30								8	9	10	11	12	13	14	15	16	17	18	19	20	21			39	40					
31									9	10	11	12	13	14	15	16	17	18	19	20	21	22			40					
32										10	11	12	13	14	15	16	17	18	19	20	21	22	23							
33											11	12	13	14	15	16	17	18	19	20	21	22	23	24						
34												12	13	14	15	16	17	18	19	20	21	22	23	24	25					
35													13	14	15	16	17	18	19	20	21	22	23	24	25	26				
36														14	15	16	17	18	19	20	21	22	23	24	25	26	27			
37															15	16	17	18	19	20	21	22	23	24	25	26	27	28		
38																16	17	18	19	20	21	22	23	24	25	26	27	28	29	
39																	17	18	19	20	21	22	23	24	25	26	27	28	29	30
40																		18	19	20	21	22	23	24	25	26	27	28	29	30 31

3.2 Carrier-to-noise ratio

§ 3.3 of Annex 5 to Appendix **30** provides guidance for planning and the basis for the evaluation of the carrier-to-noise (*C*/*N*) ratios of the feeder-link and downlink Plans.

As guidance for planning, the reduction in quality in the downlink due to thermal noise in the feeder-link is taken as equivalent to a degradation in the downlink *C*/*N* ratio of approximately 0.5 dB not exceeded for 99% of the worst month.

For downlinks, as indicated in Appendix **30**, the 1977 Conference (WARC SAT-77) adopted a *C*/*N* value of 14.5 dB for 99% of the worst month at the edge of the service area. The required feeder-link *C*/*N* is 24 dB for 99% of the worst month, at the edge of the service area, to produce an overall *C*/*N* performance of 14 dB.

3.3 Protection ratios

For planning in Regions 1 and 3 at the 1988 Conference (WARC Orb-88), the following protection ratios were applied for the purpose of calculating the feeder-link equivalent protection margins[41]:

– co-channel protection ratio = 40 dB;

– adjacent channel protection ratio = 21 dB.

The method for the calculation of the feeder-link equivalent protection margin is given in § 1.7.

For revising the Regions 1 and 3 feeder-link Plan at WRC-97, the corresponding values of aggregate protection ratio that were used to calculate the feeder-link equivalent protection margins which appear in the alternative formula for overall equivalent protection margin given in § 1.12 are specified in Recommendation ITU-R BO.1297, as follows[42, 43]:

– co-channel protection ratio = 30 dB;

– adjacent channel protection ratio = 22 dB. (WRC-2000)

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[41] These protection ratio values were used for assignments notified, which are in conformity with this Appendix, brought into use, and for which the date of bringing into use has been confirmed to the Bureau before 27 October 1997.

[42] These protection ratio values were used for assignments notified, which are in conformity with this Appendix, brought into use, and for which the date of bringing into use has been confirmed to the Bureau between 27 October 1997 and 12 May 2000. (WRC-2000)

[43] These protection ratio values were used for protection of digital and analogue assignments from analogue emissions. (WRC-2000)

However, it should be noted that the revision of the Regions 1 and 3 feeder-link Plan by WRC-97 was based on "simultaneous planning of feeder links and downlinks with calculation of overall equivalent protection margins" (as defined in § 1.11 of Annex 5 to Appendix **30** and in § 1.12) using the following values of aggregate protection ratio:

– co-channel = 23 dB;

– adjacent channel = 15 dB. (WRC-03)

It was also specified that, for the revision of the Regions 1 and 3 feeder-link Plan, no overall co-channel single entry *C*/*I* ratio should be lower than 28 dB. (WRC-03)

Nevertheless, for assignments notified, which are in conformity with this Appendix, brought into use, and for which the date of bringing into use has been confirmed to the Bureau before 27 October 1997, the overall equivalent protection margins were calculated using a co-channel overall protection ratio of 30 dB and lower and upper overall adjacent channel protection ratios of 14 dB.

Revision of the Regions 1 and 3 feeder-link Plan at WRC-97 and planning at WRC-2000 were generally based on a set of reference parameters such as the average e.i.r.p., the reference earth station transmitting antenna, all test points placed within the −3 dB contour, a bandwidth of 27 MHz and the predetermined value of *C*/*N*. The Regions 1 and 3 feeder-link Plan as established by WRC-2000 is generally based on the use of digital modulation. (WRC-2000)

WRC-2000 adopted for the protection of digital assignments from digital emissions the following protection ratio values to be applied for calculation of feeder-link equivalent protection margins of the WRC-2000 Regions 1 and 3 feeder-link Plan:

– 27 dB for co-channel signals;

– 22 dB for adjacent channel signals. (WRC-2000)

During planning at WRC-2000, these values were used for all assignments of the Regions 1 and 3 feeder-link Plan and List, except those for which WRC-2000 adopted different values to be used in the planning process[44]. (WRC-03)

Protection masks and associated calculation methods for interference into broadcasting-satellite systems involving digital emissions shall be in accordance with Recommendation ITU-R BO.1293-2 (Annexes 1 and 2[45]). (WRC-03)

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[44] For analogue assignments, the protection ratios of WRC-97 (30 dB co-channel, 22 dB adjacent channel) were used. (WRC-2000)

[45] Annex 3 of this Recommendation may be applied only in compatibility analysis for bilateral coordination between administrations. (WRC-03)

3.4 Feeder-link e.i.r.p.

The level of e.i.r.p. of each feeder link is specified in Article 9A.

The level of e.i.r.p. specified in the Plan can only be exceeded under certain conditions explained in § 3.11 of this Annex (see also Article 5, § 5.1.1).

3.5 Transmitting antenna

3.5.1 Antenna diameter

The feeder-link Plan is based on an antenna diameter of 5 m for the band 17.3-18.1 GHz and 6 m for the band 14.5-14.8 GHz.

For all antenna diameters including antennas smaller than 5 m for the 17.3-18.1 GHz band and 6 m for the 14.5-14.8 GHz band, the off-axis e.i.r.p. shall not exceed the limits indicated by Curve A in Fig. A of § 3.5.3 of this Annex for assignments notified, which are in conformity with this Appendix, brought into use, and for which the date of bringing into use has been confirmed to the Bureau before 27 October 1997 and by the Curve A′ of Fig. A for other assignments.

3.5.2 On-axis gain

The on-axis gain for the 5 m antenna at 17.3-18.1 GHz and for the 6 m antenna at 14.5-14.8 GHz is taken as 57 dBi.

3.5.3 Off-axis e.i.r.p. of transmitting antennas

The co-polar and cross-polar off-axis e.i.r.p. values used for the original 1988 feeder-link Plan in Regions 1 and 3 are shown by Curves A and B respectively in Fig. A[46].

The corresponding off-axis e.i.r.p. values used for planning at WRC-97 are shown by Curves A′ and B′ in Fig. A as specified in Recommendation ITU-R BO.1295.

3.5.4 Pointing accuracy

The Plan has been developed to accommodate a loss in gain of 1 dB due to earth station antenna mispointing.

The deviation of the antenna beam from its nominal pointing direction must not exceed a limit of 0.1° in any direction. Moreover, the angular rotation of the receiving beam about its axis must not exceed a limit of ±1°; the limit on rotation is not necessary for beams of circular cross section using circular polarization.

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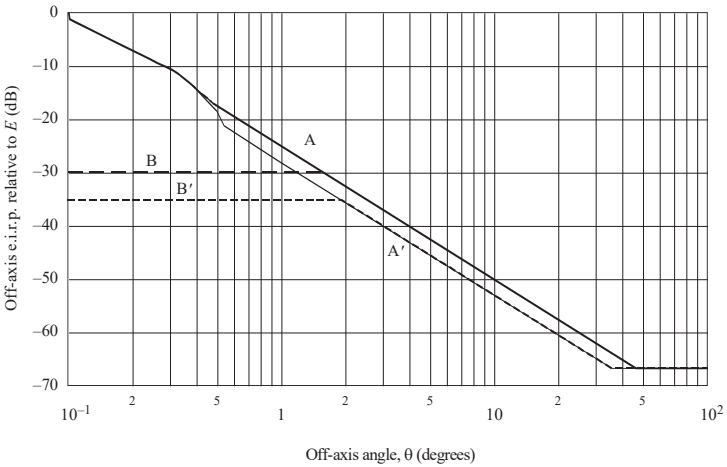
[46] This antenna pattern is used in the revision of the Regions 1 and 3 Plan for assignments notified, which are in conformity with this Appendix, brought into use, and for which the date of bringing into use has been confirmed to the Bureau before 27 October 1997.

FIGURE A

Earth station e.i.r.p. at off-axis antenna angles



Curves A: WARC Orb-88 Regions 1 and 3 co-polar
A′: WRC-97 co-polar
B: WARC Orb-88 Regions 1 and 3 cross-polar
B′: WRC-97 cross-polar

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Co-polar component (dBW):

Curve A (WARC Orb-88)			*Curve A′* (WRC-97)		
E	for	$0° \leq \theta \leq 0.1°$	E	for	$0° \leq \theta \leq 0.1°$
$E - 21 - 20 \log \theta$	for	$0.1° < \theta \leq 0.32°$	$E - 21 - 20 \log \theta$	for	$0.1° < \theta \leq 0.32°$
$E - 5.7 - 53.2\, \theta^2$	for	$0.32° < \theta \leq 0.44°$	$E - 5.7 - 53.2\, \theta^2$	for	$0.32° < \theta \leq 0.54°$
$E - 25 - 25 \log \theta$	for	$0.44° < \theta \leq 48°$	$E - 28 - 25 \log \theta$	for	$0.54° < \theta \leq 36.31°$
$E - 67$	for	$48° < \theta$	$E - 67$	for	$36.31° < \theta$

Cross-polar component (dBW): (WRC-03)

Curve B (WARC Orb-88)			*Curve B′* (WRC-97)		
$E - 30$	for	$0° \leq \theta \leq 1.6°$	$E - 35$	for	$0° \leq \theta \leq 1.91°$
$E - 25 - 25 \log \theta$	for	$1.6° < \theta \leq 48°$	$E - 28 - 25 \log \theta$	for	$1.91° < \theta \leq 36.31°$
$E - 67$	for	$48° < \theta$	$E - 67$	for	$36.31° < \theta$

where:

E : earth station e.i.r.p. on the antenna axis (dBW);

θ : off-axis angle referred to the main lobe axis (degrees).

3.6 Transmitter power

The maximum transmitter power delivered to the input of the antenna of the feeder-link earth station per 27 MHz television channel shall be such as to ensure that the e.i.r.p. envelope in § 3.5.3 is not exceeded except under certain conditions specified in § 3.11.

3.7 Satellite receiving antenna

3.7.1 Cross-section of receiving antenna beam

Planning has generally been based on beams of elliptical or circular cross-section. When the assignments are implemented, or when the Plan is modified, administrations may use non-elliptical (shaped) beams as described in Annex 2.

For planning purposes at WRC-97, an antenna diameter of 5 m for the band 17.3-18.1 GHz and 6 m for the band 14.5-14.8 GHz were assumed.

The on-axis gain for the 5 m antenna at 17.3-18.1 GHz and for the 6 m antenna at 14.5-14.8 GHz is taken as 57 dBi.

If the cross-section of the receiving antenna beam is elliptical, the effective beamwidth φ_0 is a function of the angle of rotation q between the plane containing the satellite and the major axis of the beam cross-section and the plane in which the beamwidth is required.

The relationship between the maximum gain of an antenna and the half-power beamwidth can be derived from the expression:

$$G_m = 27\,843/ab$$

where:

a and b are the angles (degrees) subtended at the satellite by the major and minor axes of the elliptical cross-section of the beam. An antenna efficiency of 55% is assumed.

3.7.2 Minimum beamwidth

A minimum value of 0.6° for the half-power beamwidth of the receiving antenna has been used for planning.

3.7.3 Reference patterns

The reference patterns for the co-polar and cross-polar components of the satellite receiving antenna used for planning at the 1988 Conference (WARC Orb-88) are given by Curves A and B respectively in Fig. B[47].

The corresponding curves used for replanning at WRC-97 are given by Curves A′ and B′ in Fig. B, as specified in Recommendation ITU-R BO.1296.

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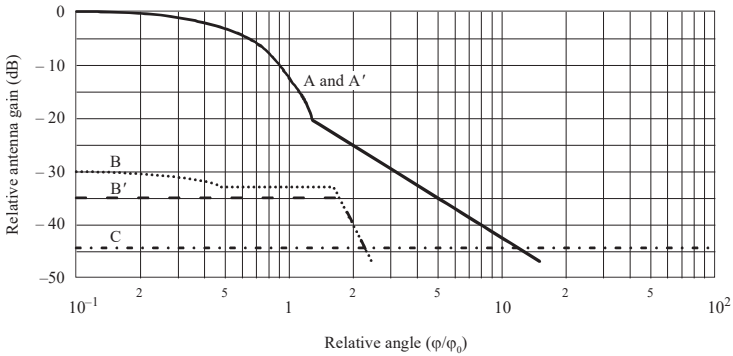
[47] See footnote 46.

FIGURE B

Receiving space station circularly polarized antenna co-polar and cross-polar reference patterns for elliptical beams for planning in Regions 1 and 3



Curves A and A′: WARC Orb-88 and WRC-97 co-polar

B: WARC Orb-88 cross-polar

B′: WRC-97 cross-polar

C: Curve C (minus the on-axis gain)

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Co-polar relative gain (dB):

Curve A (WARC Orb-88) and *Curve A′* (WRC-97):

$G = -12\ (\varphi/\varphi_0)^2$ for $0 \le \varphi/\varphi_0 < 1.3$

$G = -17.5 - 25 \log (\varphi/\varphi_0)$ for $1.3 \le \varphi/\varphi_0$

After intersection with Curve C, as Curve C

Cross-polar relative gain (dB):

Curve B (WARC Orb-88)

$G = -30 - 12\ (\varphi/\varphi_0)^2$ for $0 \le \varphi/\varphi_0 \le 0.5$

$G = -33$ for $0.5 < \varphi/\varphi_0 \le 1.67$

$G = -40 - 40 \log \left(\frac{\varphi}{\varphi_0} - 1 \right)$ for $1.67 \le \varphi/\varphi_0$

After intersection with Curve C, as Curve C

Curve B′ (WRC-97)

$G = -35$ for $0 \le \varphi/\varphi_0 < 1.75$

$G = -40 - 40 \log \left(\frac{\varphi}{\varphi_0} - 1 \right)$ for $1.75 \le \varphi/\varphi_0$

After intersection with Curve C, as Curve C

Curve C: minus the on-axis gain (Curve C in the above Figure illustrates the particular case of an antenna with an on-axis gain of 44.44 dBi)

where:

φ: off-axis angle (degrees)

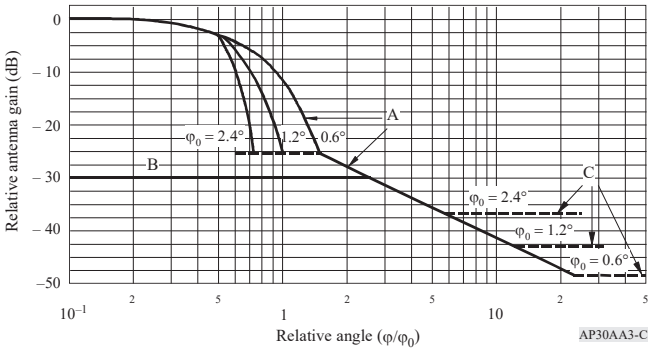
φ_0: cross-sectional half-power beamwidth in the direction of interest (degrees).

The relationship between the maximum gain of an antenna and the half-power beamwidth can be derived from the expression in § 3.7.1.

In some cases, to reduce co-polar interference, the pattern shown in Fig. C is used; this use is indicated in the Plan by note 1. This pattern is derived from an antenna producing an elliptical beam with fast roll-off in the main lobe assuming a "beamlet" beamwidth of 0.6°. Three curves for different values of φ_0 are shown as examples.

FIGURE C

Reference patterns for co-polar and cross-polar components for satellite receiving antennas with fast roll-off in the main beam for Regions 1 and 3



Curve A: co-polar component (dB relative to main beam gain)

$-12\,(\varphi/\varphi_0)^2$	for	$0 \le \varphi/\varphi_0 \le 0.5$
$-33.33\,\varphi_0^2\left(\frac{\varphi}{\varphi_0} - x\right)^2$	for	$0.5 < \varphi/\varphi_0 \le \frac{0.87}{\varphi_0} + x$
-25.23	for	$\frac{0.87}{\varphi_0} + x < \varphi/\varphi_0 \le 1.45$
$-(22 + 20 \log(\varphi/\varphi_0))$	for	$\varphi/\varphi_0 > 1.45$

after intersection with Curve C, as Curve C.

Curve B: cross-polar component (dB relative to main beam gain)

-30	for	$0 \le \varphi/\varphi_0 < 2.51$

after intersection with Curve A, as Curve A.

Curve C: minus the on-axis gain (curves A and C represent examples for three antennas having different values of φ_0 as labelled in Fig. C. The on-axis gains of these antennas are 37, 43 and 49 dBi, respectively),

where:

φ: off-axis angle (degrees);

φ_0: dimension of the minimum ellipse fitted around the feeder-link service area in the direction of interest (degrees);

$$x = 0.5\left(1 - \frac{0.6}{\varphi_0}\right)$$

3.7.4 Pointing accuracy

The deviation of the receiving antenna beam from its nominal pointing direction must not exceed 0.1° in any direction. Moreover, the angular rotation of the receiving beam about its axis must not exceed ±1°; this limit is not necessary for beams of circular cross-section using circular polarization.

3.7.5 Composite beam (WRC-2000)

A composite beam represents a single beam (i.e. "simulated shaped beam") and is formed by combining two or more elliptical beams at a given orbital position. In general, composite beams were used at WRC-2000 for administrations which had more than one beam at a given orbital position in the WRC-97 Regions 1 and 3 feeder-link Plan. (WRC-2000)

3.8 System noise temperature

The satellite system noise temperature values generally used in the Plan at the 1988 Conference (WARC Orb-88) are 1 800 K for 17 GHz and 1 500 K for 14 GHz[48]. For revising the Regions 1 and 3 Plan at WRC-97 these values are 900 K for 17 GHz and 750 K for 14 GHz. A value of 600 K was used for the 17 GHz band in the revision of the Regions 1 and 3 Plan at WRC-2000. WRC-2000 did not change the value for the 14 GHz band. (WRC-03)

3.9 Polarization

In Regions 1 and 3, circular polarization was normally used for the purpose of planning the feeder-links.

For the definitions of the terms "direct and indirect polarization", see § 3.2.3 of Annex 5 to Appendix **30**.

For the planning of the broadcasting-satellite service, circular polarization is generally used. However, for implementation of assignments in the Regions 1 and 3 Plan, linear polarization may also be used subject to successful application of the modification procedure of Article 4. Linear polarization is defined in the most recent version of Recommendation ITU-R BO.1212. This Recommendation should be used when analysing linearly polarized signals. (WRC-23)

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[48] These system temperature values are still used for assignments notified, which are in conformity with this Appendix, brought into use, and for which the date of bringing into use has been confirmed to the Bureau before 27 October 1997.

3.10 Automatic gain control

The downlink Plan was based on constant satellite output power. However, the feeder-link Plan does not take account of the effect of automatic gain control on board satellites. Up to 15 dB of automatic gain control is permitted, subject to no increase in interference to other satellite systems.

3.11 Power control

In Regions 1 and 3, a permitted increase which may be used to overcome rain fading for each assignment is included in the Plan.

In the calculation, in cases where satellites do not use common or adjacent channels cross-polarized to each other, the maximum permissible e.i.r.p. increase, which must not exceed 10 dB, corresponds to the amount of rain attenuation which occurs on the interfering feeder link.

3.11.1 Method for determination of the increase in e.i.r.p. during rain attenuation for an assignment over the Plan value

Condition to be observed

The increase in e.i.r.p. of the assignment studied must not entail an impairment of more than 0.5 dB of the feeder-link equivalent protection margin of any other assignment of any other administration.

Calculation method

Step 1: compile a list of all assignments of other administrations (A, B, C, . . .) in the same orbital position and positions within ± 6° (or further if no station is found within 6° arc) liable to suffer interference from the assignment studied.

Step 2: calculate the feeder-link equivalent protection margin of assignment A in free-space conditions, taking account of all interference sources affecting A at the worst test points, namely:

– for assignment A: the point corresponding to the minimum *C*/*N* ratio;

– for each interference source affecting A: the point corresponding to the maximum interference power affecting A.

Step 3: introduce for the assignment studied the rain attenuation for 0.1% of the worst month and the corresponding rain depolarization value.

Step 4: recalculate the feeder-link equivalent protection margin of assignment A at the worst test points, namely:

– for assignment A: the test point used in Step 2 above;

– for the assignment studied: the test point corresponding to the maximum interference power affecting A.

At this stage, the e.i.r.p. of the assignment studied is that contained in the Plan.

Step 5: increase the e.i.r.p. of the assignment studied by 0.1 dB and recalculate the equivalent uplink margin of A as in Step 4 above.

Step 6: repeat the operation of Step 5 above until the equivalent uplink margin of assignment A is impaired by more than 0.5 dB in relation to the value found under Step 2 above, or until the e.i.r.p. increase exceeds 10 dB or the rain attenuation (see Step 3). Adopt the e.i.r.p. increase in the preceding iteration step.

Step 7: repeat the operations in Step 2 to Step 6 above, considering the assignments B, C, . . .

Step 8: adopt the smallest of the increases in e.i.r.p. found under Step 6 above for the various assignments A, B, C, . . .

3.11.2 Propagation model

For the calculation of rain attenuation for 0.1% of the worst month, the model described in § 2.2 should be used. It shall be assumed that the 0.1% value is 3.3 times the 1% value (dB).

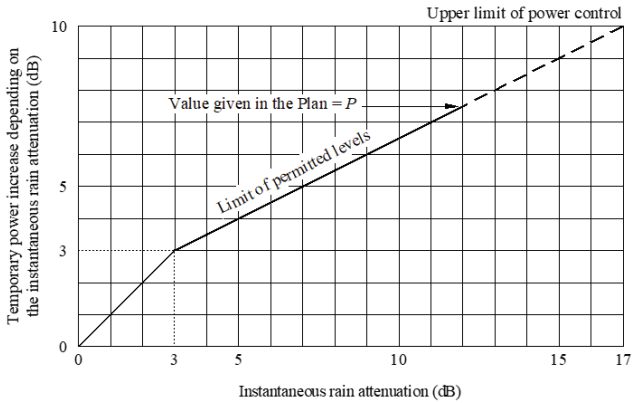
Rain depolarization shall be calculated on the basis of attenuation, using the method described in § 2.4.

3.11.3 Variation of power with rain attenuation

The instantaneous increase in power to overcome rain attenuation must not exceed the bounds given by the characteristics shown in Fig. 5.

FIGURE 5

Characteristic for up-link power control



P: value of permitted increase given in the Plan, or calculated by the BR, which varies for each assignment. The upper limit of this value is 10 dB.

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3.11.4 Procedures

An administration wishing to introduce power control may use a value not exceeding that given in Article 9A or it may request, where this is possible, the use of a higher value for a given earth station location. In this latter case, it shall request the Bureau to calculate the maximum permissible value for that site. The administration shall provide the Bureau with the coordinates of the station, the proposed antenna characteristics, including the off-axis co-polar and cross-polar characteristics, and the rain climatic zone.

The Bureau shall calculate the permissible increase in power using the method described in § 3.11.1.

The Bureau shall communicate the results of the calculations to the requesting administrations as well as to those administrations whose feeder-link equivalent protection margin is reduced.

In any case, the permitted increase in e.i.r.p. above that given in the Plan shall not exceed 10 dB.

In the event of modifications to the Plan, the Bureau shall recalculate the value of power control for the assignment subject to the modification and insert the appropriate value for that assignment in the Plan. A modification to the Plan shall not require the adjustment of the values of permissible power increase of other assignments in the Plan.

3.12 (SUP - WRC-97)

3.13 Depolarization compensation

The Plan is developed without the use of depolarization compensation. Depolarization compensation is permitted only to the extent that interference to other satellites does not increase by more than 0.5 dB[49] relative to that calculated in the feeder-link Plan.

3.14 Amplitude-modulation to phase-modulation conversion

The degradation caused by AM to PM conversion was taken into account when calculating the carrier-to-noise ratio of the feeder link. A value of 2.0 dB was allowed.

3.15 Orbit positions

The Plan is generally based on the use of a regular spacing of 6°. The orbital positions are those given in the Plan. (WRC-03)

3.16 Satellite station-keeping

Space stations in the broadcasting-satellite service must be maintained in position with an accuracy equal to or better than ±0.1° in the E-W direction. For such space stations, the maintenance of the tolerance ±0.1° in the N-S direction is recommended but is not a requirement.

3.17 Orbital separation limit for interference calculation (WRC-2000)

WRC-2000 has adopted the use of an orbital separation limit for interference calculation in Regions 1 and 3. Beyond this limit no interference was taken into account. (WRC-2000)

Initially, the values used for the orbital separation limit were 15° for co-polar and 9° for cross-polar emissions. At a later stage, the unique value of the orbital separation limit of 9° was adopted by WRC-2000. (WRC-2000)

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[49] This margin has to be shared between power control effects and depolarization compensation effects when both are involved (see § 3.11).

4 Basic technical characteristics for Region 2

4.1 Translation frequency and guard bands

The feeder-link Plan is based on the use of a single frequency translation of 5.1 GHz between the 17 GHz feeder-link channels and the 12 GHz downlink channels. Other values of the translation frequency may be used, provided that the corresponding channels have been assigned to the space station of the administration concerned.

With a single value frequency translation between the feeder-link frequency band (17.3-17.8 GHz) and the downlink frequency band (12.2-12.7 GHz), the guard bands present in the downlink Plan result in corresponding bandwidths of 12 MHz at the upper and lower feeder-link band edges. These feeder-link guard bands may be used to provide space operation functions in accordance with No. **1.23** in support of the operation of geostationary-satellite networks in the broadcasting-satellite service. (WRC-03)

4.2 Carrier-to-noise ratio

Section 3.3 of Annex 5 to Appendix **30** provides guidance for planning and the basis for the evaluation of the carrier-to-noise ratios of the feeder-link and downlink Plans.

As a guidance for planning, the reduction in quality in the downlink due to thermal noise in the feeder link is taken as equivalent to a degradation in the downlink carrier-to-noise ratio of approximately 0.5 dB not exceeded for 99% of the worst month.

4.3 Carrier-to-noise ratio

Section 3.4 of Annex 5 to Appendix **30** provides guidance for planning for the contribution of the feeder-link co-channel interference to the overall co-channel carrier-to-interference ratio. However, the feeder-link and downlink Plans are evaluated on the overall equivalent protection margin which includes the combined downlink and feeder-link contributions. Definitions given in § 1.7, 1.8, 1.9, 1.10 and 1.11 of this Annex and the protection ratios given in Section 3.4 of Annex 5 to Appendix **30** are used in the analysis of the Plans.

For the adjacent channels, the Plan is based on an orbital separation of 0.4° between nominally co-located satellites having cross-polarized adjacent channel assignments.

For the second adjacent channels, the Plan is based on a 10 dB improvement on the feeder-link carrier-to-interference ratio due to the satellite receive filtering.

4.4 Transmitting antenna

4.4.1 Antenna diameter

The feeder-link Plan is based on an antenna diameter of 5 m.

The minimum antenna diameter permitted in the Plan is 2.5 m. However, the feeder-link carrier-to-noise ratio and carrier-to-interference ratio resulting from the use of antennas with diameters smaller than 5 m would generally be less than those calculated in the Plan.

The use of antennas larger than 5 m, with corresponding values of on-axis e.i.r.p. higher than the planned value (indicated in § 4.4.3) but without augmented off-axis e.i.r.p., is permitted if the orbital separation between the assigned orbital location of the administration and the assigned orbital location of any other administration is greater than 0.5°.

Antennas with diameters larger than 5 m can also be implemented if the above orbital separation is less than 0.5° and if the e.i.r.p. of the desired feeder-link earth station does not exceed the planned value of e.i.r.p.

If the above orbital separation is less than 0.5° and if the e.i.r.p. of the desired feeder-link earth station exceeds the planned value, agreement between administrations is required.

4.4.2 Transmitting antenna reference patterns (WRC-03)

The co-polar and cross-polar reference patterns of transmitting antennas used for planning in Region 2 are given in Fig. 6.

4.4.3 Antenna efficiency

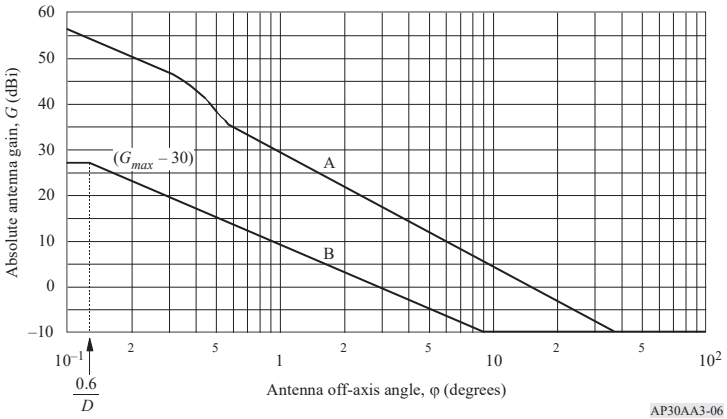
The Plan is based on an antenna efficiency of 65%. The corresponding on-axis gain for an antenna having a 5 m diameter is 57.4 dBi at 17.55 GHz, and the corresponding value of e.i.r.p. used for planning purposes is 87.4 dBW.

4.4.4 Pointing accuracy

The Plan has been developed to accommodate a loss in gain due to earth station antenna mis-pointing of 1 dB. Under no circumstances shall the Plan allow for a mis-pointing angle greater than 0.1°.

FIGURE 6

Reference patterns for co-polar and cross-polar components for transmitting antennas for Region 2



Curve A: co-polar component (dBi)

$G_{co} = G_{max}$ for $0° \leq \varphi < 0.1°$

$G_{co} = 36 - 20 \log \varphi$ for $0.1° \leq \varphi < 0.32°$

$G_{co} = 51.3 - 53.2\, \varphi^2$ for $0.32° \leq \varphi < 0.54°$

$G_{co} = \max (29 - 25 \log \varphi, -10)$ for $0.54° \leq \varphi \leq 180°$

If $G_{co} > G_{max}$: $G_{co} = G_{max}$ (WRC-03)

Curve B: cross-polar component (dBi)

$G_{cross} = G_{max} - 30$ for $0° \leq \varphi < (0.6/D)°$

$G_{cross} = \max (9 - 20 \log \varphi, -10)$ for $(0.6/D)° \leq \varphi \leq 180°$

If $G_{cross} > G_{max} - 30$: $G_{cross} = G_{max} - 30$ (WRC-03)

where:

φ : off-axis angle referred to the main-lobe axis (degrees)

G_{max} : on-axis co-polar gain of the antenna (dBi)

D : diameter of the antenna (m) ($D \geq 2.5$).

NOTE 1 – In the angular range between 0.1° and 0.54°, the co-polar gain must not exceed the reference pattern.

NOTE 2 – In the angular range between 0° and (0.6/*D*)°, the cross polar gain must not exceed the reference pattern.

NOTE 3 – At the larger off–axis angles and for 90% of all side-lobe peaks in each of the reference angular windows, the gain must not exceed the reference pattern. The reference angular windows are 0.54° to 1°, 1° to 2°, 2° to 4°, 4° to 7°, 7° to 10°, 10° to 20°, 20° to 40°, 40° to 70°, 70° to 100° and 100° to 180°. The first reference angular window for evaluating the cross-polar component should be (0.6/*D*)° to 1°.

4.5 Transmit power

The maximum transmit power delivered to the input of the antenna of the feeder-link earth station is 1 000 W per 24 MHz television channel. This level of power can only be exceeded under certain conditions specified in § 4.10.

4.6 Receiving antenna

4.6.1 Cross-section of receiving antenna beam

Planning has been based on beams of elliptical or circular cross-section. When the assignments are implemented, or when the Plan is modified, administrations may use non-elliptical or shaped beams.

If the cross-section of the receiving antenna beam is elliptical, the effective beamwidth φ_0 is a function of the angle of rotation q between the plane containing the satellite and the major axis of the beam cross-section and the plane in which the beamwidth is required.

The relationship between the maximum gain of an antenna and the half-power beamwidth can be derived from the expression:

$$G_m = 27\,843/ab$$

or

$$G_m \text{ (dB)} = 44.44 - 10 \log a - 10 \log b$$

where:

a and b are the angles (degrees) subtended at the satellite by the major and minor axes of the elliptical cross-section of the beam.

An antenna efficiency of 55% is assumed.

4.6.2 Minimum beamwidth

A minimum value of 0.6° for the half-power beamwidth of the receiving antenna has been agreed on for planning.

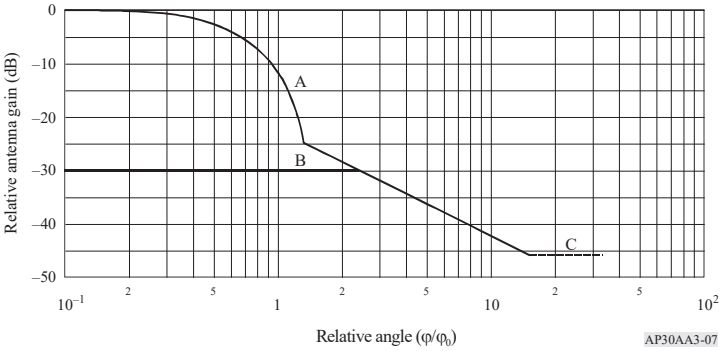
4.6.3 Receiving antenna reference patterns (WRC-03)

The reference patterns for the co-polar and cross-polar components of the satellite receiving antenna used in preparing the Plan are given in Fig. 7.

Where it was necessary to reduce interference, the pattern shown in Fig. 8 was used; this use will be indicated in the Plan by an appropriate symbol. This pattern is derived from an antenna producing an elliptical beam with fast roll-off in the main lobe. Three curves for different values of φ_0 are shown as examples.

FIGURE 7

Reference patterns for co-polar and cross-polar components for satellite receiving antenna in Region 2



Curve A: co-polar component (dB relative to main beam gain)

$-12\,(\varphi/\varphi_0)^2$ for $0 \leq (\varphi/\varphi_0) \leq 1.45$

$-(22 + 20 \log (\varphi/\varphi_0))$ for $(\varphi/\varphi_0) > 1.45$

after intersection with Curve C, as Curve C.

Curve B: cross-polar component (dB relative to main beam gain)

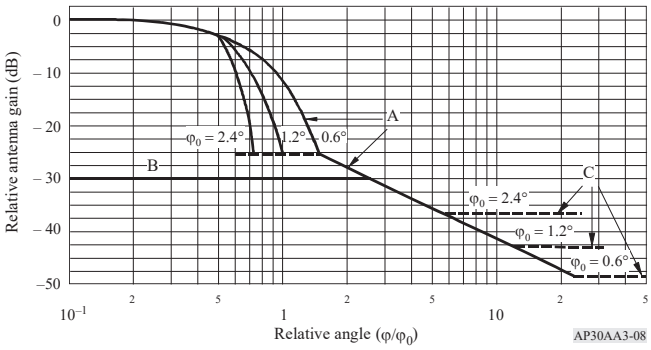
-30 for $0 \leq (\varphi/\varphi_0) \leq 2.51$

after intersection with Curve A, as Curve A.

Curve C: minus the on-axis gain (Curve C in this Figure illustrates the particular case of an antenna with an on-axis gain of 46 dBi)

FIGURE 8

Reference patterns for co-polar and cross-polar components for satellite receiving antennas with fast roll-off in the main beam for Region 2



Curve A: co-polar component (dB relative to main beam gain)

$-12\ (\varphi/\varphi_0)^2$	for	$0 \leq \varphi/\varphi_0 \leq 0.5$
$-33.33\ \varphi_0^2\ (\varphi/\varphi_0 - x)^2$	for	$0.5 < \varphi/\varphi_0 \leq \dfrac{0.87}{\varphi_0} + x$
-25.23	for	$\dfrac{0.87}{\varphi_0} + x < \varphi/\varphi_0 \leq 1.45$
$-(22 + 20 \log (\varphi/\varphi_0))$	for	$\varphi/\varphi_0 > 1.45$

after intersection with Curve C, as Curve C. (WRC-03)

Curve B: cross-polar component (dB relative to main beam gain)

-30	for	$0 \leq (\varphi/\varphi_0) \leq 2.51$

after intersection with Curve A, as Curve A.

Curve C: minus the on-axis gain (Curves A and C represent examples for three antennas having different values of φ_0 as labelled in Fig. 8. The on-axis gains of these antennas are 37, 43 and 49 dBi, respectively).

where:

φ : off-axis angle (degrees)

φ_0 : dimension of the minimum ellipse fitted around the feeder-link service area in the direction of interest (degrees)

$$x = 0.5 \left(1 - \frac{0.6}{\varphi_0}\right)$$

4.6.4 Pointing accuracy

The deviation of the receiving antenna beam from its nominal pointing direction must not exceed 0.1° in any direction. Moreover, the angular rotation of the receiving beam about its axis must not exceed ±1°; this latter limit is not necessary for beams of circular cross-section using circular polarization.

4.7 System noise temperature

The Plan is based on a value of 1 500 K for the satellite system noise temperature. WRC-03 decided that for feeder-link assignments in the Plan which have not been subsequently modified through successful application of Article 4, a value of 600 K (instead of 1 500 K) is used in application of § 5 of Annex 1 and § 1 of Annex 4. For those assignments which have been subsequently modified, the noise temperature value provided in that modification is used. (WRC-03)

4.8 Polarization

4.8.1 In Region 2, for the purpose of planning the feeder links, circular polarization is used.

4.8.2 In the cases where there are polarization constraints, use of polarization other than circular is permitted only upon agreement of administrations that may be affected.

4.9 Automatic gain control

4.9.1 The Plan is based on the use of automatic gain control on board satellites to maintain a constant signal level at the satellite transponder output.

4.9.2 The dynamic range of automatic gain control is limited to 15 dB when satellites are located within 0.4° of each other and operate on cross-polarized adjacent channels serving common or adjacent feeder-link service areas.

4.9.3 The 15 dB limit of automatic gain control does not apply to satellites other than those specified in § 4.9.2 above.

4.10 Power control

The Plan has been developed without the use of power control.

The use of transmit power levels higher than those given in § 4.5 is permitted only when rain attenuation exceeds 5 dB at 17 GHz. In such cases, the transmit power may be increased by the amount that the instantaneous rain attenuation exceeds 5 dB at 17 GHz up to the limit given in Table 5.

TABLE 5

Transmit radio frequency power (delivered to the input of the feeder-link earth station antenna) permitted in excess of 1 000 W as a function of elevation angle

Elevation angle of feeder-link earth station antenna (degrees)	Transmit power permitted in excess of 1 000 W (dB)
0 to 40	0
40 to 50	2
50 to 60	3
60 to 90	5

4.11 Site diversity

Site diversity refers to the alternate use during rain of two or more transmitting earth stations which may be separated by sufficient distance to ensure uncorrelated rainfall conditions.

The use of site diversity is permitted and is considered to be an effective technique for maintaining high carrier-to-noise ratio and carrier-to-interference ratio during periods of moderate to severe rain attenuation. However, the Plan is not based on the use of site diversity.

4.12 Depolarization compensation

The Plan is developed without the use of depolarization compensation. Depolarization compensation is permitted only to the extent that interference to other satellites does not increase by more than 0.5 dB relative to that calculated in the feeder-link Plan.

4.13 Minimum separation between satellites

Figure 9 illustrates two adjacent clusters of satellites separated by 0.9° between the centres of the clusters. Aη identifies a satellite of administration η. A cluster is formed by two or more satellites separated by 0.4° and located at two nominal orbital positions as specified in the Plan; one position for right-hand polarized channels and the other position for left-hand polarized channels.

4.13.1 Satellites of the same cluster

The Plan is based on an orbital separation of 0.4° between satellites having cross-polarized adjacent channels (i.e. satellites located at +0.2° and −0.2° from the centre of the cluster). However, satellites within a cluster may be located at any orbital position within the cluster, requiring only the agreement of the other administrations having satellites sharing the same cluster. Such orbital positioning of satellites within a cluster is illustrated in Fig. 9 by some of the satellites A5, A6 and A7.

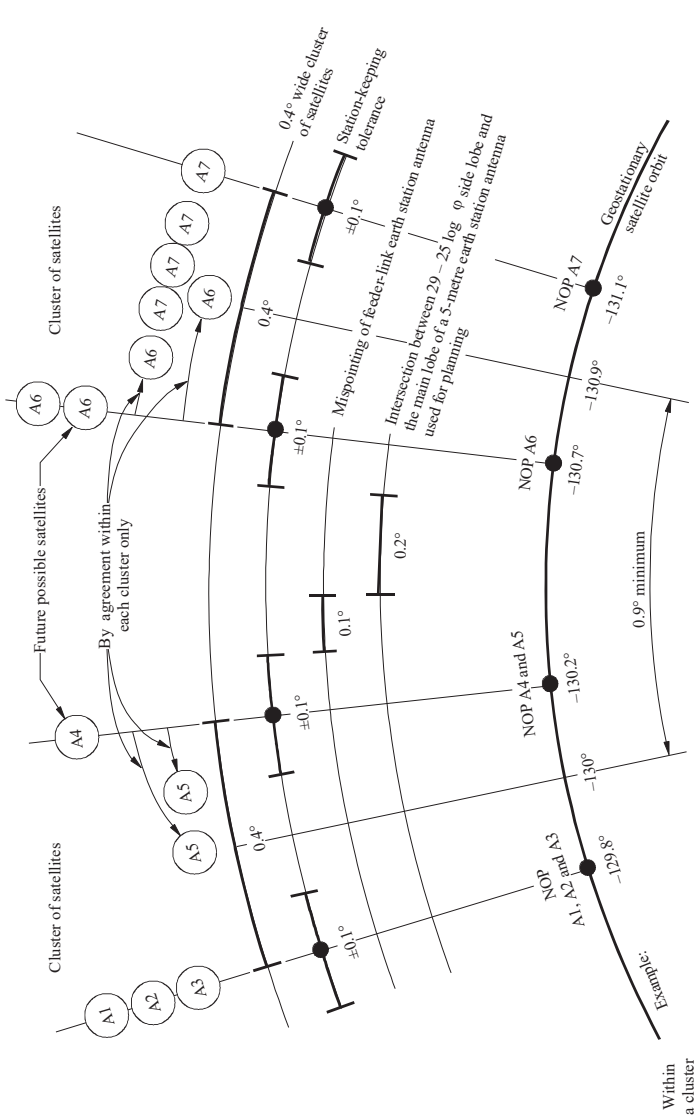
The station-keeping tolerance of ±0.1° indicated in § 3.11 of Annex 5 to Appendix **30** must be applied to satellites located at any position within the 0.4° wide cluster.

4.13.2 Satellites of different clusters

In the Plan, the orbital separation between the centres of adjacent clusters of satellites is at least 0.9°. The value of 0.9° is also the minimum orbital separation to provide flexibility in the implementation of feeder links indicated in § 4.4.1 without the need for an agreement (see § 4.13.1).

FIGURE 9

Exploded view of geostationary satellite orbit



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Aη: specific Administration
NOP 1: nominal orbital position, right-hand polarization
NOP 2: nominal orbital position, left-hand polarization

ANNEX 4 (REV.WRC-19)

Criteria for sharing between services

1 Threshold values for determining when coordination is required between, on one hand, transmitting space stations in the fixed-satellite service or the broadcasting-satellite service and, on the other hand, a receiving space station in the feeder-link Plan or List or a proposed new or modified receiving space station in the List, in the frequency bands 17.3-18.1 GHz (Regions 1 and 3) and in the feeder-link Plan or a proposed modification to the Plan in the frequency band 17.3-17.8 GHz (Region 2) (WRC-03)

With respect to § 7.1, Article 7, coordination of a transmitting space station in the fixed-satellite service or in the broadcasting-satellite service with a receiving space station in a broadcasting-satellite service feeder link in the Regions 1 and 3 feeder-link Plan or List, or a proposed new or modified receiving space station in the List, or in the Region 2 feeder-link Plan or proposed modification to the Plan is required when the power flux-density arriving at the receiving space station of a broadcasting-satellite service feeder link of another administration would cause an increase in the noise temperature of the feeder-link space station which exceeds a threshold value of $\Delta T_s / T_s$ corresponding to 6%. $\Delta T_s / T_s$ is calculated in accordance with Case II of the method given in Appendix **8**. (WRC-03)

2 Threshold values for determining when coordination is required between transmitting feeder-link earth stations in the fixed-satellite service in Region 2 and a receiving space station in the Regions 1 and 3 feeder-link Plan or List or a proposed new or modified receiving space station in the List, in the frequency bands 14.5-14.8 GHz and 17.8-18.1 GHz (WRC-19)

With respect to § 7.1, Article **7**, coordination of a transmitting feeder-link earth station in the fixed-satellite service with a receiving space station in a broadcasting-satellite feeder link in the Regions 1 and 3 feeder-link Plan or List, or a proposed new or modified receiving space station in the List, is required when the power flux density arriving at the receiving space station of a broadcasting-satellite service feeder link of another administration would cause an increase in the noise temperature of the feeder-link space station which exceeds a threshold value of $\Delta T/T$ corresponding to 6%, where $\Delta T/T$ is calculated in accordance with the method given in Appendix **8**. (WRC-19)

3 Threshold values for determining when coordination is required between transmitting earth stations in the fixed-satellite service in the frequency band 14.5-14.75 GHz (in countries listed in Resolution 163 (WRC-15)) and 14.5-14.8 GHz (in countries listed in Resolution 164 (WRC-15)) not for feeder links for the broadcasting-satellite service and a receiving space station subject to a Plan in the frequency band 14.5-14.8 GHz (WRC-15)

With respect to § 7.1, Article 7, coordination of a transmitting earth station in the fixed-satellite service with a receiving space station in a broadcasting-satellite feeder link in the Regions 1 and 3 feeder-link Plan or List, or a proposed new or modified receiving space station in the List, is required when the power flux-density arriving at the receiving space station of a broadcasting-satellite service feeder link of another administration exceeds the value of:

−197.0 – GRx dB(W/(m^2 · Hz)) with regard to the assignment in the Regions 1 and 3 feeder-link Plan or

−193.9 – GRx dB(W/(m^2 · Hz)), with regard to the assignment included in the feeder-link List or for which complete Appendix **4** information has been received by the Radiocommunication Bureau in accordance with the provisions of § 4.1.3,

where GRx is the relative receive antenna gain of the space station subject to a Plan at the location of the transmitting earth station in the fixed-satellite service not for feeder links for the broadcasting-satellite service. (WRC-15)

APPENDIX 30B (REV.WRC-23)

Provisions and associated Plan for the fixed-satellite service in the frequency bands 4 500-4 800 MHz, 6 725-7 025 MHz, 10.70-10.95 GHz, 11.20-11.45 GHz and 12.75-13.25 GHz

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Note by the Secretariat: Reference to an Article with the number in roman is referring to an Article in this Appendix.

ARTICLE 1 (REV.WRC-07)

Objective of the provisions and associated Plan

1.1 The objective of the procedures prescribed in this Appendix is to guarantee in practice, for all countries, equitable access to the geostationary-satellite orbit in the frequency bands of the fixed-satellite service covered by this Appendix.

1.2 The procedures prescribed in this Appendix shall in no way prevent the implementation of assignments in conformity with the national allotments of the Plan. (WRC-07)

ARTICLE 2 (REV.WRC-07)

Definitions

2.1 *Conference*: World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It, First Session, Geneva, 1985; Second Session, Geneva, 1988.

2.2 *Plan*: The Plan for the fixed-satellite service in the frequency bands contained in this Appendix, consisting of national allotments. (WRC-07)

2.2*bis* *List of assignments (hereinafter, called the "List")*: The List associated with the Plan containing assignments resulting from the successful application of the provisions of Article 6 of Appendix **30B** or the application of Resolution **148 (WRC-07)**. (WRC-07)

2.3 *Allotment*: For the purpose of this Appendix, an allotment comprises:

– a nominal orbital position;

– a bandwidth of 800 MHz (up-link and down-link) in the frequency bands listed in Article 3 of this Appendix;

– a service area for national coverage. (WRC-07)

2.4 *Existing systems*: Those satellite systems in the frequency bands covered by this Appendix which are identified in Resolution **148 (WRC-07)**. (WRC-07)

2.5 (SUP - WRC-07)

2.6 *Additional system*: For the application of the provisions of this Appendix, an additional system is a system for which the assignments submitted by an administration are not the result of conversion of an allotment into assignments. When submitting an additional system, the national allotment in the Plan of the submitting administration shall be retained. An additional system may also be submitted on behalf of a group of named administrations, with one administration designated to act as the notifying administration in respect of that additional system. (WRC-07)

2.6*bis* When submitting additional system(s), administrations shall fully comply with the requirements stipulated in Article 44 of the ITU Constitution. In particular, these administrations shall limit the number of orbital positions and associated spectrum so that:

a) the orbital/spectrum natural resources are used rationally, efficiently and economically; *and*

b) the use of multiple orbital locations to cover the same service area is avoided. (WRC-07)

ARTICLE 3

Frequency bands

3.1 The provisions of this Appendix shall apply to the fixed-satellite service in the frequency bands between:

– 4 500 and 4 800 MHz (space-to-Earth);

– 6 725 and 7 025 MHz (Earth-to-space);

– 10.70 and 10.95 GHz (space-to-Earth);

– 11.20 and 11.45 GHz (space-to-Earth);

– 12.75 and 13.25 GHz (Earth-to-space).

ARTICLE 4

Execution of the provisions and associated Plan

4.1 The Member States of the Union shall adopt, for their fixed-satellite service stations operating in the frequency bands referred to in this Appendix, the characteristics consistent with those specified in the Plan and its associated provisions.

4.2 The Member States of the Union shall not change the characteristics, or bring into use assignments to fixed-satellite service stations, or stations in the other services to which these frequency bands are allocated, except as provided for in the Radio Regulations and the appropriate Articles and Annexes of this Appendix.

ARTICLE 5 (SUP - WRC-07)

ARTICLE 6 (REV.WRC-23)

Procedures for the conversion of an allotment into an assignment, for the introduction of an additional system or for the modification of an assignment in the List[1, 2, 2bis, 2ter] (WRC-23)

6.1 When an administration intends to convert an allotment into an assignment or when an administration, or one acting on behalf of a group of named administrations[3], intends to introduce an additional system or modify the characteristics of assignments in the List that have been brought into use, it shall, not earlier than eight years and preferably not later than two years before the planned date of bringing the assignment into use, send to the Bureau the information specified in Appendix **4**[4, 5]. (WRC-19)

6.1*bis* Administrations, in submitting an additional use under § 6.1 of Appendix **30B**, may submit the information specified in Appendix **4** for both sub-bands each of 250 MHz (10.7-10.95 GHz and 11.2-11.45 GHz for downlink and 12.75-13.0 GHz and 13.0-13.25 GHz for uplink) and notify and bring into use under Article 8 only one of the two sub-bands each of 250 MHz (10.7-10.95 GHz or 11.2-11.45 GHz for downlink and 12.75-13.0 GHz or 13.0-13.25 GHz for uplink) or submit under § 6.1 either of the two sub-bands each of 250 MHz (10.7-10.95 GHz or 11.2-11.45 GHz for downlink and 12.75-13.0 GHz or 13.0-13.25 GHz for uplink) and notify and bring into use that sub-band under Article 8. The Bureau shall process that sub-band as it has been submitted under Article 6 and shall apply Article 8 for the sub-band notified and brought into use and cancel the other sub-band from its database. (WRC-19)

6.2 If the information received by the Bureau under § 6.1 is found to be incomplete, the Bureau shall immediately seek any clarification required and information not provided from the administration concerned.

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1 If the payments are not received in accordance with the provisions of Council Decision 482, as amended, on the implementation of cost recovery for satellite network filings, the Bureau shall cancel the publication specified in § 6.7 and/or § 6.23 and the corresponding entries in the List under § 6.23 and/or § 6.25, as appropriate, and reinstate any allotments back into the Plan after informing the administration concerned. The Bureau shall inform all administrations of such action and that the network specified in the publication in question no longer has to be taken into consideration by the Bureau and other administrations. The Bureau shall send a reminder to the notifying administration not later than two months prior to the deadline for the payment in accordance with the above-mentioned Council Decision 482, unless the payment has already been received. (WRC-23)

2 Resolution **49 (Rev.WRC-23)** applies. (WRC-23)

2*bis* Resolution **170 (Rev.WRC-23)** applies. (WRC-23)

2*ter* In respect of proposed allotments by new Member States of the Union under Article 7 of this Appendix, Annex 7 to this Appendix shall apply. (WRC-23)

3 Whenever, under § 6.1, an administration acts on behalf of a group of named administrations, all members of that group retain the right to respond in respect of their own allotments or assignments.

4 Submissions may include conversion of the 6/4 GHz or the 13/10-11 GHz portion (both uplink and downlink) of an allotment into an assignment provided that the orbital location of the assignment is the same as the unconverted portion of the allotment.

5 Submissions for additional systems may include use of only space-to-Earth or only Earth-to-space links.

6.3 Upon receipt of a complete notice under § 6.1, the Bureau shall examine it with respect to its conformity with:

a) the Table of Frequency Allocations and the other provisions[6] of the Radio Regulations, except those provisions relating to conformity with the fixed-satellite service Plan; *and*

b) Annex 3 to this Appendix.

6.4 When the examination with respect to § 6.3 leads to an unfavourable finding, the relevant part of the notice shall be returned to the notifying administration with an indication of the appropriate action.

6.4*bis* When the examination of a notice received under § 6.1 to convert an allotment into an assignment leads to a favourable finding with respect to § 6.3, the Bureau shall immediately send a telefax to administrations which have applied § 6.15*quat* with respect to the allotment covered in this notice. This telefax shall inform these administrations of the reception of this notice under § 6.1. (WRC-23)

6.5 When the examination of each assignment in a notice received under § 6.1 with respect to § 6.3 leads to a favourable finding, the Bureau shall use the method of Annex 4 to determine administrations whose:

a) allotments in the Plan; *or*

b) assignments which appear in the List; *or*

c) assignments which the Bureau has previously examined under this paragraph after receiving complete information in accordance with § 6.1 of this Article,

are considered as being affected by any assignment in that notice.

6.6 The Bureau shall then identify those administrations whose territories have been included in the service area of the assignment under examination. The notifying administration shall seek the agreement of any administration whose territory is partially or wholly included in the intended service area of the assignment.

6.7 The Bureau shall publish, in a Special Section of its International Frequency Information Circular (BR IFIC), the complete information received under § 6.1 and examined under § 6.5, together with:

a) the names of the administrations identified under § 6.5 and the corresponding allotments in the Plan, assignments in the List and assignments for which the Bureau has previously received complete information in accordance with § 6.1 and which it has examined under § 6.5 of this Article;

b) the names of the administrations identified under § 6.6.

6.8 Following the examination under § 6.5 and 6.6, the Bureau shall immediately send a telegram or fax to the administration that has submitted the notice under § 6.1, drawing attention to the requirement to seek and obtain the agreement of those administrations identified in the Special Section of the BR IFIC published under § 6.7.

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6 The "other provisions" shall be identified and included in the Rules of Procedure.

6.9 The Bureau shall also send a telegram or fax to each administration listed in the Special Section of the BR IFIC published under § 6.7, drawing its attention to the information it contains.

6.10 Comments from administrations identified as affected under § 6.5 in the Special Section of the BR IFIC published under § 6.7 shall be sent to the Bureau and to the administration that has submitted the notice under § 6.1, either directly or through the Bureau, within a period of four months following the date of the publication in the BR IFIC. When an administration has not replied within this four-month period, it is deemed that this administration has not agreed to the proposed assignment, unless the provisions of § 6.13 to 6.15 are applied.

The above-mentioned four-month period shall be extended for an administration that has requested the assistance of the Bureau by up to thirty days following the date on which the Bureau communicated the result of its action.

6.11 Thirty days prior to the expiry of the same four month period, the Bureau shall dispatch a reminder telegram or fax to each administration listed in the Special Section published under § 6.7 which has not made its comments under § 6.10, bringing the matter to its attention.

6.12 An administration which considers that it should have been identified as affected in the publication referred to under § 6.7 above shall, within four months of the date of publication of the relevant BR IFIC, request the Bureau to include its name in the publication while providing the reasons therefor. The Bureau shall study this information on the basis of Annex 4 and shall inform both the affected administration and the administration that submitted the notice of its conclusions. Should the Bureau agree to the administration's request, it shall publish an addendum to the publication under § 6.7.

6.13 After the same time period as specified in § 6.10, the notifying administration may request the Bureau to assist in respect of an administration which has not replied within this time period.

6.14 The Bureau, acting on a request for assistance under § 6.13, shall send a reminder to the administration which has not replied, together with the results of its previously published compatibility analysis, containing the change in the calculated overall aggregate $(C/I)_{agg}$ value referred to in paragraph 2.1 of Annex 4 to Appendix **30B**, requesting a decision. (WRC-23)

6.14*bis* Fifteen days before the expiry of the 30-day period referred to in § 6.15, the Bureau shall send a reminder to the above-mentioned administration drawing its attention to the consequence of no reply.

6.15 If no decision is communicated to the Bureau within 30 days after the date of dispatch of the reminder under § 6.14 and the identification is for:

a) an allotment in the Plan, it shall be deemed that the administration which has not given a decision has no objection to the proposed assignment until this administration plans to bring into use its allotment in the Plan, and an agreement under § 6.15*quat* is considered as concluded between the administration for the affected allotment in the Plan and the notifying administration for the proposed assignment; or

b) an assignment, it shall be deemed that the administration which has not given a decision has agreed to the proposed assignment. (WRC-23)

6.15*bis* The course of action described in §§ 6.13 to 6.15 do not apply to the agreement requested under § 6.6. (WRC-19)

6.15*ter* The agreement of the administrations affected may also be obtained in accordance with this Article for a specified period. When this specific period of agreement expires for an assignment in the List, the assignment in question shall be maintained in the List until the end of the period referred to in § 6.1 above. After that date this assignment in the List shall lapse unless the agreement of the administrations affected is renewed. (WRC-19)

6.15*quat* The notifying administration shall provide a firm, objective, measurable and enforceable commitment to respect the power flux-density limits shown in section 2.2 of Annex 4 to Appendix **30B** with respect to the allotment that was identified as affected under § 6.5 and for which no decision has been communicated to the Bureau, in accordance with § 6.15, from the date on which the frequency assignment is to be brought into use, communicated under § 8.10*bis* or within 12 months of the date of dispatch of the telefax sent under § 8.10*bis*, whichever comes later. In the space-to-Earth direction, the power flux-density limits shall be respected at any point within the territory, situated inside the −3 dB contour of the associated beam area, of the administration responsible for the allotment. The agreement of an administration identified as being affected under § 6.5 with respect to its allotment and having stated its disagreement may also be obtained in accordance with this paragraph. Resolution **126 (WRC-23)** applies. (WRC-23)

6.15*quin* When entering in the List an assignment subject to § 6.15*quat*, the Bureau shall indicate those administrations whose allotments were the basis of the application of § 6.15*quat*. (WRC-23)

6.16 An administration may at any time during or after the above-mentioned four-month period inform the Bureau about its objection to being included in the service area of any assignment, even if this assignment has been entered in the List. The Bureau shall then inform the administration responsible for the assignment and exclude the territory and test points[6*bis*] that are within the territory of the objecting administration from the service area. The Bureau shall update the reference situation without reviewing the previous examinations. (WRC-23)

6.17 If agreements have been reached with administrations published in accordance with § 6.7, the administration proposing the new or modified assignment may request the Bureau to have the assignment entered into the List, indicating the final characteristics of the assignment together with the names of the administrations with which agreement has been reached. For this purpose, it shall send to the Bureau the information specified in Appendix **4**. In submitting this notice, the administration may request the Bureau to examine the notice under §§ 6.19, 6.21 and 6.22 (entry into the List) and then under Article 8 of this Appendix (notification)[6*ter*]. (WRC-19)

6*bis* The administration responsible for the assignment may request to relocate the test points from the excluded territory to a new location within the remaining part of its service area. The relocation of uplink test points shall not cause more interference. (WRC-23)

6*ter* A single notice containing the information specified in Appendix **4** under Article 8 of Appendix **30B** (notification) shall be submitted. When examining the notice under §§ 6.19, 6.21 and 6.22 of Article 6 of Appendix **30B**, the Bureau shall use the values of the maximum power density per frequency group contained in the submitted notice as well as predefined values for the assigned frequency (10.825 GHz for 10.7-10.95 GHz, 11.325 GHz for 11.20-11.45 GHz, 12.875 GHz for 12.75-13 GHz, 13.125 GHz for 13-13.25 GHz, 4 650 MHz for 4 500-4 800 MHz and 6 875 MHz for 6 725-7 025 MHz) and the necessary bandwidth (250 MHz for 13/11 GHz or 300 MHz for 6/4 GHz). (WRC-19)

6.17*bis* An administration that has submitted the notice for an additional use under § 6.1 may request the Bureau to enter into the List only one sub-band of 250 MHz (10.7-10.95 GHz or 11.2-11.45 GHz for downlink and 12.75-13.0 GHz or 13.0-13.25 GHz for uplink). (WRC-19)

6.18 If the information received by the Bureau under § 6.17 is found to be incomplete, the Bureau shall immediately seek any clarification required and information not provided from the administration concerned.

6.19 Upon receipt of a complete notice under § 6.17, the Bureau shall examine each assignment in the notice:

a) with respect to the requirement for the notifying administration to seek the agreement of those administrations whose territories are included in the service area; (WRC-19);

b) with respect to its conformity with respect to the Table of Frequency Allocations and the other provisions[7] of the Radio Regulations, except those provisions relating to conformity with the fixed-satellite service Plan; *and*

c) with respect to its conformity with Annex 3 to this Appendix.

6.20 When the examination with respect to § 6.19 of an assignment received under § 6.17 leads to an unfavourable finding, the notice shall be returned to the notifying administration with an indication that subsequent resubmission under § 6.17 will be considered with a new date of receipt.

6.21 When the examination with respect to § 6.19 of an assignment received under § 6.17 leads to a favourable finding, the Bureau shall use the method of Annex 4 to examine if there is any administration and the corresponding:

a) allotment in the Plan;

b) assignment which appears in the List at the date of receipt of the examined notice submitted under § 6.1;

c) assignment for which the Bureau has previously received complete information in accordance with § 6.1 and has conducted the examination under § 6.5 of this Article at the date of receipt of the examined notice submitted under § 6.17*bis*;

considered as being affected and whose agreement has not been provided under § 6.17. (WRC-19)

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7 The "other provisions" shall be identified and included in the Rules of Procedure.

7*bis* For any remaining affected networks whose assignments were entered in the List before the notice received under § 6.17, the Bureau shall use the method in Annex 4 to further examine if the remaining corresponding assignments in the List are still considered as being affected. The examination in respect of those remaining affected networks is conducted independently using the Appendix **30B** master database corresponding to the A6B Special Section that was published under § 6.23 or § 6.25. (WRC-19)

6.22 The Bureau shall determine if the final characteristics of an assignment received under § 6.17 cause more interference by checking if they decrease the uplink and/or downlink single-entry *C*/*I* value of an allotment in the Plan or an assignment in the List or an assignment for which the Bureau has received complete information in accordance with this Article before the date of receipt of the complete notice under § 6.17. If the final characteristics cause more interference than was produced by the characteristics previously submitted under § 6.1 to an allotment in the Plan or assignment in the List or assignment for which the Bureau has received complete information in accordance with this Article, the Bureau shall use the method of Annex 4 to determine whether that allotment or assignment is considered as being affected by the proposed assignment without the explicit agreement of the identified administrations.

6.23 In the event of a favourable finding under § 6.21 and 6.22, the Bureau shall enter the proposed assignment in the List[8] and publish in a Special Section of its BR IFIC the characteristics of the assignment received under § 6.17, together with the names of administrations with which the provisions of this Article have been successfully applied. The administration may then notify the assignment in accordance with Article 8 of this Appendix.

6.24 When the examination under § 6.21 or 6.22 leads to an unfavourable finding, the Bureau shall return the notice received under § 6.17 to the notifying administration together with the names of the administrations with which necessary agreements under § 6.21 or 6.22 have not been provided and with an indication that subsequent resubmission under § 6.17 will be considered with a new date of receipt.

6.25 After a notice is returned under § 6.24, should the notifying administration resubmit the notice and insist upon its reconsideration, the Bureau, on the condition of a favourable finding under § 6.21 and 6.22 with respect to allotments in the Plan, shall enter the assignment provisionally in the List, with an indication of those administrations whose assignments were the basis of the unfavourable finding. The entry in the List shall be changed from provisional to definitive only if the Bureau is informed that all required agreements have been obtained.

6.26 Notices submitted under § 6.25 shall also include a signed commitment by the notifying administration, indicating that use of an assignment recorded in the List under § 6.25 shall not cause unacceptable interference to, nor claim protection from, those assignments for which agreement still needs to be obtained.

6.27 When an assignment is entered provisionally in the List under the provisions of § 6.25, that assignment shall not be taken into account in updating the reference situation of those assignments which were the basis for the unfavourable finding. If the Bureau is informed that an agreement has been reached with respect to a given assignment, the reference situation of this assignment shall be updated.

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[8] In the case of a conversion of an allotment into an assignment, the part of the allotment that has been converted shall be removed from the Plan and the reference situation shall be updated.

6.27*bis* When entered in the List in accordance with § 6.15*quin*, the assignment shall not be taken into account in updating the reference situation for those allotments which were the basis for the application of § 6.15*quat*. (WRC-23)

6.28 Should the assignments that were the basis of the unfavourable finding not be brought into use within the period specified in § 6.1 or within the extension period under § 6.31*bis*, then the status of the assignment in the List shall be reviewed accordingly. (WRC-12)

6.29 Should unacceptable interference be caused by an assignment entered in the List under § 6.25 to any assignment in the List which was the basis of the disagreement, the notifying administration of the assignment entered in the List under § 6.25 shall, upon receipt of advice thereof, immediately eliminate this unacceptable interference.

6.29*bis* Should the Bureau be informed that the notifying administration for an assignment in the List to which § 6.15*quat* applies is not complying with its commitment, the Bureau shall immediately consult this administration and request immediate compliance with the commitment. (WRC-23)

6.29*ter* If, in spite of the application of § 6.29*bis*, the notifying administration for an assignment in the List subject to § 6.15*quat* is still not complying with its commitment, the Bureau shall send the case to the Radio Regulations Board, together with relevant information, for the necessary actions, as appropriate. (WRC-23)

6.30 When an assignment included in the List is no longer required, the notifying administration shall so inform the Bureau.

6.31 The regulatory time-limit for bringing into use an assignment to a space station of a satellite network is no more than eight years from the date of receipt by the Bureau of the complete notice under § 6.1. (WRC-15)

6.31*bis* The regulatory time-limit in § 6.31 for bringing into use of an assignment to a space station of a satellite network may be extended once by not more than three years due to launch failure in the following cases:

– the destruction of the satellite intended to bring the assignment into use;

– the destruction of the satellite launched to replace an already operating satellite which is intended to be relocated to bring another assignment into use; *or*

– the satellite is launched, but fails to reach its assigned orbital location.

For this extension to be granted, the launch failure must have occurred at least five years after the date of receipt of the complete Appendix **4** data. In no case shall the period of the extension of the regulatory time-limit exceed the difference in time between the three-year period and the period remaining from the date of the launch failure to the end of the regulatory time-limit. In order to take advantage of this extension, the administration shall have, within one month of the launch failure or one month after 17 February 2012, whichever comes later, notified the Bureau in writing of such failure, and shall also provide the following information to the Bureau before the end of the regulatory time-limit of § 6.31:

– date of launch failure;

– due diligence information as required in Resolution **49 (Rev.WRC-15)***, if this Resolution applies to the satellite network in which the space station is to operate, for the assignments with respect to the satellite that suffered the launch failure, if that information has not already been provided.

If, 11 months after the request for extension, the administration has not provided to the Bureau updated Resolution **49 (Rev.WRC-15)*** information, the Bureau shall promptly send a reminder to the notifying administration. If, for a satellite network or satellite system to which Resolution **49 (Rev.WRC-15)*** applies, the administration has not provided to the Bureau updated Resolution **49 (Rev.WRC-15)*** information for the new satellite under procurement within one year of the request for extension, the related frequency assignments shall lapse. (WRC-15)

6.31*ter* Notwithstanding § 6.31, the regulatory time-limit to bring into use an assignment to a space station of a satellite network that has been converted from an allotment without any modification, or with modification within the envelope of the characteristics[8*bis*] of an allotment in the Plan, may be extended upon request from the notifying administration. (WRC-23)

6.32 Thirty days prior to the date of bringing into use under § 6.31, § 6.31*bis* or § 6.31*ter*, the Bureau shall dispatch a reminder telegram or fax to the notifying administration which has not brought its assignment into use, bringing the matter to its attention. (WRC-23)

6.33

When:

i) an assignment is no longer required; *or*

ii) an assignment recorded in the List and brought into use has been suspended for a period exceeding the suspension period resulting from the application of § 8.17 below and ending after the expiry date specified in § 6.31; *or* (WRC-15)

iii) an assignment recorded in the List has not been brought into use within the eight-year period following the receipt by the Bureau of the relevant complete information under § 6.1 (or within the extended period in the event of an extension under § 6.31*bis* or § 6.31*ter*), with the exception of assignments submitted by new Member States where §§ 6.35 and 7.7 apply,

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* *Note by the Secretariat*: This Resolution was revised by WRC-19 and WRC-23.

8*bis* When an administration converts an allotment into an assignment with characteristics different from those in the Plan, the Bureau shall perform calculations to determine if the proposed new characteristics increase the interference level caused to other allotments and assignments. The increase in interference due to characteristics different from those of the allotment in question in the Plan will be checked by comparing the *C*/*I* ratios for these other allotments and assignments, which result from the use of the proposed new characteristics of the assignment in question, on the one hand, and those obtained using the characteristics of the allotment in question in the Plan, on the other hand. This *C*/*I* calculation is performed under the same technical assumptions and conditions. (WRC-23)

the Bureau shall:

a) publish in a Special Section of its BR IFIC the cancellation of the related Special Sections and the assignments recorded in the Appendix **30B** List;

b) if the cancelled assignment is the result of a conversion of an allotment without modification, reinstate the allotment in the Appendix **30B** Plan;

c) if the cancelled assignment is the result of the conversion of an allotment with modifications, reinstate the allotment with the same orbital location and technical parameters of the cancelled assignment except for its service area, which shall be the national territory of the administration whose allotment is being reinstated; *and*

d) update the reference situation for the allotments of the Plan and the assignments of the List. (WRC-23)

6.34 When a proposed new or modified frequency assignment has not fulfilled all the requirements for entering the List, in accordance with § 6.23 or 6.25, by the expiry date specified in § 6.31 or § 6.31*bis* in the event of an extension under that provision, the Bureau shall publish in a Special Section of the BR IFIC the cancellation of the related Special Sections. (WRC-12)

6.35 The procedure of this Article may be applied by the administration of a country* which has joined the Union as an ITU Member State and does not have a national allotment in the Plan or an assignment in the List stemming from the conversion of an allotment in order to include new assignments in the List. Upon completion of the procedure, the next world radiocommunication conference may be requested to consider, among the assignments included in the List after the successful completion of this procedure, the inclusion in the Plan of a new allotment over the national territory of the new Member State.

6.36 Should the assignments mentioned in § 6.35 over the national territory of the administration not be brought into use within the eight years following the receipt by the Bureau of the relevant complete information under § 6.1 or within the extension period under § 6.31*bis*, they would be retained in the List until the end of the World Radiocommunication Conference immediately following the successful completion of the procedure referred to in § 6.35. (WRC-12)

6.37 An administration, or an administration acting on behalf of a group of named administrations, responsible for a notice with:

– a service area limited to the national territory of an administration or to the national territories of a group of named administrations, as appropriate; and

– a coverage area that shall be the smallest area which encompasses the associated service area

* This procedure may be applied by Palestine to obtain assignments in the Appendix **30B** Plan. Such assignments are for exclusive use by Palestine, in accordance with the Israeli-Palestinian Interim Agreement of 28 September 1995, Resolution 741 of the Council notwithstanding, and Resolution 99 (Rev. Antalya, 2006) of the Plenipotentiary Conference. This is without prejudice of future agreements between the State of Israel and Palestine.

may request the Bureau to be entitled under this Article to apply the procedure described in §§ 6.39 to 6.40 when none of those administrations have a frequency assignment included in the List for which complete Appendix **4** information has been received by the Bureau in accordance with the provisions of § 6.1 and published in accordance with § 6.7. The administration may seek the assistance of the Bureau in selecting an orbital position. (WRC-23)

6.37*bis* Before applying the procedure described in §§ 6.39 to 6.40, an administration, or a group of named administrations, requesting to be entitled under § 6.39 is requested to take all practical steps in accordance with the Radio Regulations to reach a coordination agreement with the administrations identified under § 6.5. The Bureau will inform the administrations identified under § 6.5 and request them to make the utmost effort to coordinate with the administration applying § 6.37. The responsible administration may at any time seek the assistance of the Bureau and its support in the coordination process. (WRC-23)

6.38 If, in spite of the application of § 6.37*bis*, there is still continuing disagreement between the administration, or the group of named administrations, applying § 6.37 and the administrations identified under § 6.5, administrations may seek the assistance of the Bureau, which shall take into account the actual operational parameters of the affected networks under § 6.5, as provided by the administration, to the extent possible, in its compatibility analysis. (WRC-23)

6.38*bis* If, in spite of the application of § 6.38, there is still continuing disagreement, the Bureau shall, upon receipt of a request from the administration or the group of named administrations applying § 6.37, submit the case, together with additional supporting materials from administrations, to the subsequent meeting of the Radio Regulations Board for review and the necessary actions. If the case relates to an assignment having global coverage with a limited service area in the Earth-to-space direction, the necessary actions of the Board shall also include consideration of whether to instruct the Bureau to apply the procedure described in §§ 6.39 to 6.40 with respect to the administrations identified under § 6.5 at the time of the examination, under § 6.17, of the frequency assignments of the administration applying § 6.37. The same course of action shall apply when the frequency assignments identified under § 6.5*c)* above are entered in the List after the entry in the List of the frequency assignments in question. (WRC-23)

6.39 For examination of a proposed new or modified assignment to the List that is subject to § 6.37, and following instruction from the Radio Regulations Board under § 6.38*bis* against an assignment for an additional system and not subject to Resolution **170 (Rev.WRC-23)** or a conversion of an allotment into an assignment with modification outside the envelope of the allotment and not subject to Resolution **170 (Rev.WRC-23)**, the Bureau will generate coverage diagrams that shall be the smallest area which encompasses the associated service area of the satellite network[9], using the Bureau's relevant software applications and following the procedure below:

[9] For satellite networks whose assignments were received by the Bureau under § 6.17 on or before 1 January 2025, the Bureau will use the coverage diagram contained in the List. In addition, administrations responsible for such satellite networks shall notify the Bureau when all the assignments associated with such networks are used by a space station launched after 1 January 2028. In such cases, the coverage area will be established as defined in § 6.39.

Individual minimum ellipses will be created for each country/territory included in the service area of the incumbent network contained in the Part A or the initial Part B, as appropriate:

– if the −10 dB contours of individual minimum ellipses overlap with each other, the beam contains only one coverage area formed by the contours stemming from the elliptical coverage generated by the Bureau that encompasses these countries/territories;

– if the −10 dB contours of individual minimum ellipses do not overlap with each other, the beam consists of multiple spots stemming from the non-overlapping ellipses and each spot is formed by the contours stemming from minimum ellipses generated for countries/territories as described in the bullet above. (WRC-23)

6.40 When an assignment subject to § 6.37 is entered in the List, the Bureau shall not update the reference situation for the latter assignment referred to in § 6.37 if the latter assignment is still affected, based on its submitted uplink coverage area. (WRC-23)

ARTICLE 7 (REV.WRC-23)

Procedure for the addition of a new allotment to the Plan for a new Member State of the Union

7.1 The administration of a country** which has joined the Union as a Member State and does not have a national allotment in the Plan or an assignment stemming from the conversion of an allotment shall obtain a national allotment by the following procedure. (WRC-15)

7.2 The administration shall submit its request for an allotment to the Bureau, with the following information:

a) the geographical coordinates of not more than 20 test points for determining the minimal ellipse to cover its national territory;

b) the height above sea level of each of its test points;

c) any special requirement which is to be taken into account to the extent practicable.

7.3 Upon receipt of the complete information (mentioned in § 7.2 above), the Bureau shall expeditiously and ahead of submissions for which the examination under § 6.5 has not yet started, identify appropriate technical characteristics and associated orbital locations for a prospective national allotment based on Annex 1 to Appendix **30B**. The Bureau shall send this information to the requesting administration. (WRC-23)

** This procedure may be applied by Palestine to obtain an allotment in the Appendix **30B** Plan. Such allotment is for exclusive use by Palestine, in accordance with the Israeli-Palestinian Interim Agreement of 28 September 1995, Resolution 741 of the Council notwithstanding, and Resolution 99 (Rev. Antalya, 2006) of the Plenipotentiary Conference. This is without prejudice of future agreements between the State of Israel and Palestine.

7.4 Upon receipt of the Bureau's response under § 7.3, the requesting administration shall, within thirty days, indicate which of the proposed orbital locations with the associated technical parameters as identified by the Bureau it has selected. During this period, the requesting administration may at any time seek the assistance of the Bureau.

7.4*bis* If a selection for an allotment under § 7.4 has not been received by the Bureau within the specified time-limit referred to in § 7.4 above, the Bureau shall resume examination of submissions under § 6.5, or subsequent submission under Article 7, as appropriate, and inform the requesting administration that its request will be processed under § 7.5 when the Bureau is informed about the selected orbit location. (WRC-23)

7.5 Upon receipt of a request under § 7.4, the Bureau shall process the request ahead of submissions for which the examination under § 6.5 has not yet started and, using Annexes 3 and 7, examine it with respect to its conformity with:

a) the Table of Frequency Allocations and the other provisions[10] of the Radio Regulations, except those provisions relating to conformity with the fixed-satellite service Plan which are the subject of the following subparagraph;

b) allotments in the Plan;

c) assignments which appear in the List;

d) assignments for which the Bureau has previously received complete information and which have been examined, or are at the stage of examination under § 6.5. (WRC-23)

7.6 When the examination under § 7.5 leads to a favorable finding, the Bureau shall enter the national allotment of the new Member State of the Union in the Plan and publish the characteristics of the allotment concerned and the result of its examination in a Special Section of the BR IFIC with the updated reference situation.

7.7 In the event that the Bureau's findings under § 7.5 are unfavourable, the proposed allotment of the Member State shall be treated as a submission under § 6.1 and shall be treated by the Bureau ahead of any other submissions received under Article 6, except for submissions which were already under examination under § 6.5 by the Bureau at the time of completion of the examination of the request of the new Member State under § 7.5. The measures and technical criteria specified in Annex 7 shall be used during technical examinations at the various stages of the Article 6 procedure. (WRC-23)

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[10] The "other provisions" shall be identified and included in the Rules of Procedure.

7.8 During the Article 6 procedure for the proposed allotment of the new Member State of the Union, the additional provisions contained in §§ 8 and 9 of Attachment 1 to Resolution **170 (Rev.WRC-23)** shall apply. (WRC-23)

ARTICLE 8 (REV.WRC-23)

Procedure for notification and recording in the Master Register of assignments in the planned bands for the fixed-satellite service[11, 12] (WRC-19)

8.1 Any assignment for which the relevant procedure of Article 6 has been successfully applied shall be notified to the Bureau using the relevant characteristics listed in Appendix **4**, not earlier than three years before the assignments are brought into use. (WRC-03)

8.2 If the first notice referred to in § 8.1 has not been received by the Bureau within the eight-year period mentioned in § 6.1 of Article 6, the assignments in the List shall no longer be taken into account by the Bureau and administrations. The Bureau shall then act as if the assignment in the List has not been brought into use in conformity with § 6.1 of Article 6. The Bureau shall inform the notifying administration, three months in advance of the end of the eight-year period, of the actions it intends to take. (WRC-07)

8.2*bis* § 8.2 shall not apply to assignments converted from an allotment without any modification or with modification within the envelope of the characteristics of an allotment in the Plan, where § 6.31*ter* applies. (WRC-23)

8.3 Notices not containing those characteristics specified in Appendix **4** as mandatory or required shall be returned with comments to help the notifying administration to complete and resubmit them, unless the information not provided is immediately forthcoming in response to an inquiry by the Bureau. (WRC-03)

8.4 (SUP - WRC-07)

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[11] If the payments are not received in accordance with the provisions of Council Decision 482, as amended, on the implementation of cost recovery for satellite network filings, the Bureau shall cancel the publication specified in §§ 8.5 and 8.12 and the corresponding entries in the Master Register under § 8.11 or § 8.16*bis*, as appropriate, after informing the administration concerned. The Bureau shall inform all administrations of such action and that any resubmitted notice shall be considered to be a new notice. The Bureau shall send a reminder to the notifying administration not later than two months prior to the deadline for the payment in accordance with the above-mentioned Council Decision 482, unless the payment has already been received. (WRC-19)

[12] Resolution **49 (Rev.WRC-15)*** applies. (WRC-15)

* *Note by the Secretariat*: This Resolution was revised by WRC-19 and WRC-23.

8.5 Complete notices shall be marked by the Bureau with their date of receipt and shall be examined in the date order of their receipt. Following receipt of a complete notice the Bureau shall, as soon as possible after the date of entry of the corresponding assignment into the List, or within not more than two months if the corresponding assignment has already been entered into the List, publish its contents, with any diagrams and maps and the date of receipt, in the BR IFIC, which shall constitute the acknowledgement to the notifying administration of receipt of its notice. When the Bureau is not in a position to comply with the time-limit referred to above, it shall periodically so inform the administrations, giving the reasons thereof. (WRC-19)

8.6 The Bureau shall not postpone the formulation of a finding on a complete notice unless it lacks sufficient data to reach a conclusion thereon. (WRC-03)

8.7 Each notice shall be examined: (WRC-03)

8.8 *a)* with respect to its conformity with the Table of Frequency Allocations and the other provisions[13] of these Regulations, except those provisions relating to conformity with the fixed-satellite service Plan which are the subject of the following subparagraph; (WRC-03)

8.9 *b)* with respect to its conformity with the fixed-satellite service Plan and the associated provisions[14]. (WRC-07)

8.10 When the examination with respect to § 8.8 leads to a favourable finding, the assignment shall be examined further with respect to § 8.9; otherwise the notice shall be returned with an indication of the appropriate action. (WRC-03)

8.10*bis* When the examination with respect to § 8.9 leads to a favourable finding, the Bureau shall immediately send a telefax to administrations which applied § 6.15*quat* with respect to the allotment covered in this notice, if any. This telefax shall inform these administrations of the notification under § 8.1 and the date on which the frequency assignment stemming from the conversion of an allotment and with respect to which § 6.15*quat* has been applied is planned to be brought into use. (WRC-23)

8.10*ter* Upon receipt of the telefax referred to in § 8.10*bis*, the administration which applied § 6.15*quat* with respect to the allotment covered in this notice shall reply to the Bureau, with a copy to the administration responsible for the allotment, confirming its commitment to respect the power flux-density limits in § 6.15*quat* with respect to the allotment from the date on which the frequency assignment is to be brought into use, or within 12 months of the date of dispatch of telefax sent under §8.10bis, whichever comes later, and shall submit in accordance with § 8.13 the updated characteristics of the frequency assignment with respect to which § 6.15*quat* has been applied. (WRC-23)

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[13] The "other provisions" shall be identified and included in the Rules of Procedure. (WRC-03)

[14] When an administration notifies any assignment with characteristics different from those entered in the List through successful application of Article 6 of Appendix **30B**, the Bureau shall undertake calculation to determine if the proposed new characteristics increase the interference level caused to other allotments and assignments in the Plan and List. The increase of the interference due to characteristics different from those entered in the List will be checked by comparing the *C*/*I* ratios of these other allotments and assignments, which result from the use of the proposed new characteristics of the subject assignment on the one hand, and those obtained with the characteristics of the subject assignment in the List, on the other hand. This *C*/*I* calculation is performed under the same technical assumptions and conditions. (WRC-07)

8.11 When the examination with respect to § 8.9 leads to a favourable finding, the assignment shall be recorded in the Master Register. When the finding is unfavourable, the notice shall be returned to the notifying administration, with an indication of the appropriate action. (WRC-03)

8.12 In every case when a new assignment is recorded in the Master Register it shall, in accordance with the provisions of Article **8**, include an indication of the finding reflecting the status of the assignment. This information shall also be published in the BR IFIC. (WRC-03)

8.13 A notice of a change in the characteristics of an assignment already recorded, as specified in Appendix **4**, shall be examined by the Bureau under § 8.8 and § 8.9, as appropriate. Any changes to the characteristics of an assignment that has been recorded and confirmed as having been brought into use shall be brought into use within eight years from the date of the notification of the modification. Any changes to the characteristics of an assignment that has been recorded but not yet brought into use shall be brought into use within the period provided for in §§ 6.1, 6.31 or 6.31*bis* of Article 6. (WRC-19)

8.14 (SUP - WRC-07)

8.15 In applying the provisions of this Article, any resubmitted notice which is received by the Bureau more than six months after the date on which the original notice was returned by the Bureau shall be considered to be a new notice. (WRC-03)

8.16 All frequency assignments notified in advance of their being brought into use shall be entered provisionally in the Master Register. Any frequency assignment provisionally recorded under this provision shall be brought into use no later than the end of the period provided for in § 6.31, § 6.31*bis* or § 6.31*ter* in the event of an extension under these provisions. Unless the Bureau has been informed by the notifying administration of the bringing into use of the assignment, it shall, no later than 15 days before the end of the regulatory period established under § 6.31, § 6.31*bis* or § 6.31*ter*, send a reminder requesting confirmation that the assignment has been brought into use within the regulatory period. If the Bureau does not receive that confirmation within 30 days following the period provided under § 6.31, § 6.31*bis* or § 6.31*ter* in the event of an extension under these provisions, it shall cancel the entry in the Master Register. In the event that an extension was requested under § 6.31*bis* but the Bureau determines that the conditions for an extension under § 6.31*bis* are not met, the Bureau shall inform the administration of its findings and cancel the entry in the Master Register. (WRC-23)

8.16*bis* In the event that the Bureau has been informed of agreement to new or modified frequency assignments in the List for a specified period of time in accordance with Article 6, the frequency assignment shall be recorded in the Master Register with a note indicating that the frequency assignment is valid only for the period specified[14*bis*]. The notifying administration using the frequency assignment over a specified period shall not subsequently invoke this fact to justify the continued use of the frequency beyond the period specified unless it obtains the agreement of the administration(s) concerned. (WRC-19)

[14*bis*] Unless the Bureau has been informed by the notifying administration of the renewal of the agreement, it shall, no later than six months before the end of the specified period, send a reminder to the notifying administration. (WRC-19)

8.17 Wherever the use of a recorded frequency assignment to a space station is suspended for a period exceeding six months, the notifying administration shall inform the Bureau of the date on which such use was suspended. When the recorded assignment is brought back into use, the notifying administration shall so inform the Bureau, as soon as possible. On receipt of the information sent under this provision, the Bureau shall make that information available on the ITU website as soon as possible and shall publish it in the BR IFIC. The date on which the assignment is brought back into use[14*ter*, 14*quater*] shall be no later than three years from the date on which the use of the frequency assignment was suspended, provided that the notifying administration informs the Bureau of the suspension within six months from the date on which the use was suspended. If the notifying administration informs the Bureau of the suspension more than six months after the date on which the use of the frequency assignment was suspended, this three-year time period shall be reduced. In this case, the amount by which the three-year period shall be reduced shall be equal to the amount of time that has elapsed between the end of the six-month period and the date that the Bureau is informed of the suspension. If the notifying administration informs the Bureau of the suspension more than 21 months after the date on which the use of the frequency assignment was suspended, the frequency assignment shall be cancelled from the Master Register and the Bureau shall apply the provisions of § 6.33. (WRC-23)

8.18 No provision of this Appendix shall be considered as modifying the requirements of Article **9** relating to coordination between earth stations in the fixed-satellite service and stations of terrestrial services sharing the planned bands on an equal primary basis. (WRC-03)

8.19 Notification of assignments to a specific earth station using assignments included in the List shall be effected applying the provisions of Article **11**. (WRC-03)

ARTICLE 9 (REV.WRC-07)

General provisions

9.1 The Plan is limited to national systems providing a domestic service. Administrations may, however, in accordance with the provisions of Article 6, convert their allotments or propose additional systems to provide national or multinational services.

9.2 (SUP - WRC-07)

14*ter* The date of bringing back into use of a frequency assignment to a space station in the geostationary-satellite orbit shall be the date of the commencement of the 90-day period defined below. A frequency assignment to a space station in the geostationary-satellite orbit shall be considered as having been brought back into use when a space station in the geostationary-satellite orbit with the capability of transmitting or receiving that frequency assignment has been deployed and maintained at the notified orbital position for a continuous period of 90 days. The notifying administration shall inform the Bureau within 30 days from the end of the 90-day period. Resolution **40 (Rev.WRC-19)** shall apply. (WRC-19)

14*quater* If the notifying administration has informed the Bureau of the date of commencement of the 90-day bringing-back-into-use period, but, as of 15 days after the end of the 90-day bringing-back-into-use period, has not yet informed the Bureau of the completion of the bringing-back-into-use period in accordance with footnote 14*ter*, the Bureau shall promptly send the notifying administration a reminder of its obligation to inform the Bureau of the completion of the bringing-back-into-use period under footnote 14*ter*. (WRC-23)

ARTICLE 10 (REV.WRC-23)

Plan for the fixed-satellite service in the frequency bands 4 500-4 800 MHz, 6 725-7 025 MHz, 10.70-10.95 GHz, 11.20-11.45 GHz and 12.75-13.25 GHz

A.1 COLUMN HEADINGS OF THE PLAN

Col. 2 *Nominal orbital position*, in degrees

Col. 3 *Longitude of the boresight*, in degrees

Col. 4 *Latitude of the boresight*, in degrees

Col. 5 *Major axis of the elliptical cross-section half-power beam*, in degrees

Col. 6 *Minor axis of the elliptical cross-section half-power beam*, in degrees

Col. 7 *Orientation of the ellipse* determined as follows: in a plane normal to the beam axis, the direction of the major axis of the ellipse is defined by the angle measured anticlockwise from a line parallel to the equatorial plane to the major axis of the ellipse, to the nearest degree

Col. 8 Earth station *e.i.r.p.* density (dB(W/Hz))

Col. 9 Satellite *e.i.r.p.* density (dB(W/Hz))

Col. 10 *Remarks*

1 Assignment converted from allotment.

2 The Administration of Luxembourg (LUX) agreed to operate the LUX-30B-6 satellite network within the characteristics included in the Appendix **30B** List, as modified during WRC-07, and to immediately eliminate interference that could be caused by LUX-30B-6 to the national allotment of the Islamic Republic of Iran (IRN00000) (IRN).

3 Allotment converted into assignment with a shaped beam and then reinstated back into the Plan.

4-5 (SUP - WRC-07)

6 Allotment reinstated from assignments which were provisionally entered in the List in accordance with § 6.25. §§ 6.26 to 6.29 apply. (WRC-15)

7 The conditions for conversion of this allotment into an assignment and the consequential bringing into use of the converted assignment are included in the notes in the relevant AP30B/P Special Section. (WRC-23)

Note by the Secretariat (applicable when an asterisk (*) appears in column 10): It is to be noted that this beam is intended to be implemented as part of a multi-beam network, operating from a single orbital location. Within any multi-beam network, the beams are the responsibility of a single administration, hence interference between them has not been taken into account during the Conference. The number which appears in the alphanumeric code that follows the asterisk serves to identify the multi-beam network concerned.

4 500-4 800 MHz, 6 725-7 025 MHz

1	2	3	4	5	6	7	8	9	10
ABW00000	−98.20	−69.10	12.40	1.60	1.60	90.00	−9.6	−41.4	
ADL00000	113.00	140.00	−66.70	1.60	1.60	90.00	−9.6	−41.3	*/MB1
AFG00000	50.00	66.40	33.90	2.20	1.60	15.00	−9.6	−39.4	
AFS00000	71.00	27.20	−30.10	5.30	1.60	128.00	−7.8	−38.6	
AGL00000	−36.10	15.90	−12.40	2.40	1.60	78.00	−9.6	−39.1	
ALB00000	4.13	20.00	41.10	1.60	1.60	90.00	−9.6	−41.4	
ALG00000	−33.50	1.60	27.80	3.30	2.20	133.00	−8.6	−38.9	
ALS00000	−159.00	−158.60	57.50	6.30	1.60	1.00	−7.9	−38.8	*/MB2
AND00000	−41.00	1.50	42.50	1.60	1.60	90.00	−9.6	−41.4	
ARG00000	−51.00	−62.00	−33.60	4.80	2.90	93.00	−2.5	−38.1	*/MB3
ARGINSUL	−51.00	−60.00	−57.50	3.60	1.60	154.00	−9.6	−38.5	*/MB3
ARM00000	71.40	45.13	40.12	1.60	1.60	90.00	−9.6	−40.4	
ARS00000	51.90	45.70	23.10	3.70	2.60	153.00	−8.7	−39.3	
ASCSTHTC	−37.10	−11.80	−19.60	5.60	1.80	77.00	−8.0	−39.0	*/MB4
ATG00000	−77.70	−61.80	17.00	1.60	1.60	90.00	−9.6	−41.8	
AUS00001	144.10	134.30	−24.50	6.60	5.30	146.00	1.9	−38.2	*/MB6
AUS00002	144.10	163.60	−30.50	1.60	1.60	90.00	−9.6	−39.5	*/MB6
AUS00003	144.10	101.50	−11.10	1.60	1.60	90.00	−9.6	−40.5	*/MB6
AUS00004	144.10	159.00	−54.50	1.60	1.60	90.00	−9.6	−41.6	*/MB6
AUS00005	144.10	110.40	−66.30	1.60	1.60	90.00	−9.6	−41.3	*/MB6
AUT00000	−11.40	13.20	47.50	1.60	1.60	90.00	−9.6	−40.8	
AZE00000	95.90	47.20	40.34	1.60	1.60	0.00	−9.6	−42.2	
AZR00000	−10.60	−28.00	38.70	1.60	1.60	90.00	−9.6	−41.1	*/MB7
B 00011	−65.00	−62.60	−6.00				−2.5	−38.7	3
B 00022	−56.50	−45.40	−6.30				−1.9	−38.6	3
B 00003	−69.45	−50.00	−20.90	4.30	3.00	60.00	−3.4	−38.5	
BAH00000	−74.30	−75.80	24.00	1.60	1.60	133.00	−9.6	−39.4	
BDI00000	−3.50	29.90	−3.40	1.60	1.60	90.00	−9.6	−41.6	
BEL00000	54.55	5.20	50.60	1.60	1.60	90.00	−9.6	−41.2	
BEN00000	−30.60	2.30	9.30	1.60	1.60	90.00	−9.6	−39.9	
BERCAYS	−37.10	−68.60	22.50	3.70	2.30	41.00	−5.6	−38.2	*/MB4
BFA00000	10.79	−1.40	12.20	1.70	1.60	24.00	−9.6	−39.5	
BGD00000	133.00	90.20	24.00	1.60	1.60	90.00	−9.6	−40.3	
BHR00000	13.60	50.60	26.10	1.60	1.60	90.00	−9.6	−41.9	
BIH00000	46.00	18.07	44.19	1.60	1.60	90.00	−5.1	−38.3	7
BLR00000	64.40	27.01	53.60	1.60	1.60	0.00	−9.4	−41.3	
BLZ00000	−90.80	−88.60	17.20	1.60	1.60	90.00	−9.6	−41.6	
BOL00000	−34.80	−64.40	−17.10	2.70	1.70	129.00	−7.5	−38.6	
BOT00000	21.20	24.00	−21.80	1.60	1.60	90.00	−9.6	−40.0	
BRB00000	−29.60	−59.60	13.20	1.60	1.60	90.00	−9.6	−41.6	
BRM00000	111.50	97.00	18.90	3.20	1.60	88.00	−7.2	−38.8	
BRU00000	157.30	114.60	4.50	1.60	1.60	90.00	−9.6	−40.9	
BTN00000	59.10	90.40	27.00	1.60	1.60	90.00	−9.6	−41.5	
BUL00000	56.02								1
CAF00000	14.40	21.50	6.50	2.70	1.70	14.00	−8.4	−39.1	
CAN0CENT	−111.10	−96.10	51.40	4.30	2.00	155.00	−7.6	−38.4	
CAN0EAST	−107.30	−76.60	50.10	5.00	1.70	154.00	−7.0	−38.3	
CAN0EASTM	−107.50	−76.60	50.10	5.00	1.70	154.00	−7.0	−38.4	
CAN0WEST	−114.90	−120.10	57.40	3.10	1.90	173.00	−9.6	−38.7	
CBG00000	96.10	105.10	12.90	1.60	1.60	90.00	−9.6	−40.4	
CHL00000	−74.90	−82.60	−32.80	8.10	6.10	155.00	−0.7	−38.4	
CHN00001	101.40	103.70	35.00	8.10	4.30	2.00	−0.1	−38.3	

4 500-4 800 MHz, 6 725-7 025 MHz

1	2	3	4	5	6	7	8	9	10
CHN00002	135.50	114.80	16.40	4.90	2.40	65.00	−3.6	−38.7	
CLM00000	−70.90	−74.00	5.70	4.00	2.30	121.00	−5.1	−38.9	
CLN00000	121.50	80.10	7.70	1.60	1.60	90.00	−9.6	−41.2	
CME00000	7.98	12.90	6.30	2.50	1.90	84.00	−8.4	−39.5	
CNR00000	−30.00	−15.90	28.50	1.60	1.60	90.00	−9.6	−41.3	*/MB8
COD00000	50.95	24.40	−4.60	3.90	3.50	92.00	−7.4	−38.5	
COG00000	−16.35	14.80	−0.60	2.00	1.60	63.00	−9.1	−38.8	
COM00000	94.50	44.10	−12.20	1.60	1.60	90.00	−9.6	−41.0	
CPV00000	−85.70	−24.10	16.00	1.60	1.60	90.00	−9.6	−41.3	
CTI00000	−15.76	−5.90	7.80	1.60	1.60	90.00	−9.6	−40.0	
CTR00000	−96.00	−85.30	8.20	1.60	1.60	90.00	−9.6	−40.2	
CUB00000	−80.60	−79.50	21.00	2.00	1.60	172.00	−9.6	−39.3	
CVA00000	59.00	12.50	41.90	1.60	1.60	90.00	−9.6	−41.3	
CYP00000	0.50	33.20	35.10	1.60	1.60	90.00	−9.6	−41.6	
CYPSBA00	57.50	32.90	34.60	1.60	1.60	90.00	−9.6	−41.7	*/MB9
CZE00000	−31.90	15.68	49.81	1.60	1.60	0.00	−9.6	−41.3	
D 00001	26.40	9.70	50.70	1.60	1.60	90.00	−9.6	−40.5	
D 00002	37.20	12.60	51.40	1.60	1.60	90.00	−9.6	−40.8	
DJI00000	−17.46	42.60	11.70	1.60	1.60	90.00	−9.6	−41.3	
DMA00000	−70.00	−61.30	15.30	1.60	1.60	90.00	−9.6	−41.8	
DNK00001	32.28	11.60	56.00	1.60	1.60	90.00	−9.6	−40.9	
DNK00002	−49.00	12.50	56.30	1.60	1.60	90.00	−9.6	−40.6	*/MB10
DNK00FAR	−49.00	−7.20	61.70	1.60	1.60	90.00	−9.6	−41.1	*/MB10
DOM00000	−85.40	−70.40	18.70	1.60	1.60	90.00	−9.6	−41.7	
E 00002	−30.00	−3.00	39.90	2.10	1.60	8.00	−9.6	−39.5	*/MB8
EGY00000	67.11	30.30	26.20	2.30	1.60	54.00	−9.6	−39.2	
EQA00000	−104.00	−83.10	−1.40	3.10	1.60	174.00	−7.8	−38.9	
ETH00000	58.30	40.60	10.30	2.80	2.80	64.00	−9.4	−39.4	
F 00000	−8.00								1
FIN00000	46.80	23.80	64.30	1.60	1.60	90.00	−9.6	−39.3	
FJI00000	148.80	178.50	−17.20	1.60	1.60	90.00	−9.6	−41.5	
FLKSTGGL	−37.10	−46.80	−59.60	3.70	1.60	170.00	−9.6	−38.8	*/MB4
G 00000	−37.10	−4.10	53.90	1.60	1.60	151.00	−9.6	−39.0	*/MB4
GAB00000	39.00	11.70	−0.70	1.60	1.60	90.00	−9.6	−39.8	
GDL00000	−8.00								1
GDL00002	−115.90	−61.80	16.40	1.60	1.60	90.00	−9.6	−40.3	*/MB13
GEO00000	78.00	43.29	42.21	1.60	1.60	90.00	−9.6	−42.4	7
GHA00000	15.90	−1.30	7.70	1.60	1.60	90.00	−9.6	−39.7	
GIB00000	57.50	−5.40	36.10	1.60	1.60	90.00	−9.6	−40.9	*/MB9
GMB00000	−34.00	−16.40	13.40	1.60	1.60	90.00	−9.6	−42.1	
GNB00000	40.00	−15.40	12.00	1.60	1.60	90.00	−9.6	−41.3	
GNE00000	−32.30	10.50	1.70	1.60	1.60	90.00	−9.6	−40.9	
GRC00000	22.05	24.70	38.30	1.70	1.60	160.00	−9.6	−39.3	
GRD00000	−32.80	−61.60	12.00	1.60	1.60	90.00	−9.6	−41.6	
GRL00000	−49.00	−42.90	68.60	2.30	1.60	174.00	−9.6	−38.6	*/MB10
GTM00000	−135.70	−90.50	15.50	1.60	1.60	90.00	−9.6	−40.5	
GUF00000	−8.00								1
GUF00002	−115.90	−53.30	4.30	1.60	1.60	90.00	−8.6	−39.4	*/MB13
GUI00000	27.50	−10.90	10.20	1.60	1.60	90.00	−9.6	−39.2	
GUMMRA0	−159.00	145.40	16.70	1.70	1.60	79.00	−9.4	−38.3	*/MB2
GUY00000	−23.80	−59.20	4.70	1.60	1.60	90.00	−9.6	−39.4	
HKG00000	57.50	114.50	22.40	1.60	1.60	90.00	−9.6	−40.6	

4 500-4 800 MHz, 6 725-7 025 MHz

1	2	3	4	5	6	7	8	9	10
HND00000	−76.20	−86.10	15.40	1.60	1.60	90.00	−9.6	−40.0	
HNG00000	−7.50	19.40	47.40	1.60	1.60	90.00	−9.6	−41.0	
HOL00000	−5.00	5.40	52.40	1.60	1.60	90.00	−9.6	−41.4	*/MB5
HRV00000	63.00	17.60	44.10	1.60	1.60	90.00	−9.6	−42.0	7
HTI00000	−92.00	−73.00	18.80	1.60	1.60	90.00	−9.6	−41.7	
HWA00000	−159.00	−157.60	20.70	1.60	1.60	90.00	−9.6	−40.2	*/MB2
HWL00000	−159.00	−176.60	0.10	1.60	1.60	90.00	−9.6	−41.8	*/MB2
I 00000	−23.40	11.30	40.90	2.10	1.60	141.00	−9.6	−38.9	
IND00000	74.00	82.70	18.90	6.20	4.90	120.00	0.3	−38.5	
INS00000	115.40	117.60	−1.80	9.40	4.30	170.00	1.8	−38.6	
IRL00000	−21.80	−8.20	53.20	1.60	1.60	90.00	−9.6	−41.1	
IRN00000	24.19	54.30	33.00	3.70	1.60	143.00	−9.6	−39.0	
IRQ00000	65.45	44.30	33.10	1.60	1.60	90.00	−9.6	−39.4	
ISL00000	−35.20	−18.20	64.90	1.60	1.60	90.00	−9.6	−40.5	
ISR00000	−4.00								1
J 00000	152.50	140.40	30.40	5.70	3.70	15.00	−2.3	−38.5	
JAR00000	−159.00	−160.00	−0.40	1.60	1.60	90.00	−9.6	−41.9	*/MB2
JMC00000	−108.60	−77.60	18.20	1.60	1.60	90.00	−9.6	−41.5	
JON00000	−159.00	−168.50	17.00	1.60	1.60	90.00	−9.6	−42.2	*/MB2
JOR00000	81.76	36.70	31.30	1.60	1.60	90.00	−9.6	−40.9	
KAZ00000	58.50	66.36	46.72	4.60	1.69	176.88	−9.6	−41.0	
KEN00000	78.20	38.40	0.80	2.10	1.60	95.00	−9.6	−39.3	
KER00000	113.00	69.30	−43.90	1.90	1.60	169.00	−9.6	−38.7	*/MB1
KGZ00000	64.60	74.54	41.15	1.60	1.60	90.00	−9.6	−38.8	
KIR00000	150.00	173.00	1.00	1.60	1.60	90.00	−9.6	−41.8	
KNA00000	−88.80	−62.90	17.30	1.60	1.60	90.00	−9.6	−41.6	
KOR00000	116.20	127.70	36.20	1.60	1.60	90.00	−9.6	−40.5	
KRE00000	145.00	127.80	39.80	1.60	1.60	90.00	−9.6	−39.6	
KWT00000	30.90	47.70	29.10	1.60	1.60	90.00	−9.6	−41.9	
LAO00000	142.00	104.10	18.10	1.60	1.60	90.00	−9.6	−39.1	
LBN00000	97.50	35.80	33.80	1.60	1.60	90.00	−9.6	−41.3	
LBR00000	−41.80	−8.90	6.50	1.60	1.60	90.00	−9.6	−40.4	
LBY00000	28.90	19.00	25.90	3.00	2.70	165.00	−6.8	−39.2	
LIE00000	−17.10	9.50	47.20	1.60	1.60	90.00	−9.6	−41.7	
LSO00000	−19.30	28.40	−29.50	1.60	1.60	90.00	−9.6	−41.5	
LTU00000	−9.30	23.67	55.23	1.60	1.60	0.00	−9.6	−42.8	
LUX00000	19.20	6.20	49.70	1.60	1.60	90.00	−9.6	−41.6	
MAC00000	117.00	113.60	22.20	1.60	1.60	90.00	−9.6	−41.8	
MAU00000	92.20	57.50	−20.20	1.60	1.60	90.00	−9.6	−41.4	
MCO00000	52.00						−15.6	−28.7	3, 6
MDA00000	75.10	28.34	46.96	1.60	1.60	90.00	−9.6	−42.4	7
MDG00000	16.90	46.60	−18.70	2.60	1.60	66.00	−7.5	−38.6	
MDR00000	−10.60	−16.20	31.60	1.60	1.60	90.00	−9.6	−41.7	*/MB7
MDW00000	−159.00	−177.40	28.20	1.60	1.60	90.00	−9.6	−42.0	*/MB2
MEX00000	−113.00	−103.60	23.30	5.80	2.40	161.00	−4.7	−38.8	
MHL00000	−159.00	175.30	8.70	2.30	1.60	94.00	−8.6	−38.8	*/MB2
MKD00000	−16.70	21.80	41.62	1.60	1.60	90.00	0.1	−33.1	7
MLA00000	78.50	108.20	4.70	3.20	1.60	0.00	−6.3	−38.5	
MLD00000	117.60	73.40	2.50	2.20	1.60	88.00	−9.6	−38.7	
MLI00000	−6.00	−3.90	17.60	3.30	2.50	21.00	−7.6	−39.2	
MLT00000	−3.00	14.40	35.90	1.60	1.60	90.00	−9.6	−41.8	
MNE	−36.6	19.22	42.65	1.6	1.6	0	−9.6	−42.3	

4 500-4 800 MHz, 6 725-7 025 MHz

1	2	3	4	5	6	7	8	9	10
MNG00000	113.60	103.80	46.80	3.60	1.60	3.00	−9.6	−38.9	
MOZ00000	90.60	35.60	−17.20	3.10	1.60	98.00	−7.7	−38.3	
MRC00000	32.86	−8.90	27.90	3.40	1.60	45.00	−9.6	−38.8	
MTN00000	−21.10	−10.30	19.80	2.50	2.40	76.00	−9.6	−39.4	
MWI00000	28.00	34.10	−13.30	1.60	1.60	90.00	−9.6	−40.0	
MYT00000	−8.00								1
NCG00000	−84.40	−84.90	12.90	1.60	1.60	90.00	−9.6	−40.6	
NCL00000	113.00	165.80	−21.40	1.60	1.60	90.00	−9.6	−40.6	*/MB1
NGR00000	−38.50	7.50	17.20	2.10	1.70	100.00	−9.6	−38.9	
NIG00000	41.82	8.00	9.90	2.50	1.60	47.00	−7.7	−38.5	
NMB00000	12.20	18.50	−21.00	2.70	2.60	155.00	−9.6	−39.5	
NOR00000	−0.80	11.70	64.60	2.00	1.60	17.00	−9.6	−38.7	
NPL00000	123.30	84.40	28.00	1.60	1.60	90.00	−9.6	−40.8	
NRU00000	146.00	166.90	−0.50	1.60	1.60	90.00	−9.6	−41.8	
NZL00001	152.00	170.90	−44.80	5.40	1.60	49.00	−7.4	−38.1	*/MB14
NZL00002	152.00	−165.40	−13.20	2.70	2.00	82.00	−7.3	−38.3	*/MB14
OCE00000	−115.90	−141.90	−16.10	3.50	2.40	139.00	−7.1	−38.9	*/MB13
OMA00000	104.00	55.10	21.60	1.90	1.60	61.00	−9.6	−39.2	
PAK00000	56.50	69.90	29.80	3.00	2.00	22.00	−9.3	−39.0	
PHL00000	161.00	122.23	11.37	3.33	1.60	79.65	−6.3	−38.4	
PLM00000	−159.00	−161.40	7.00	1.60	1.60	90.00	−9.6	−41.9	*/MB2
PNG00000	154.10	148.40	−6.60	3.30	2.30	167.00	−6.2	−39.0	
PNR00000	−79.20	−80.20	8.50	1.60	1.60	90.00	−9.6	−40.4	
POL00000	15.20	19.30	52.00	1.60	1.60	90.00	−9.6	−40.0	
POR00000	−10.60	−8.00	39.70	1.60	1.60	90.00	−9.6	−41.2	*/MB7
PRG00000	−81.50	−58.70	−23.10	1.60	1.60	90.00	−9.6	−39.1	
PRU00000	−89.90	−74.20	−8.40	3.60	2.40	111.00	−5.4	−38.7	
PTC00000	−62.30	−130.10	−25.10	1.60	1.60	90.00	−9.6	−41.2	
QAT00000	0.90	51.60	25.40	1.60	1.60	90.00	−9.6	−41.6	
REU00000	−8.00								1
REU00002	113.00	55.60	−21.10	1.60	1.60	90.00	−9.6	−40.6	*/MB1
ROU00000	30.45								1
RRW00000	17.60	29.70	−1.90	1.60	1.60	90.00	−9.6	−41.9	
RUS00001	61.00	51.50	52.99	5.56	2.01	10.74	−7.2	−38.3	
RUS00002	88.10	94.80	48.60	7.50	3.50	175.00	−1.4	−38.3	
RUS00003	138.50	138.14	53.83	5.86	2.09	8.41	−6.7	−38.2	
S 00000	5.00	16.70	60.90	1.60	1.60	90.00	−9.6	−40.2	
SDN00001	23.55	29.30	10.30	3.00	1.90	131.00	−9.3	−39.0	*/MB15
SDN00002	23.55	29.40	16.70	2.60	2.40	171.00	−9.6	−39.3	*/MB15
SEN00000	−48.40	−14.00	14.10	1.60	1.60	90.00	−9.6	−40.3	
SEY00000	42.25	51.50	−3.20	13.80	3.80	48.50	−3.0	−43.8	
SLM00000	147.50	159.00	−9.10	1.60	1.60	90.00	−9.6	−39.5	
SLV00000	−130.50	−89.00	13.70	1.60	1.60	90.00	−9.6	−40.9	
SMA00000	−159.00	−170.70	−14.20	1.60	1.60	90.00	−9.6	−42.2	*/MB2
SMO00000	−125.50	−172.10	−13.70	1.60	1.60	90.00	−9.6	−41.1	
SMR00000	16.50	12.50	43.90	1.60	1.60	90.00	−9.6	−42.0	
SNG00000	98.10	103.90	1.30	1.60	1.60	90.00	−9.6	−41.6	
SOM00000	98.40	46.00	6.30	3.10	1.60	72.00	−9.6	−38.8	
SPM00000	−8.00								1
SRB00000	−26.70	20.57	44.07	1.60	1.60	90.00	−9.6	−41.9	7
SRL00000	−51.80	−11.90	8.50	1.60	1.60	90.00	−9.6	−41.4	

4 500-4 800 MHz, 6 725-7 025 MHz

1	2	3	4	5	6	7	8	9	10
SSD00000	−23.90	30.25	8.06	1.73	1.60	110.06	−9.6	−39.7	7
STP00000	30.25	7.00	1.00	1.60	1.60	90.00	−9.6	−41.7	
SUI00000	9.45	8.20	46.50	1.60	1.60	90.00	−9.6	−41.3	
SUR00000	−77.00	−55.60	3.90	1.60	1.60	90.00	−9.6	−40.7	
SVK00000	−19.82	17.30	49.60	1.60	1.60	90.00	−9.6	−40.0	
SVN00000	43.04	18.70	44.40	1.60	1.60	90.00	−10.0	−40.5	
SWZ00000	30.10	31.30	−26.40	1.60	1.60	90.00	−9.6	−42.0	
SYR00000	18.00	38.60	35.30	1.60	1.60	90.00	−9.6	−40.8	
TCD00000	−9.90	18.40	15.60	3.50	1.60	97.00	−8.9	−39.0	
TGO00000	−23.15	0.80	8.60	1.60	1.60	90.00	−9.6	−40.4	
THA00000	120.60	100.90	12.80	2.80	1.60	83.00	−7.7	−38.8	
TON00000	−128.00	−175.20	−21.20	1.60	1.60	90.00	−9.6	−41.0	
TRD00000	−73.40	−61.10	10.80	1.60	1.60	90.00	−9.6	−41.8	
TUN00000	5.74	9.40	33.50	1.60	1.60	90.00	−9.6	−40.3	
TUR00000	8.50	34.10	38.90	2.80	1.60	171.00	−6.4	−38.6	
TUV00000	158.00	179.20	−8.50	1.60	1.60	90.00	−9.6	−41.8	
TZA00000	67.50	35.40	−5.90	2.40	1.60	117.00	−9.6	−39.3	
UAE00000	63.50	53.80	24.90	1.60	1.60	90.00	−9.6	−41.1	
UGA00000	31.50	32.20	0.90	1.60	1.60	90.00	−9.6	−40.3	
UKR00001	38.20	31.73	48.22	1.98	1.60	178.15	−15.1	−40.7	
URG00000	−86.10	−56.30	−33.70	1.60	1.60	90.00	−9.6	−40.7	
USA00000	−101.30	−93.90	36.80	8.20	3.60	172.00	−0.9	−38.3	*/MB16
USAVIPRT	−101.30	−64.50	17.80	1.60	1.60	90.00	−9.6	−41.4	*/MB16
UZB00000	110.50	65.45	41.09	1.60	1.60	0.00	−9.6	−40.3	
VCT00000	−93.10	−61.10	13.20	1.60	1.60	90.00	−9.6	−41.5	
VEN00001	−82.70	−66.40	6.80	2.80	2.10	142.00	−7.0	−38.9	*/MB17
VEN00002	−82.70	−63.60	15.70	1.60	1.60	90.00	−9.6	−41.7	*/MB17
VTN00000	107.00	16.00					−7.1	−35.8	3
VUT00000	150.70	168.40	−17.20	1.60	1.60	90.00	−9.6	−40.3	
WAK00000	−159.00	166.50	19.20	1.60	1.60	90.00	−9.6	−41.9	*/MB2
WAL00000	113.00	−177.10	−13.80	1.60	1.60	90.00	−9.0	−39.8	*/MB1
XAN00000	−5.00	−65.60	15.10	1.60	1.60	90.00	−9.6	−38.9	*/MB5
XCQ00000	−159.00	173.40	4.60	10.20	2.40	175.00	4.5	−35.6	*/MB2
YEM00001	27.00	44.20	15.10	1.60	1.60	90.00	−9.6	−41.4	
YEM00002	108.00	49.90	14.80	1.60	1.60	90.00	−9.6	−39.7	
ZMB00000	39.55	27.90	−12.80	2.40	1.60	26.00	−9.6	−39.6	
ZWE00000	65.60	30.00	−18.90	1.60	1.60	90.00	−9.6	−39.9	

10.70-10.95 GHz, 11.20-11.45 GHz, 12.75-13.25 GHz

1	2	3	4	5	6	7	8	9	10
ABW00000	−98.20	−69.10	12.40	0.80	0.80	90.00	−6.4	−25.8	
ADL00000	113.00	140.00	−66.70	0.80	0.80	90.00	−10.2	−31.9	*/MB1
AFG00000	50.00	66.40	33.90	2.20	1.30	15.00	−4.1	−29.2	
AFS00000	71.00	27.20	−30.10	5.30	1.40	128.00	3.3	−26.7	
AGL00000	−36.10	15.90	−12.40	2.40	1.40	78.00	1.1	−25.8	
ALB00000	4.13	20.00	41.10	0.80	0.80	90.00	−8.6	−28.2	
ALG00000	−33.50	1.60	27.80	3.30	2.20	133.00	3.4	−26.6	
ALS00000	−159.00	−158.60	57.50	6.30	1.50	1.00	1.6	−28.7	*/MB2
AND00000	−41.00	1.50	42.50	0.80	0.80	90.00	−10.2	−30.0	
ARG00000	−51.00	−62.00	−33.60	4.80	2.90	93.00	9.4	−21.9	*/MB3
ARGINSUL	−51.00	−60.00	−57.50	3.60	1.30	154.00	−1.4	−28.6	*/MB3
ARM00000	71.40	45.13	40.12	0.80	0.80	90.00	−10.2	−30.1	
ARS00000	51.90	45.70	23.10	3.70	2.60	153.00	0.8	−29.4	
ASCSTHTC	−37.10	−11.80	−19.60	5.60	1.80	77.00	2.1	−28.6	*/MB4
ATG00000	−77.70	−61.80	17.00	0.80	0.80	90.00	−7.2	−27.1	
AUS00001	144.10	134.30	−24.50	6.60	5.30	146.00	13.4	−22.1	*/MB6
AUS00002	144.10	163.60	−30.50	1.60	1.00	15.00	−2.9	−26.5	*/MB6
AUS00003	144.10	101.50	−11.10	1.10	1.00	15.00	−6.9	−28.5	*/MB6
AUS00004	144.10	159.00	−54.50	0.80	0.80	90.00	−10.2	−32.3	*/MB6
AUS00005	144.10	110.40	−66.30	0.80	0.80	90.00	−10.2	−31.8	*/MB6
AUT00000	−11.40	13.20	47.50	0.80	0.80	90.00	−8.1	−27.2	
AZE00000	95.90	47.20	40.34	0.80	0.80	0.00	−10.2	−31.0	
AZR00000	−10.60	−28.00	38.70	0.80	0.80	90.00	−8.7	−27.9	*/MB7
B 00011	−65.00	−62.60	−6.00				9.8	−22.4	3
B 00022	−56.50	−45.40	−6.30				0.8	−22.4	3
B 00003	−69.45	−50.00	−20.90	4.30	3.00	60.00	8.9	−22.2	
BAH00000	−74.30	−75.80	24.00	1.60	1.00	133.00	−0.8	−24.5	
BDI00000	−3.50	29.90	−3.40	0.80	0.80	90.00	−10.2	−29.9	
BEL00000	54.55	5.20	50.60	0.80	0.80	90.00	−10.2	−30.2	
BEN00000	−30.60	2.30	9.30	1.20	1.00	89.00	−2.1	−23.0	
BERCAYS	−37.10	−68.60	22.50	3.70	2.30	41.00	7.4	−21.8	*/MB4
BFA00000	10.79	−1.40	12.20	1.70	1.00	24.00	−0.6	−25.0	
BGD00000	133.00	90.20	24.00	0.80	0.80	90.00	−3.9	−21.9	
BHR00000	13.60	50.60	26.10	0.80	0.80	90.00	−10.2	−32.2	
BIH00000	46.00	18.07	44.19	0.80	0.80	90.00	−5.7	−27.5	7
BLR00000	64.40	27.01	53.60	1.14	0.80	25.74	−3.0	−30.0	
BLZ00000	−90.80	−88.60	17.20	0.80	0.80	90.00	−6.5	−26.6	
BOL00000	−34.80	−64.40	−17.10	2.70	1.70	129.00	4.3	−22.5	
BOT00000	21.20	24.00	−21.80	1.50	1.50	94.00	−6.0	−30.0	
BRB00000	−29.60	−59.60	13.20	0.80	0.80	90.00	−7.0	−26.4	
BRM00000	111.50	97.00	18.90	3.20	1.60	88.00	4.6	−22.6	
BRU00000	157.30	114.60	4.50	0.80	0.80	90.00	−6.9	−24.9	
BTN00000	59.10	90.40	27.00	0.80	0.80	90.00	−10.2	−29.3	
BUL00000	56.02								1
CAF00000	14.40	21.50	6.50	2.70	1.70	14.00	3.8	−22.8	
CAN0CENT	−111.10	−96.10	51.40	4.30	2.00	155.00	3.9	−26.7	
CAN0EASTM	−107.50	−76.60	50.10	5.00	1.70	154.00	6.2	−25.1	
CAN0WEST	−114.90	−120.10	57.40	3.10	1.90	173.00	−0.6	−28.7	
CBG00000	96.10	105.10	12.90	1.20	1.00	35.00	−2.5	−23.2	
CHL00000	−74.90	−82.60	−32.80	8.10	6.10	155.00	9.0	−28.4	
CHN00001	101.40	103.70	35.00	8.10	4.30	2.00	13.6	−23.2	
CHN00002	135.50	114.80	16.40	4.90	2.40	65.00	8.2	−22.5	

10.70-10.95 GHz, 11.20-11.45 GHz, 12.75-13.25 GHz

1	2	3	4	5	6	7	8	9	10
CLM00000	−70.90	−74.00	5.70	4.00	2.30	121.00	7.1	−22.6	
CLN00000	121.50	80.10	7.70	0.80	0.80	90.00	−6.5	−24.8	
CME00000	7.98	12.90	6.30	2.50	1.90	84.00	3.9	−22.7	
CNR00000	−30.00								1
COD00000	50.95	24.40	−4.60	3.90	3.50	92.00	6.5	−24.4	
COG00000	−16.35	14.80	−0.60	2.00	1.10	63.00	0.7	−22.7	
COM00000	94.50	44.10	−12.20	0.80	0.80	90.00	−6.7	−24.7	
CPV00000	−85.70	−24.10	16.00	0.80	0.80	90.00	−10.2	−30.4	
CTI00000	−15.76	−5.90	7.80	1.40	1.20	66.00	−0.9	−23.1	
CTR00000	−96.00	−85.30	8.20	1.30	1.00	64.00	−2.1	−23.2	
CUB00000	−80.60	−79.50	21.00	2.00	1.00	172.00	0.1	−24.6	
CVA00000	59.00	12.50	41.90	0.80	0.80	90.00	−9.3	−28.8	
CYP00000	0.50	33.20	35.10	0.80	0.80	90.00	−10.2	−29.8	
CYPSBA00	57.50	32.90	34.60	0.80	0.80	90.00	−10.2	−30.2	*/MB9
CZE00000	−31.90	15.68	49.81	0.80	0.80	0.00	−8.4	−30.5	
D 00001	26.40	9.70	50.70	1.10	1.00	41.00	−7.7	−28.7	
D 00002	37.20	12.60	51.40	0.80	0.80	90.00	−9.3	−28.2	
DJI00000	−17.46	42.60	11.70	0.80	0.80	90.00	−10.2	−30.1	
DMA00000	−70.00	−61.30	15.30	0.80	0.80	90.00	−7.3	−27.3	
DNK00001	32.28	11.60	56.00	0.80	0.80	90.00	−10.2	−29.0	
DNK00002	−49.00	12.50	56.30	0.80	0.80	90.00	−8.2	−27.7	*/MB10
DNK00FAR	−49.00	−7.20	61.70	0.80	0.80	90.00	−10.2	−29.5	*/MB10
DOM00000	−85.40	−70.40	18.70	0.80	0.80	90.00	−7.2	−27.1	
E 00002	−30.00								1
EGY00000	67.11	30.30	26.20	2.30	1.50	54.00	−2.7	−28.8	
EQA00000	−104.00	−83.10	−1.40	3.10	1.40	174.00	3.8	−22.7	
ETH00000	58.30	40.60	10.30	2.80	2.80	64.00	1.1	−28.6	
F 00000	−8.00								1
FIN00000	46.80	23.80	64.30	1.50	1.00	23.00	−6.2	−28.6	
FJI00000	148.80	178.50	−17.20	0.80	0.80	90.00	−7.0	−26.2	
FLKSTGGL	−37.10	−46.80	−59.60	3.70	1.40	170.00	−0.9	−28.7	*/MB4
G 00000	−37.10	−4.10	53.90	1.60	1.00	151.00	−4.7	−27.8	*/MB4
GAB00000	39.00	11.70	−0.70	1.40	1.10	79.00	−1.5	−23.0	
GDL00000	−8.00								1
GDL00002	−115.90	−61.80	16.40	0.80	0.80	90.00	−4.6	−22.7	*/MB13
GEO00000	78.00	43.29	42.21	0.80	0.80	90.00	−10.2	−31.1	7
GHA00000	15.90	−1.30	7.70	1.50	1.10	90.00	−1.0	−23.0	
GIB00000	57.50	−5.40	36.10	0.80	0.80	90.00	−6.8	−27.0	*/MB9
GMB00000	−34.00	−16.40	13.40	0.80	0.80	90.00	−10.2	−31.0	
GNB00000	40.00	−15.40	12.00	0.80	0.80	90.00	−9.2	−28.8	
GNE00000	−32.30	10.50	1.70	0.80	0.80	90.00	−6.8	−24.9	
GRC00000	22.05	24.70	38.30	1.70	1.00	160.00	−2.7	−26.6	
GRD00000	−32.80	−61.60	12.00	0.80	0.80	90.00	−7.1	−26.5	
GRL00000	−49.00	−42.90	68.60	2.30	1.00	174.00	−3.3	−27.8	*/MB10
GTM00000	−135.70	−90.50	15.50	0.80	0.80	90.00	−4.2	−22.2	
GUF00000	−8.00								1
GUF00002	−115.90	−53.30	4.30	0.80	0.80	90.00	−5.3	−23.4	*/MB13
GUI00000	27.50	−10.90	10.20	1.30	1.10	104.00	−1.5	−22.9	
GUMMRA0	−159.00	145.40	16.70	1.70	1.00	79.00	0.0	−22.2	*/MB2
GUY00000	−23.80	−59.20	4.70	1.40	1.00	94.00	−1.4	−22.8	
HKG00000	57.50	114.50	22.40	0.80	0.80	90.00	−6.5	−24.5	
HND00000	−76.20	−86.10	15.40	1.40	1.00	26.00	−1.8	−23.1	

10.70-10.95 GHz, 11.20-11.45 GHz, 12.75-13.25 GHz

1	2	3	4	5	6	7	8	9	10
HNG00000	−7.50	19.40	47.40	0.80	0.80	90.00	−8.8	−28.1	
HOL00000	−5.00	5.40	52.40	0.80	0.80	90.00	−10.2	−30.8	*/MB5
HRV00000	63.00	17.60	44.10	0.84	0.80	39.13	−3.8	−23.4	7
HTI00000	−92.00	−73.00	18.80	0.80	0.80	90.00	−7.1	−26.9	
HWA00000	−159.00	−157.60	20.70	1.20	1.00	157.00	−2.2	−23.1	*/MB2
HWL00000	−159.00	−176.60	0.10	0.80	0.80	90.00	−7.3	−27.4	*/MB2
I 00000	−23.40	11.30	40.90	2.10	1.00	141.00	−1.6	−26.4	
IND00000	74.00	82.70	18.90	6.20	4.90	120.00	12.6	−22.2	
INS00000	115.40	117.60	−1.80	9.40	4.30	170.00	13.7	−22.4	
IRL00000	−21.80	−8.20	53.20	0.80	0.80	90.00	−10.2	−29.3	
IRN00000	24.19	54.30	33.00	3.70	1.50	143.00	1.1	−27.5	2
IRQ00000	65.45	44.30	33.10	1.60	1.30	178.00	−4.0	−28.0	
ISL00000	−35.20	−18.20	64.90	0.80	0.80	90.00	−8.5	−27.4	
ISR00000	−4.00								1
J 00000	152.50	140.40	30.40	5.70	3.70	15.00	11.1	−22.8	
JAR00000	−159.00	−160.00	−0.40	0.80	0.80	90.00	−7.5	−27.5	*/MB2
JMC00000	−108.60	−77.60	18.20	0.80	0.80	90.00	−6.9	−25.9	
JON00000	−159.00	−168.50	17.00	0.80	0.80	90.00	−10.2	−32.5	*/MB2
JOR00000	81.76	36.70	31.30	0.80	0.80	90.00	−9.7	−28.5	
KAZ00000	58.50	66.36	46.72	4.60	1.69	176.88	−0.6	−28.0	
KEN00000	78.20	38.40	0.80	2.10	1.30	95.00	−2.1	−27.6	
KER00000	113.00	69.30	−43.90	1.90	1.60	169.00	−2.2	−27.8	*/MB1
KGZ00000	64.60	74.54	41.15	1.56	0.80	10.12	−8.3	−29.7	
KIR00000	150.00	173.00	1.00	0.80	0.80	90.00	−7.2	−27.1	
KNA00000	−88.80	−62.90	17.30	0.80	0.80	90.00	−7.1	−26.5	
KOR00000	116.20	127.70	36.20	1.30	1.00	4.00	−4.3	−26.7	
KRE00000	145.00	127.80	39.80	1.40	1.00	14.00	−1.2	−23.3	
KWT00000	30.90	47.70	29.10	0.80	0.80	90.00	−10.2	−31.6	
LAO00000	142.00	104.10	18.10	1.50	1.00	101.00	−0.7	−22.6	
LBN00000	97.50	35.80	33.80	0.80	0.80	90.00	−10.2	−30.5	
LBR00000	−41.80	−8.90	6.50	0.80	0.80	90.00	−4.0	−22.1	
LBY00000	28.90	19.00	25.90	3.00	2.70	165.00	3.1	−27.8	
LIE00000	−17.10	9.50	47.20	0.80	0.80	90.00	−10.2	−31.2	
LSO00000	−19.30	28.40	−29.50	0.80	0.80	90.00	−10.2	−31.1	
LTU00000	−9.30	23.67	55.23	0.80	0.80	0.00	−10.2	−32.5	
LUX00000	19.20	6.20	49.70	0.80	0.80	90.00	−10.2	−31.6	
MAC00000	117.00	113.60	22.20	0.80	0.80	90.00	−7.2	−27.1	
MAU00000	92.20	57.50	−20.20	0.80	0.80	90.00	−6.9	−25.6	
MCO00000	52.00								1
MDA00000	75.10	28.34	46.96	0.80	0.80	90.00	−10.2	−31.5	7
MDG00000	16.90	46.60	−18.70	2.60	1.00	66.00	1.6	−22.5	
MDR00000	−10.60	−16.20	31.60	0.80	0.80	90.00	−10.2	−30.5	*/MB7
MDW00000	−159.00	−177.40	28.20	0.80	0.80	90.00	−10.2	−32.2	*/MB2
MEX00000	−113.00								1
MHL00000	−159.00	175.30	8.70	2.30	1.40	94.00	2.7	−22.6	*/MB2
MKD00000	−16.70	21.80	41.62	0.80	0.80	90.00	6.9	−15.9	7
MLA00000	78.50	108.20	4.70	3.20	1.40	0.00	4.1	−22.3	
MLD00000	117.60	73.40	2.50	2.20	0.80	88.00	0.1	−22.4	
MLI00000	−6.00	−3.90	17.60	3.30	2.50	21.00	6.3	−24.8	
MLT00000	−3.00	14.40	35.90	0.80	0.80	90.00	−10.2	−30.4	
MNE	−36.6	19.22	42.65	0.8	0.8	0	−10.2	−30.8	
MNG00000	113.60	103.80	46.80	3.60	1.10	3.00	−0.3	−27.6	

10.70-10.95 GHz, 11.20-11.45 GHz, 12.75-13.25 GHz

1	2	3	4	5	6	7	8	9	10
MOZ00000	90.60	35.60	−17.20	3.10	1.10	98.00	3.2	−22.0	
MRC00000	32.86	−8.90	27.90	3.40	1.00	45.00	−0.5	−27.0	
MTN00000	−21.10	−10.30	19.80	2.50	2.40	76.00	0.1	−28.4	
MWI00000	28.00	34.10	−13.30	1.60	1.00	101.00	−6.7	−29.3	
MYT00000	−8.00								1
NCG00000	−84.40	−84.90	12.90	1.10	1.00	16.00	−2.8	−23.1	
NCL00000	113.00	165.80	−21.40	0.80	0.80	90.00	−5.9	−23.9	*/MB1
NGR00000	−38.50	7.50	17.20	2.10	1.70	100.00	−0.6	−27.3	
NIG00000	41.82	8.00	9.90	2.50	1.60	47.00	3.4	−22.4	
NMB00000	12.20	18.50	−21.00	2.70	2.60	155.00	−0.7	−29.6	
NOR00000	−0.80								1
NPL00000	123.30	84.40	28.00	0.80	0.80	90.00	−7.2	−26.6	
NRU00000	146.00	166.90	−0.50	0.80	0.80	90.00	−7.2	−27.2	
NZL00001	152.00	170.90	−44.80	5.40	1.00	49.00	2.0	−26.5	*/MB14
NZL00002	152.00	−165.40	−13.20	2.70	2.00	82.00	5.4	−22.0	*/MB14
OCE00000	−115.90	−141.90	−16.10	3.50	2.40	139.00	6.8	−24.2	*/MB13
OMA00000	104.00	55.10	21.60	1.90	1.00	61.00	−6.0	−29.3	
PAK00000	56.50	69.90	29.80	3.00	2.00	22.00	3.7	−25.7	
PHL00000	161.00	122.23	11.37	3.33	1.41	79.65	4.8	−22.3	
PLM00000	−159.00	−161.40	7.00	0.80	0.80	90.00	−7.6	−27.6	*/MB2
PNG00000	154.10	148.40	−6.60	3.30	2.30	167.00	6.0	−22.7	
PNR00000	−79.20	−80.20	8.50	1.20	1.00	177.00	−2.4	−23.2	
POL00000	15.20	19.30	52.00	1.30	1.00	166.00	−7.0	−28.7	
POR00000	−10.60	−8.00	39.70	0.80	0.80	90.00	−9.0	−28.1	*/MB7
PRG00000	−81.50	−58.70	−23.10	1.50	1.30	116.00	0.1	−22.8	
PRU00000	−89.90	−74.20	−8.40	3.60	2.40	111.00	6.9	−22.5	
PTC00000	−62.30	−130.10	−25.10	0.80	0.80	90.00	−10.2	−27.3	
QAT00000	0.90	51.60	25.40	0.80	0.80	90.00	−10.2	−31.5	
REU00000	−8.00								1
REU00002	113.00	55.60	−21.10	0.80	0.80	90.00	−6.4	−24.5	*/MB1
ROU00000	30.45								1
RRW00000	17.60	29.70	−1.90	0.80	0.80	90.00	−10.2	−30.8	
RUS00001	61.00	51.50	52.99	5.56	2.01	10.74	3.1	−28.2	
RUS00002	88.10						5.4	−26.32	3
RUS00003	138.50	138.14	53.83	5.86	2.09	8.41	3.3	−28.4	
S 00000	5.00								1
SDN00001	23.55	29.30	10.30	3.00	1.90	131.00	5.3	−24.0	*/MB15
SDN00002	23.55	29.40	16.70	2.60	2.40	171.00	1.1	−27.4	*/MB15
SEN00000	−48.40	−14.00	14.10	1.10	1.00	148.00	−2.3	−23.8	
SEY00000	42.25	51.50	−3.20	13.80	3.80	48.50	−1.3	−33.8	
SLM00000	147.50	159.00	−9.10	1.50	1.00	147.00	−1.2	−23.0	
SLV00000	−130.50	−89.00	13.70	0.80	0.80	90.00	−6.8	−24.9	
SMA00000	−159.00	−170.70	−14.20	0.80	0.80	90.00	−10.2	−31.1	*/MB2
SMO00000	−125.50	−172.10	−13.70	0.80	0.80	90.00	−6.6	−24.6	
SMR00000	16.50	12.50	43.90	0.80	0.80	90.00	−10.2	−30.3	
SNG00000	98.10	103.90	1.30	0.80	0.80	90.00	−7.3	−25.4	
SOM00000	98.40	46.00	6.30	3.10	1.00	72.00	−0.8	−25.5	
SPM00000	−8.00								1
SRB00000	−26.70	20.57	44.07	0.90	0.80	143.42	−9.6	−29.7	7
SRL00000	−51.80	−11.90	8.50	0.80	0.80	90.00	−6.9	−25.4	
SSD00000	−23.90	30.25	8.06	1.73	1.18	110.06	−3.8	−26.6	7
STP00000	30.25	7.00	1.00	0.80	0.80	90.00	−7.1	−27.0	

10.70-10.95 GHz, 11.20-11.45 GHz, 12.75-13.25 GHz

1	2	3	4	5	6	7	8	9	10
SUI00000	9.45	8.20	46.50	0.80	0.80	90.00	−10.2	−29.4	
SUR00000	−77.00	−55.60	3.90	1.00	0.90	37.00	−3.6	−23.2	
SVK00000	−19.82	17.30	49.60	1.30	1.00	166.00	−5.1	−27.4	
SVN00000	43.04	18.70	44.40	1.10	1.00	161.00	−7.1	−27.3	
SWZ00000	30.10	31.30	−26.40	0.80	0.80	90.00	−10.2	−30.9	
SYR00000	18.00	38.60	35.30	1.10	1.00	32.00	−7.1	−28.3	
TCD00000	−9.90	18.40	15.60	3.50	1.60	97.00	5.0	−24.1	
TGO00000	−23.15	0.80	8.60	1.10	1.00	116.00	−2.7	−23.2	
THA00000	120.60	100.90	12.80	2.80	1.60	83.00	4.0	−22.6	
TON00000	−128.00	−175.20	−21.20	0.80	0.80	90.00	−6.7	−24.7	
TRD00000	−73.40	−61.10	10.80	0.80	0.80	90.00	−7.2	−27.3	
TUN00000	5.74	9.40	33.50	1.30	1.00	104.00	−5.9	−28.2	
TUR00000	8.50	34.10	38.90	2.80	1.00	171.00	0.0	−26.0	
TUV00000	158.00	179.20	−8.50	0.80	0.80	90.00	−7.1	−27.1	
TZA00000	67.50	35.40	−5.90	2.40	1.40	117.00	−1.3	−27.8	
UAE00000	63.50	53.80	24.90	1.10	1.00	12.00	−9.7	−30.4	
UGA00000	31.50	32.20	0.90	1.50	1.00	70.00	−6.3	−28.9	
UKR00001	38.20	31.73	48.22	2.21	0.97	178.15	−9.1	−31.0	
URG00000	−86.10	−56.30	−33.70	1.10	1.00	58.00	−6.5	−27.7	
USA00000	−101.30								1
USAVIPRT	−101.30								1
UZB00000	110.50	65.45	41.09	1.49	1.05	10.98	−10.2	−31.0	
VCT00000	−93.10	−61.10	13.20	0.80	0.80	90.00	−7.0	−26.2	
VEN00001	−82.70	−66.40	6.80	2.80	2.10	142.00	4.9	−22.8	*/MB17
VEN00002	−82.70	−63.60	15.70	0.80	0.80	90.00	−7.1	−27.0	*/MB17
VTN00000	107.00						2.9	−18.6	3
VUT00000	150.70	168.40	−17.20	1.20	1.00	122.00	−2.4	−23.1	
WAK00000	−159.00	166.50	19.20	0.80	0.80	90.00	−10.2	−31.9	*/MB2
WAL00000	113.00	−177.10	−13.80	0.80	0.80	90.00	−6.0	−24.1	*/MB1
XAN00000	−5.00	−65.60	15.10	1.30	1.00	58.00	−1.1	−22.3	*/MB5
XCQ00000	−159.00	173.40	4.60	10.20	2.40	175.00	16.0	−16.0	*/MB2
YEM00001	27.00	44.20	15.10	1.00	1.00	103.00	−9.8	−30.1	
YEM00002	108.00	49.90	14.80	1.40	1.00	53.00	−5.7	−26.9	
ZMB00000	39.55	27.90	−12.80	2.40	1.60	26.00	−3.0	−29.2	
ZWE00000	65.60	30.00	−18.90	1.50	1.10	140.00	−6.0	−28.9	

ARTICLE 11 (REV.WRC-07)

Period of validity of the provisions and associated Plan

11.1 These provisions and associated Plan have been prepared in order to guarantee in practice for all countries equitable access to the GSO and the frequency bands contained in Article 3, to meet the requirements of the fixed-satellite service for a period of at least 20 years from the date of entry into force of this Appendix.

11.2 These provisions and associated Plan shall, in any event, remain in force until their revision by a competent world radiocommunication conference, convened in accordance with the relevant provisions of the ITU Constitution and Convention in force. (WRC-07)

ANNEX 1 (WRC-03)

Parameters used in characterizing the fixed-satellite service allotment Plan (WRC-07)

Section A (SUP - WRC-07)

1 Basic technical characteristics

The allotments in the Plan are based on a reference satellite network with the following assumptions:

1.1 Type of modulation

The Plan is independent of modulation characteristics and accessing techniques.

1.2 Parameters used for calculating the earth station and space station power densities

The carrier-to-noise ratio (C/N) is as follows:

a) the uplink C/N ratio exceeds 21 dB under rain-faded conditions with a minimum earth station transmitter power density of −60 dB(W/Hz) averaged over the necessary bandwidth of the modulated carrier;

b) the downlink C/N ratio exceeds 15 dB under rain-faded conditions;

c) for the 6/4 GHz bands, the above C/Ns are exceeded for 99.95% of the year

(NOTE – The rain attenuation margin is limited to a maximum of 8 dB);

d) for the 13/10-11 GHz bands, the above C/Ns are exceeded for 99.9% of the year

(NOTE – The rain attenuation margin is limited to a maximum of 8 dB);

e) the gaseous atmospheric attenuation and rain attenuation models used are those described in Recommendations ITU-R P.676-7 and ITU-R P.618-9. (WRC-07)

1.3 Earth station antenna elevation angle

The minimum elevation angle for each test point included in the service area is based on the following:

10° for $Rp \leq 40$ mm/h;

20° for $40 < Rp \leq 70$ mm/h;

30° for $70 < Rp \leq 100$ mm/h;

40° for $Rp > 100$ mm/h.

Where Rp is the rainfall rate exceeded for any given percentage p of the average year, calculated in accordance with Recommendation ITU-R P.837-5. Administrations may select lower elevation angles for their service areas. For countries at high latitudes or with dispersed territories, in the absence of such a request, if the above values for minimum elevation angle are unobtainable, then the highest elevation angle leading to a non-zero range of possible orbital positions applies. In mountainous areas, the elevation angles are specified by the administrations concerned. (WRC-07)

1.4 Interference criteria

The Plan has been prepared with a view to assuring for each allotment an overall aggregate carrier-to-interference value under free-space conditions of 21 dB or higher, and an overall single entry carrier-to-interference value under free-space conditions of 25 dB. (WRC-07)

1.5 Polarization

Polarization isolation between satellite networks was not used in the development of the Allotment Plan.

1.6 Earth station characteristics

1.6.1 The diameters of the earth station antennas are:

5.5 m for the 6/4 GHz band;

2.7 m for the 13/10-11 GHz band. (WRC-07)

1.6.2 The earth station receiving system noise temperature referred to the output of the receiving antenna is:

95 K for the 4 GHz band;

125 K for the 10-11 GHz band. (WRC-07)

1.6.3 The earth station antenna efficiency is 70%.

1.6.3*bis* The gains of the earth station antennas for the diameters and the efficiency specified above at the indicated evaluation frequencies are as follows:

50.4 dBi at 6 875 MHz;

47.0 dBi at 4 650 MHz;

49.8 dBi at 13.0 GHz;

48.4 dBi at 11.075 GHz. (WRC-07)

1.6.4 The applicable earth station reference antenna pattern is shown in Table 1 below. (WRC-07)

TABLE 1 (WRC-07)

$G_{max} = 10 \log (\eta(\pi D/\lambda)^2)$			dBi
$G(\varphi) = G_{max} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda}\varphi\right)^2$	for	$0 < \varphi < \varphi_m$	dBi
$G(\varphi) = \min (G_1, 29 - 25 \log \varphi)$	for	$\varphi_m \le \varphi \le 19.95°$	dBi
$G(\varphi) = \max (\min (-3.5, 32 - 25 \log \varphi), -10)$	for	$\varphi > 19.95°$	dBi

where:

D : antenna diameter
λ : wavelength
} expressed in the same unit

φ : off-axis angle of the antenna (degrees)

G_1 : gain of the first side lobe $= -1 + 15 \log \frac{D}{\lambda}$ dBi

$$\varphi_m = \frac{20\lambda}{D} \times \sqrt{G_{\max} - G_1} \quad \text{degrees}$$

η : antenna efficiency

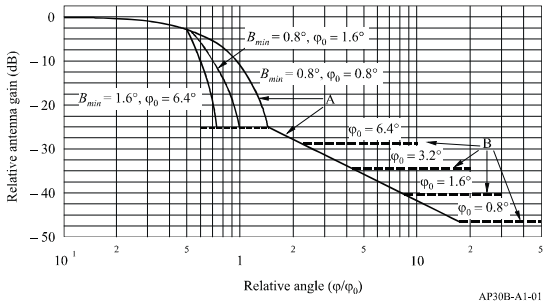
1.7 Space station characteristics (WRC-07)

1.7.1 The allotment Plan is based on the use of space station antennas with beams of elliptical cross-section.

1.7.2 The antenna radiation characteristics are as shown in Fig. 1.

FIGURE 1* (WRC-07)

Reference patterns for satellite antennas with fast roll-off in the main beam



$G_{max} = 44.45 - 10 \log (\varphi_{01} \cdot \varphi_{02})$ dBi (WRC-07)

* Figure 1 represents patterns for some combinations of B_{min} and φ_0. (WRC-07)

Curve A: dB relative to main beam gain

$-12\,(\varphi/\varphi_0)^2$ for $0 \le (\varphi/\varphi_0) \le 0.5$

$-12\left[\dfrac{(\varphi/\varphi_0) - x}{B_{min}/\varphi_0}\right]^2$ for $0.5 < (\varphi/\varphi_0) \le \left(\dfrac{1.45B_{min}}{\varphi_0} + x\right)$

-25.23 for $\left(\dfrac{1.45B_{min}}{\varphi_0} + x\right) < (\varphi/\varphi_0) \le 1.45$

$-(22 + 20 \log (\varphi/\varphi_0))$ for $(\varphi/\varphi_0) > 1.45$

after intersection with Curve B: Curve B.

Curve B: minus the on-axis gain (Curve B represents examples of four antennas having different values of φ_0 as labelled in Fig. 1. The on-axis gains of these antennas are approximately 28.3, 34.3, 40.4 and 46.4 dBi, respectively) (WRC-07)

where:

φ : off-axis angle (degrees)

φ_0 : cross-sectional half-power beamwidth in the direction of interest (degrees)

φ_{01}, φ_{02} : major and minor axis half-power beamwidth, respectively, of elliptical beam (degrees) (WRC-07)

$$x = 0.5\left(1 - \frac{B_{min}}{\varphi_0}\right)$$

where:

$$B_{min} = \begin{cases} 0.8° & \text{for 13/10-11 GHz} \\ 1.6° & \text{for 6/4 GHz} \end{cases}$$

1.7.3 The space station receiving system noise temperature referred to the output of the receiving antenna is:

500 K for the 6 GHz band;

550 K for the 13 GHz band.

1.7.4 The minimum beamwidth size, in terms of the half-power beamwidth, is 1.6° for the 6/4 GHz band and 0.8° for the 13/10-11 GHz band.

1.7.5 The space station antenna efficiency is 55%.

1.7.6 The deviation of the space station antenna beam from its nominal pointing direction is limited to 0.1° in any direction. The rotation accuracy of elliptical beams is ±1.0°.

1.8 Bandwidth

The allotment Plan is based on the carrier power averaged over the necessary bandwidth of the modulated carrier and referred to a 1 MHz bandwidth.

Section B (SUP - WRC-07)

ANNEX 2 (SUP - WRC-07)

ANNEX 3 (REV.WRC-19)

Limits applicable to submissions received under Article 6 or Article 7[15]

Under assumed free-space propagation conditions, the power flux-density (space-to-Earth) of a proposed new allotment or assignment produced on any portion of the surface of the Earth shall not exceed:

– −131.4 dB(W/(m^2 · MHz)) in the frequency band 4 500-4 800 MHz; and

– −118.4 dB(W/(m^2 · MHz)) in the frequency bands 10.70-10.95 GHz and 11.20-11.45 GHz.

Under assumed free-space propagation conditions, the power flux-density (Earth-to-space) of a proposed new allotment or assignment shall not exceed:

– −140.0 dB(W/(m^2 · MHz)) towards any location in the geostationary-satellite orbit located more than 7° from the proposed orbital position in the frequency band 6 725-7 025 MHz, and

– −133.0 dB(W/(m^2 · MHz)) towards any location in the geostationary-satellite orbit located more than 6° from the proposed orbital position in the frequency band 12.75-13.25 GHz.

ANNEX 4 (REV.WRC-19)

Criteria for determining whether an allotment or an assignment is considered to be affected[15*bis*]

An allotment or an assignment is considered as being affected by a proposed new allotment or assignment:

1 if the orbital spacing between its orbital position and the orbital position of the proposed new allotment or assignment is equal to or less than:

1.1 7° in the frequency bands 4 500-4 800 MHz (space-to-Earth) and 6 725-7 025 MHz (Earth-to-space);

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[15] These limits shall not apply to assignments submitted in accordance with Article 6 or recorded in the List before 23 November 2019. For assignments submitted under § 6.17 after 22 November 2019, related to assignments submitted under § 6.1 before 23 November 2019, the limits specified in Annex 3 (Rev.WRC-07) apply. (WRC-19)

[15*bis*] For frequency assignments recorded in the List and brought into use before 23 November 2019, the criteria of § 2.2 of this Annex are not applicable. (WRC-19)

1.2 6° in the frequency bands 10.70-10.95 GHz (space-to-Earth), 11.20-11.45 GHz (space-to-Earth) and 12.75-13.25 GHz (Earth-to-space).

2 However, an allotment or an assignment is considered as not being affected if at least one of the following conditions is satisfied:

2.1 the calculated[16] Earth-to-space single-entry carrier-to-interference $(C/I)_u$ value at each test point associated with the allotment or assignment under consideration is greater than or equal to a reference value that is 30 dB, or $(C/N)_u$ + 9 dB[17, 17bis], whichever is the lowest, and the calculated[16] space-to-Earth single-entry $(C/I)_d$ value everywhere within the service area of the allotment or assignment under consideration is greater than or equal to a reference value[19] that is 26.65 dB, or $(C/N)_d$ + 11.65 dB[20, 20bis], whichever is the lowest, and the calculated[16] overall aggregate $(C/I)_{agg}$ value at each test point associated with the allotment or assignment under consideration is greater than or equal to a reference value that is 21 dB, or $(C/N)_t$ + 7 dB[21], or any already accepted overall aggregate $(C/I)_{agg}$ value, whichever is the lowest, with a tolerance of 0.25 dB[22] in the case of assignments not stemming from the conversion of an allotment into an assignment without modification, or when the modification is within the envelope characteristics of the initial allotment;

2.2 in the frequency band 6 725-7 025 MHz (Earth-to-space), the pfd produced at the location in the geostationary-satellite orbit of the allotment or assignment under consideration under assumed free-space propagation conditions does not exceed $-204.0 - G_{Rx}$ dB(W/(m^2 · Hz)), where G_{Rx} (dB) is the relative space station uplink receive antenna gain of the potentially affected assignment at the location of the interfering earth station;

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16 Including a computational precision of 0.05 dB.

17 C/N_u is calculated as in Appendix **2** to this Annex.

17*bis* Any already accepted Earth-to-space single-entry $(C/I)_u$ value, excluding values accepted in accordance with § 6.15 of Article 6, could be used by administrations during coordination of their respective networks. The Bureau shall continue to make available any already accepted Earth-to-space single-entry $(C/I)_u$ value. (WRC-19)

18 (SUP - WRC-19)

19 The reference values within the service area are interpolated from the reference values on the test points.

20 C/N_d is calculated as in Appendix **2** to this Annex.

20*bis* Any already accepted space-to-Earth single-entry $(C/I)_d$ value could be used by administrations during coordination of their respective networks. The Bureau shall continue to make available any already accepted space-to-Earth single-entry $(C/I)_d$ value. (WRC-19)

21 $(C/N)_t$ is calculated as in Appendix **2** of this Annex.

22 Inclusive of the 0.05 dB computational precision.

in the frequency band 4 500-4 800 MHz (space-to-Earth), the pfd produced under assumed free-space propagation conditions does not exceed the threshold values shown below, anywhere within the service area of the allotment or assignment under consideration:

$0° \leq \theta \leq 0.09°$	-243.5	dB(W/(m^2 · Hz))
$0.09° < \theta \leq 3°$	$-243.5 + 20\log(\theta/0.09)$	dB(W/(m^2 · Hz))
$3° < \theta \leq 5.5°$	$-219.79 + 0.75 \cdot \theta^2$	dB(W/(m^2 · Hz))
$5.5° < \theta \leq 7°$	$-197.1 + 25\log(\theta/5.5)$	dB(W/(m^2 · Hz))

where θ denotes nominal geocentric separation (degrees) between interfering and interfered-with satellite networks;

in the frequency band 12.75-13.25 GHz (Earth-to-space), the pfd produced at the location in the geostationary-satellite orbit of the allotment or assignment under consideration under assumed free-space propagation conditions does not exceed $-208.0 - G_{Rx}$ dB(W/(m^2 · Hz)), where G_{Rx} (dB) is the relative space station uplink receive antenna gain of the potentially affected assignment at the location of the interfering earth station;

in the frequency bands 10.7-10.95 GHz and 11.2-11.45 GHz (space-to-Earth), the pfd produced under assumed free-space propagation conditions does not exceed the threshold values shown below, anywhere within the service area of the allotment or assignment under consideration:

$0° \leq \theta \leq 0.05°$	-238.0	dB(W/(m^2 · Hz))
$0.05° < \theta \leq 3°$	$-238.0 + 20\log(\theta/0.05)$	dB(W/(m^2 · Hz))
$3° < \theta \leq 5°$	$-210.98 + 0.95 \cdot \theta^2$	dB(W/(m^2 · Hz))
$5° < \theta \leq 6°$	$-187.23 + 25\log(\theta/5)$	dB(W/(m^2 · Hz))

where θ denotes nominal geocentric separation (degrees) between interfering and interfered-with satellite networks.

APPENDIX 1 TO ANNEX 4 (REV.WRC-23)

Method for determination of the overall single-entry and aggregate carrier-to-interference value averaged over the necessary bandwidth of the modulated carrier

1 Single-entry *C*/*I*

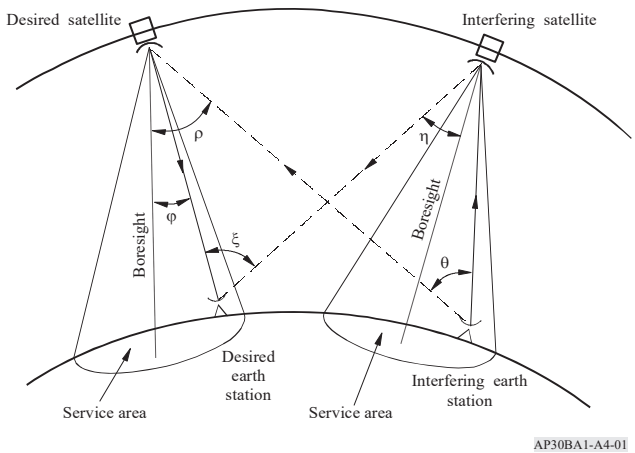
This section describes the method for calculating the single-entry interference potential.

The method is based on the single-entry carrier-to-interference ratio (*C*/*I*) which a given allotment or assignment made in accordance with the provisions of Appendix **30B** might experience due to an emission from the proposed new assignment or modification. The single-entry uplink $(C/I)_u$ and downlink $(C/I)_d$ values due to a single interfering satellite network are given by:

$$(C/I)_u = 10\log_{10}\left(\frac{p_1 g_1 g_2(\varphi) l_{su'}}{p_1' g_1'(\theta) g_2(\rho) l_{su}}\right) \quad \text{dB}$$

$$(C/I)_d = 10\log_{10}\left(\frac{p_3 g_3(\varphi) g_4 l_{sd'}}{p_3' g_3'(\eta) g_4(\xi) l_{sd}}\right) \quad \text{dB}$$

FIGURE 1



where:

θ, φ, ρ, η, ξ are angles as defined in Fig. 1 above.

In the following, all ratios are numerical power ratios:

p_1: power density, averaged over the necessary bandwidth of the modulated carrier, fed into the desired earth station transmitting antenna (W/Hz)

g_1: maximum gain of the desired transmitting earth station antenna

l_{su}: free-space path loss of the desired up-path signal

$l_{su'}$: free-space path loss of the interfering up-path signal

$g_2(\varphi)$: gain of the desired space station receiving antenna in the direction of the desired earth station

g_2: maximum gain of the desired space station receiving antenna

p_1': power density, averaged over the necessary bandwidth of the modulated carrier, fed into the interfering earth station transmitting antenna (W/Hz)

$g_1'(\theta)$: interfering earth station antenna gain in the direction of the desired satellite

l_{sd}: free-space path loss of the desired down-path signal

$l_{sd'}$: free-space path loss of the interfering down-path signal

$g_2(\rho)$: gain of the desired space station receiving antenna in the direction of the interfering earth station

p_3: power density, averaged over the necessary bandwidth of the modulated carrier, fed into the desired space station transmitting antenna (W/Hz)

$g_3(\varphi)$: desired space station transmitting antenna gain in the direction of the desired earth station

g_3: maximum gain of the desired space station transmitting antenna

g_4: maximum gain of the desired receiving earth station antenna

p_3': power density, averaged over the necessary bandwidth of the modulated carrier, fed into the interfering space station transmitting antenna (W/Hz)

$g_3'(\eta)$: interfering space station transmitting antenna gain in the direction of the desired earth station

$g_4(\xi)$: desired earth station receiving antenna gain in the direction of the interfering satellite.

The overall single-entry $(C/I)_t$ at a given downlink test point due to a single interfering allotment or assignment is given by:

$$(C/I)_t = -10\log_{10}\left[10^{-\frac{(C/I)_{u_{min}}}{10}} + 10^{-\frac{(C/I)_d}{10}}\right] \quad \text{dB}$$

where:

$(C/I)_{u_{min}}$: lowest uplink C/I value among all uplink test points

$(C/I)_d$: downlink C/I value at the test point under consideration.

2 Aggregate *C/I*

The aggregate $(C/I)_{agg}$ at a given downlink test point is given by:

$$(C/I)_{agg} = -10 \log_{10} \left(\sum_{j}^{n} 10^{-\frac{(C/I)_{t_j}}{10}} \right) \quad \text{dB}$$

$$j = 1, 2, 3 \ldots n,$$

where:

$(C/I)_{tj}$: overall carrier-to-interference ratio due to interference from the jth allotment or assignment calculated using the method for overall single-entry $(C/I)_t$ as provided in § 1 of Appendix 1 to this Annex; and

n: total number of interfering allotments or assignments for which the orbital separation with the desired satellite is less than or equal to 7° in the case of the 6/4 GHz band and less than or equal to 6° in the case of the 13/10-11 GHz band.

APPENDIX 2 TO ANNEX 4 (WRC-07)

Method for determination of the carrier-to-noise (*C/N*) values

The uplink carrier-to noise value $(C/N)_u$ and the downlink carrier-to-noise value $(C/N)_d$ are calculated as follows:

$$(C/N)_u = 10 \log_{10} \left(\frac{p_1 \cdot g_1 \cdot g_2(\varphi)}{k.Ts.l_{su}} \right) \quad \text{dB}$$

$$(C/N)_d = 10 \log_{10} \left(\frac{p_3 \cdot g_4 \cdot g_3(\varphi)}{k.Te.l_{sd}} \right) \quad \text{dB}$$

where:

In the following, all ratios are numerical power ratios.

p_1: power density, averaged over the necessary bandwidth of the modulated carrier, fed into the earth station transmitting antenna (W/Hz)

g_1: maximum gain of the transmitting earth station antenna

l_{su}: free-space path loss of the up-path signal

$g_2(\varphi)$: gain of the space station receiving antenna in the direction of the earth station

Ts: space station receiving system noise temperature referred to the output of the receiving antenna

p_3: power density, averaged over the necessary bandwidth of the modulated carrier, fed into the space station transmitting antenna (W/Hz)

$g_3(\varphi)$: space station transmitting antenna gain in the direction of the earth station

l_{sd}: free-space path loss of the down-path signal

g_4: maximum gain of the receiving earth station antenna

Te: earth station receiving system noise temperature, referred to the output of the receiving antenna

k: Boltzmann's constant.

The overall carrier-to-noise value $(C/N)_t$ is then calculated as follows:

$$(C/N)_t = -10 \log_{10} \left[10^{-\frac{(C/N)_{u_{min}}}{10}} + 10^{-\frac{(C/N)_d}{10}} \right] \quad \text{dB}$$

where:

$(C/N)_{u_{min}}$: lowest uplink *C/N* value among all test points

$(C/N)_d$: downlink *C/N* value at the test point under consideration.

NOTE – When only one of the uplink or the downlink is implemented in the bands subject to Appendix **30B**, only the contribution from the link that is implemented in the bands subject to Appendix **30B** shall be considered in calculating $(C/N)_t$.

ANNEX 5 (SUP - WRC-07)

ANNEX 6 (SUP - WRC-07)

ANNEX 7 (WRC-23)

Measures in order to facilitate the addition of a new allotment to the Plan for a new Member State of the Union[23]

1 Methods and criteria contained in Appendices 1 and 2 to Attachment 1 to Resolution **170 (Rev.WRC-23)** shall apply.

2 For examination of submissions under § 6.17 of Article 6:

2.1 If an allotment is still identified as being affected by the proposed new allotment, and the orbital position together with the associated technical parameters of the proposed new allotment are not those identified by the Bureau under § 7.4 of Article 7, and the notifying administration insists, the proposed new allotment shall be entered in the List by the Bureau provided that the administration responsible for the affected allotment does not object to the condition that an agreement shall be reached with that responsible administration before the assignment stemming from the conversion of the future allotment is brought into use under Article 8 of Appendix **30B**. In this case, in updating the reference situation of that affected allotment, the proposed new allotment shall not be taken into account.

2.2 If an assignment is still identified as being affected by the proposed new allotment, and the notifying administration insists, the proposed new allotment shall be entered in the List by the Bureau subject to the conditions that, should harmful interference be caused by an assignment stemming from the conversion of the future allotment to any assignment which was the basis of the disagreement, the notifying administration of the converted allotment shall, upon receipt of advice thereof, immediately eliminate this harmful interference. In this case, in updating the reference situation of that affected assignment, the proposed new allotment shall not be taken into account.

3 The notifying administration of a satellite network for which the Bureau has previously received complete information and which has been examined, or is at the stage of examination under § 6.5 before a proposed new allotment, shall make the utmost effort to avoid degradation of the reference situation of the proposed new allotment and to overcome difficulty in coordination with the new Member State which is requesting the new allotment, recognizing that some of these identified satellite networks could be in the final stages of implementation. The notifying administration may request the assistance of the Bureau.

4 The Bureau shall apply the same course of action of footnote 7*bis* to § 6.21*c)* of Article 6 to review the coordination status of the proposed new allotment when any remaining affected networks are entered in the List after the proposed new allotment was entered in the List and/or the Plan.

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[23] These measures are also applicable to the allotments BIH00000, GEO00000, HRV00000, MDA00000, MKD00000, SRB00000 and SSD00000, as appropriate.

5 Should the power density of the proposed new allotment be limited to a single minimum value meeting the carrier-to-noise (C/N) objectives and an overall aggregate carrier-to-interference value of 21 dB, as indicated in Annex 1 to Appendix **30B**, the following additional measures shall be applied by the Bureau and administrations:

a) An assignment shall not be considered as being affected by the Bureau if either single-entry carrier-to-interference ($(C/I)_d$ and $(C/I)_u$) or overall aggregate carrier-to-interference ($(C/I)_{agg}$) is met. In updating the reference situation of any Article 6 satellite networks identified as affected based on the criteria of Resolution **170 (Rev.WRC-23)**, the proposed new allotment shall not be taken into account when this new allotment is entered in the List and/or the Plan.

b) For a proposed new allotment received after 15 December 2023:

– paragraphs *a)* above and *d)* below shall not be applicable by the Bureau for the identification of assignments entered in the List on or before the date of receipt of the proposed new allotment under examination;

– paragraph *c)* below shall not be applicable by the Bureau in respect of assignments entered in the List before 1 January 2017.

c) Only test points are considered by the Bureau in its technical and regulatory examination of a proposed new allotment.

d) The administration responsible for an affected assignment shall accept interference produced by the proposed new allotment under examination within the −3 dB antenna gain contour of the minimum ellipse of the proposed new allotment.

e) For examination of submissions under § 6.17 of Article 6, if an allotment is still identified as being affected and the orbital position together with the associated technical parameters of the proposed new allotment are those identified by the Bureau under § 7.4 of Article 7, if the requesting administration insists, when the Bureau enters the proposed new allotment in the List a remark shall be inserted indicating that an agreement shall be reached with the administration responsible for the affected allotment before the assignment stemming from the conversion of the future allotment is brought into use under Article 8 of Appendix **30B**. In such cases, in updating the reference situation of that affected allotment, the proposed new allotment shall not be taken into account.

APPENDIX 42 (REV.WRC-19)

Table of allocation of international call sign series

(See Article **19**)

Call sign series	Allocated to
AAA-ALZ	United States of America
AMA-AOZ	Spain
APA-ASZ	Pakistan (Islamic Republic of)
ATA-AWZ	India (Republic of)
AXA-AXZ	Australia
AYA-AZZ	Argentine Republic
A2A-A2Z	Botswana (Republic of)
A3A-A3Z	Tonga (Kingdom of)
A4A-A4Z	Oman (Sultanate of)
A5A-A5Z	Bhutan (Kingdom of)
A6A-A6Z	United Arab Emirates
A7A-A7Z	Qatar (State of)
A8A-A8Z	Liberia (Republic of)
A9A-A9Z	Bahrain (Kingdom of)
BAA-BZZ	China (People's Republic of)
CAA-CEZ	Chile
CFA-CKZ	Canada
CLA-CMZ	Cuba
CNA-CNZ	Morocco (Kingdom of)
COA-COZ	Cuba
CPA-CPZ	Bolivia (Plurinational State of)
CQA-CUZ	Portugal
CVA-CXZ	Uruguay (Eastern Republic of)
CYA-CZZ	Canada
C2A-C2Z	Nauru (Republic of)
C3A-C3Z	Andorra (Principality of)
C4A-C4Z	Cyprus (Republic of)
C5A-C5Z	Gambia (Republic of the)
C6A-C6Z	Bahamas (Commonwealth of the)
*C7A-C7Z	World Meteorological Organization
C8A-C9Z	Mozambique (Republic of)
DAA-DRZ	Germany (Federal Republic of)
DSA-DTZ	Korea (Republic of)
DUA-DZZ	Philippines (Republic of the)
D2A-D3Z	Angola (Republic of)
D4A-D4Z	Cabo Verde (Republic of)
D5A-D5Z	Liberia (Republic of)
D6A-D6Z	Comoros (Union of the)
D7A-D9Z	Korea (Republic of)

Call sign series	Allocated to	
EAA-EHZ	Spain	
EIA-EJZ	Ireland	
EKA-EKZ	Armenia (Republic of)	
ELA-ELZ	Liberia (Republic of)	
EMA-EOZ	Ukraine	
EPA-EQZ	Iran (Islamic Republic of)	
ERA-ERZ	Moldova (Republic of)	
ESA-ESZ	Estonia (Republic of)	
ETA-ETZ	Ethiopia (Federal Democratic Republic of)	
EUA-EWZ	Belarus (Republic of)	
EXA-EXZ	Kyrgyz Republic	
EYA-EYZ	Tajikistan (Republic of)	
EZA-EZZ	Turkmenistan	
E2A-E2Z	Thailand	
E3A-E3Z	Eritrea	
E4A-E4Z	Palestinian Authority[1]	
E5A-E5Z	New Zealand – Cook Islands	(WRC-07)
E6A-E6Z	New Zealand – Niue	(WRC-15)
E7A-E7Z	Bosnia and Herzegovina	(WRC-07)
FAA-FZZ	France	
GAA-GZZ	United Kingdom of Great Britain and Northern Ireland	
HAA-HAZ	Hungary	
HBA-HBZ	Switzerland (Confederation of)	
HCA-HDZ	Ecuador	
HEA-HEZ	Switzerland (Confederation of)	
HFA-HFZ	Poland (Republic of)	
HGA-HGZ	Hungary	
HHA-HHZ	Haiti (Republic of)	
HIA-HIZ	Dominican Republic	
HJA-HKZ	Colombia (Republic of)	
HLA-HLZ	Korea (Republic of)	
HMA-HMZ	Democratic People's Republic of Korea	
HNA-HNZ	Iraq (Republic of)	
HOA-HPZ	Panama (Republic of)	
HQA-HRZ	Honduras (Republic of)	
HSA-HSZ	Thailand	
HTA-HTZ	Nicaragua	
HUA-HUZ	El Salvador (Republic of)	
HVA-HVZ	Vatican City State	
HWA-HYZ	France	
HZA-HZZ	Saudi Arabia (Kingdom of)	
H2A-H2Z	Cyprus (Republic of)	
H3A-H3Z	Panama (Republic of)	
H4A-H4Z	Solomon Islands	
H6A-H7Z	Nicaragua	
H8A-H9Z	Panama (Republic of)	
IAA-IZZ	Italy	

[1] In response to Resolution 99 (Rev. Dubai, 2018) of the Plenipotentiary Conference. (WRC-23)

Call sign series	Allocated to
JAA-JSZ	Japan
JTA-JVZ	Mongolia
JWA-JXZ	Norway
JYA-JYZ	Jordan (Hashemite Kingdom of)
JZA-JZZ	Indonesia (Republic of)
J2A-J2Z	Djibouti (Republic of)
J3A-J3Z	Grenada
J4A-J4Z	Greece
J5A-J5Z	Guinea-Bissau (Republic of)
J6A-J6Z	Saint Lucia
J7A-J7Z	Dominica (Commonwealth of)
J8A-J8Z	Saint Vincent and the Grenadines
KAA-KZZ	United States of America
LAA-LNZ	Norway
LOA-LWZ	Argentine Republic
LXA-LXZ	Luxembourg
LYA-LYZ	Lithuania (Republic of)
LZA-LZZ	Bulgaria (Republic of)
L2A-L9Z	Argentine Republic
MAA-MZZ	United Kingdom of Great Britain and Northern Ireland
NAA-NZZ	United States of America
OAA-OCZ	Peru
ODA-ODZ	Lebanon
OEA-OEZ	Austria
OFA-OJZ	Finland
OKA-OLZ	Czech Republic
OMA-OMZ	Slovak Republic
ONA-OTZ	Belgium
OUA-OZZ	Denmark
PAA-PIZ	Netherlands (Kingdom of the)
PJA-PJZ	Netherlands (Kingdom of the) – Curaçao, Sint Maarten (Dutch part), and the Netherlands Caribbean (WRC-19)
PKA-POZ	Indonesia (Republic of)
PPA-PYZ	Brazil (Federative Republic of)
PZA-PZZ	Suriname (Republic of)
P2A-P2Z	Papua New Guinea
P3A-P3Z	Cyprus (Republic of)
P4A-P4Z	Netherlands (Kingdom of the) – Aruba
P5A-P9Z	Democratic People's Republic of Korea
RAA-RZZ	Russian Federation

Call sign series	Allocated to	
SAA-SMZ	Sweden	
SNA-SRZ	Poland (Republic of)	
SSA-SSM	Egypt (Arab Republic of)	
SSN-STZ	Sudan (Republic of the)	
SUA-SUZ	Egypt (Arab Republic of)	
SVA-SZZ	Greece	
S2A-S3Z	Bangladesh (People's Republic of)	
S5A-S5Z	Slovenia (Republic of)	
S6A-S6Z	Singapore (Republic of)	
S7A-S7Z	Seychelles (Republic of)	
S8A-S8Z	South Africa (Republic of)	
S9A-S9Z	Sao Tome and Principe (Democratic Republic of)	
TAA-TCZ	Republic of Türkiye	(WRC-23)
TDA-TDZ	Guatemala (Republic of)	
TEA-TEZ	Costa Rica	
TFA-TFZ	Iceland	
TGA-TGZ	Guatemala (Republic of)	
THA-THZ	France	
TIA-TIZ	Costa Rica	
TJA-TJZ	Cameroon (Republic of)	
TKA-TKZ	France	
TLA-TLZ	Central African Republic	
TMA-TMZ	France	
TNA-TNZ	Congo (Republic of the)	
TOA-TQZ	France	
TRA-TRZ	Gabonese Republic	
TSA-TSZ	Tunisia	
TTA-TTZ	Chad (Republic of)	
TUA-TUZ	Côte d'Ivoire (Republic of)	
TVA-TXZ	France	
TYA-TYZ	Benin (Republic of)	
TZA-TZZ	Mali (Republic of)	
T2A-T2Z	Tuvalu	
T3A-T3Z	Kiribati (Republic of)	
T4A-T4Z	Cuba	
T5A-T5Z	Somalia (Federal Republic of)	
T6A-T6Z	Afghanistan	
T7A-T7Z	San Marino (Republic of)	
T8A-T8Z	Palau (Republic of)	
UAA-UIZ	Russian Federation	
UJA-UMZ	Uzbekistan (Republic of)	
UNA-UQZ	Kazakhstan (Republic of)	
URA-UZZ	Ukraine	

Call sign series	Allocated to	
VAA-VGZ	Canada	
VHA-VNZ	Australia	
VOA-VOZ	Canada	
VPA-VQZ	United Kingdom of Great Britain and Northern Ireland	
VRA-VRZ	China (People's Republic of) – Hong Kong	
VSA-VSZ	United Kingdom of Great Britain and Northern Ireland	
VTA-VWZ	India (Republic of)	
VXA-VYZ	Canada	
VZA-VZZ	Australia	
V2A-V2Z	Antigua and Barbuda	
V3A-V3Z	Belize	
V4A-V4Z	Saint Kitts and Nevis (Federation of)	
V5A-V5Z	Namibia (Republic of)	
V6A-V6Z	Micronesia (Federated States of)	
V7A-V7Z	Marshall Islands (Republic of the)	
V8A-V8Z	Brunei Darussalam	
WAA-WZZ	United States of America	
XAA-XIZ	Mexico	
XJA-XOZ	Canada	
XPA-XPZ	Denmark	
XQA-XRZ	Chile	
XSA-XSZ	China (People's Republic of)	
XTA-XTZ	Burkina Faso	
XUA-XUZ	Cambodia (Kingdom of)	
XVA-XVZ	Viet Nam (Socialist Republic of)	
XWA-XWZ	Lao People's Democratic Republic	
XXA-XXZ	China (People's Republic of) – Macao	(WRC-07)
XYA-XZZ	Myanmar (Union of)	
YAA-YAZ	Afghanistan	
YBA-YHZ	Indonesia (Republic of)	
YIA-YIZ	Iraq (Republic of)	
YJA-YJZ	Vanuatu (Republic of)	
YKA-YKZ	Syrian Arab Republic	
YLA-YLZ	Latvia (Republic of)	
YMA-YMZ	Republic of Türkiye	(WRC-23)
YNA-YNZ	Nicaragua	
YOA-YRZ	Romania	
YSA-YSZ	El Salvador (Republic of)	
YTA-YUZ	Serbia (Republic of)	(WRC-07)
YVA-YYZ	Venezuela (Bolivarian Republic of)	
Y2A-Y9Z	Germany (Federal Republic of)	
ZAA-ZAZ	Albania (Republic of)	
ZBA-ZJZ	United Kingdom of Great Britain and Northern Ireland	
ZKA-ZMZ	New Zealand	
ZNA-ZOZ	United Kingdom of Great Britain and Northern Ireland	
ZPA-ZPZ	Paraguay (Republic of)	

Call sign series	Allocated to	
ZQA-ZQZ	United Kingdom of Great Britain and Northern Ireland	
ZRA-ZUZ	South Africa (Republic of)	
ZVA-ZZZ	Brazil (Federative Republic of)	
Z2A-Z2Z	Zimbabwe (Republic of)	
Z3A-Z3Z	North Macedonia (Republic of)	(WRC-19)
Z8A-Z8Z	South Sudan (Republic of)	(WRC-15)
2AA-2ZZ	United Kingdom of Great Britain and Northern Ireland	
3AA-3AZ	Monaco (Principality of)	
3BA-3BZ	Mauritius (Republic of)	
3CA-3CZ	Equatorial Guinea (Republic of)	
3DA-3DM	Eswatini (Kingdom of)	(WRC-19)
3DN-3DZ	Fiji (Republic of)	
3EA-3FZ	Panama (Republic of)	
3GA-3GZ	Chile	
3HA-3UZ	China (People's Republic of)	
3VA-3VZ	Tunisia	
3WA-3WZ	Viet Nam (Socialist Republic of)	
3XA-3XZ	Guinea (Republic of)	
3YA-3YZ	Norway	
3ZA-3ZZ	Poland (Republic of)	
4AA-4CZ	Mexico	
4DA-4IZ	Philippines (Republic of the)	
4JA-4KZ	Azerbaijan (Republic of)	
4LA-4LZ	Georgia	
4MA-4MZ	Venezuela (Bolivarian Republic of)	
4OA-4OZ	Montenegro	(WRC-07)
4PA-4SZ	Sri Lanka (Democratic Socialist Republic of)	
4TA-4TZ	Peru	
*4UA-4UZ	United Nations	
4VA-4VZ	Haiti (Republic of)	
4WA-4WZ	Timor-Leste (Democratic Republic of)	(WRC-03)
4XA-4XZ	Israel (State of)	
*4YA-4YZ	International Civil Aviation Organization	
4ZA-4ZZ	Israel (State of)	
5AA-5AZ	Libya (State of)	
5BA-5BZ	Cyprus (Republic of)	
5CA-5GZ	Morocco (Kingdom of)	
5HA-5IZ	Tanzania (United Republic of)	
5JA-5KZ	Colombia (Republic of)	
5LA-5MZ	Liberia (Republic of)	
5NA-5OZ	Nigeria (Federal Republic of)	
5PA-5QZ	Denmark	
5RA-5SZ	Madagascar (Republic of)	
5TA-5TZ	Mauritania (Islamic Republic of)	
5UA-5UZ	Niger (Republic of the)	
5VA-5VZ	Togolese Republic	
5WA-5WZ	Samoa (Independent State of)	
5XA-5XZ	Uganda (Republic of)	
5YA-5ZZ	Kenya (Republic of)	

Call sign series	Allocated to
6AA-6BZ	Egypt (Arab Republic of)
6CA-6CZ	Syrian Arab Republic
6DA-6JZ	Mexico
6KA-6NZ	Korea (Republic of)
6OA-6OZ	Somalia (Federal Republic of)
6PA-6SZ	Pakistan (Islamic Republic of)
6TA-6UZ	Sudan (Republic of the)
6VA-6WZ	Senegal (Republic of)
6XA-6XZ	Madagascar (Republic of)
6YA-6YZ	Jamaica
6ZA-6ZZ	Liberia (Republic of)
7AA-7IZ	Indonesia (Republic of)
7JA-7NZ	Japan
7OA-7OZ	Yemen (Republic of)
7PA-7PZ	Lesotho (Kingdom of)
7QA-7QZ	Malawi
7RA-7RZ	Algeria (People's Democratic Republic of)
7SA-7SZ	Sweden
7TA-7YZ	Algeria (People's Democratic Republic of)
7ZA-7ZZ	Saudi Arabia (Kingdom of)
8AA-8IZ	Indonesia (Republic of)
8JA-8NZ	Japan
8OA-8OZ	Botswana (Republic of)
8PA-8PZ	Barbados
8QA-8QZ	Maldives (Republic of)
8RA-8RZ	Guyana
8SA-8SZ	Sweden
8TA-8YZ	India (Republic of)
8ZA-8ZZ	Saudi Arabia (Kingdom of)
9AA-9AZ	Croatia (Republic of)
9BA-9DZ	Iran (Islamic Republic of)
9EA-9FZ	Ethiopia (Federal Democratic Republic of)
9GA-9GZ	Ghana
9HA-9HZ	Malta
9IA-9JZ	Zambia (Republic of)
9KA-9KZ	Kuwait (State of)
9LA-9LZ	Sierra Leone
9MA-9MZ	Malaysia
9NA-9NZ	Nepal (Federal Democratic Republic of)
9OA-9TZ	Democratic Republic of the Congo
9UA-9UZ	Burundi (Republic of)
9VA-9VZ	Singapore (Republic of)
9WA-9WZ	Malaysia
9XA-9XZ	Rwanda (Republic of)
9YA-9ZZ	Trinidad and Tobago

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Radio Regulations

Resolutions and Recommendations

3

Edition of 2024

Radio Regulations

Resolutions and Recommendations

3

Edition of 2024

Disclaimer

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Note by the Secretariat

This revision of the Radio Regulations, complementing the Constitution and the Convention of the International Telecommunication Union, incorporates the decisions of the World Radiocommunication Conferences of 1995 (WRC-95), 1997 (WRC-97), 2000 (WRC-2000), 2003 (WRC-03), 2007 (WRC-07), 2012 (WRC-12), 2015 (WRC-15), 2019 (WRC-19) and 2023 (WRC-23). The majority of the provisions of these Regulations shall enter into force as from 1 January 2025; the remaining provisions shall apply as from the special dates of application indicated in Article **59** of the revised Radio Regulations.

In preparing the Radio Regulations, Edition of 2024, the Secretariat corrected the typographical errors that were drawn to the attention of WRC-23 and which were approved by WRC-23.

This edition uses the same numbering scheme as the 2001 edition of the Radio Regulations, notably:

With respect to *Article numbers*, this edition follows the standard sequential numbering. The Article numbers are not followed by any abbreviation (such as "(WRC-97)", "(WRC-2000)", "(WRC-03)", "(WRC-07)", "(WRC-12)", "(WRC-15)", "(WRC-19)" or "(WRC-23)"). Consequently, any reference to an Article, in any of the provisions of these Radio Regulations (e.g. in No. **13.1** of Article **13**), in the texts of the Appendices as contained in Volume 2 of this edition (e.g. in § 1 of Appendix **2**), in the texts of the Resolutions included in Volume 3 of this edition (e.g. in Resolution **1 (Rev.WRC-97)**), and in the texts of the Recommendations included in Volume 3 of this edition (e.g. in Recommendation **8**), is considered as a reference to the text of the concerned Article which appears in this edition, unless otherwise specified.

With respect to *provision numbers in Articles*, this edition continues to use composite numbers indicating the number of the Article and the provision number within that Article (e.g. No. 9.2B means provision No. 2B of Article **9**). The abbreviation "(WRC-23)", "(WRC-19)", "(WRC-15)", "(WRC-12)", "(WRC-07)", "(WRC-03)", "(WRC-2000)" or "(WRC-97)" at the end of such a provision means that the relevant provision was modified or added by WRC-23, by WRC-19, by WRC-15, by WRC-12, by WRC-07, by WRC-03, by WRC-2000 or by WRC-97, as applicable. The absence of an abbreviation at the end of the provision means that the provision is identical with the provision of the simplified Radio Regulations as approved by WRC-95, and whose complete text was contained in Document 2 of WRC-97.

With respect to *Appendix numbers*, this edition follows the standard sequential numbering, with the addition of the appropriate abbreviation after the Appendix number (such as "(WRC-97)", "(WRC-2000)", "(WRC-03)", "(WRC-07)", "(WRC-12)", "(WRC-15)", "(WRC-19)" or "(WRC-23)"), where applicable. As a rule, any reference to an Appendix, in any of the provisions of these Radio Regulations, in the texts of the Appendices as contained in Volume 2 of this edition, in the texts of the Resolutions and of the Recommendations included in Volume 3 of this edition, is presented in the standard manner (e.g. "Appendix **30 (Rev.WRC-23)**") if not explicitly described in the text (e.g. Appendix **4** as modified by WRC-23). In the texts of Appendices that were partially modified by WRC-23, the provisions that were modified by WRC-23 are indicated with the abbreviation "(WRC-23)" at the end of the concerned text. If an Appendix is referenced without any abbreviation after the Appendix number, in the texts of this edition (e.g. in No. **13.1**), or without other description, such reference is considered as a reference to the text of the concerned Appendix which appears in this edition.

Within the text of the Radio Regulations, the symbol, ↑, has been used to represent quantities associated with an uplink. Similarly, the symbol, ↓, has been used to represent quantities associated with a downlink.

Abbreviations have generally been used for the names of world administrative radio conferences and world radiocommunication conferences. These abbreviations are shown below.

Abbreviation	Conference
WARC Mar	World Administrative Radio Conference to Deal with Matters Relating to the Maritime Mobile Service (Geneva, 1967)
WARC-71	World Administrative Radio Conference for Space Telecommunications (Geneva, 1971)
WMARC-74	World Maritime Administrative Radio Conference (Geneva, 1974)
WARC SAT-77	World Broadcasting-Satellite Administrative Radio Conference (Geneva, 1977)
WARC-Aer2	World Administrative Radio Conference on the Aeronautical Mobile (R) Service (Geneva, 1978)
WARC-79	World Administrative Radio Conference (Geneva, 1979)
WARC Mob-83	World Administrative Radio Conference for the Mobile Services (Geneva, 1983)
WARC HFBC-84	World Administrative Radio Conference for the Planning of the HF Bands Allocated to the Broadcasting Service (Geneva, 1984)
WARC Orb-85	World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilising It (First Session – Geneva, 1985)
WARC HFBC-87	World Administrative Radio Conference for the Planning of the HF Bands Allocated to the Broadcasting Service (Geneva, 1987)
WARC Mob-87	World Administrative Radio Conference for the Mobile Services (Geneva, 1987)
WARC Orb-88	World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilising It (Second Session – Geneva, 1988)
WARC-92	World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (Malaga-Torremolinos, 1992)
WRC-95	World Radiocommunication Conference (Geneva, 1995)
WRC-97	World Radiocommunication Conference (Geneva, 1997)
WRC-2000	World Radiocommunication Conference (Istanbul, 2000)
WRC-03	World Radiocommunication Conference (Geneva, 2003)
WRC-07	World Radiocommunication Conference (Geneva, 2007)
WRC-12	World Radiocommunication Conference (Geneva, 2012)
WRC-15	World Radiocommunication Conference (Geneva, 2015)
WRC-19	World Radiocommunication Conference (Sharm El-Sheikh, 2019)
WRC-23	World Radiocommunication Conference (Dubai, 2023)
WRC-27	World Radiocommunication Conference, 2027[1]

[1] The date of this conference has not been finalized.

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RESOLUTIONS

RESOLUTION 1 (REV.WRC-97)

Notification of frequency assignments[1]

The World Radiocommunication Conference (Geneva, 1997),

referring to

– the Preamble of the Constitution,

– Article 42 of the Constitution (Special Arrangements),

– Article **6** of the Radio Regulations (Special agreements),

– Article **11** of the Radio Regulations (Notification and recording of frequency assignments),

– Article **12** of the Radio Regulations (Seasonal planning of the HF bands allocated to the broadcasting service between 5 900 kHz and 26 100 kHz),

resolves

that, unless specifically stipulated otherwise by special arrangements communicated to the Union by administrations, any notification of a frequency assignment to a station shall be made by the administration of the country on whose territory the station is located.

[1] WRC-97 made editorial amendments to this Resolution.

RESOLUTION 2 (REV.WRC-03)

Equitable use, by all countries, with equal rights, of the geostationary-satellite and other satellite orbits and of frequency bands for space radiocommunication services

The World Radiocommunication Conference (Geneva, 2003),

considering

that all countries have equal rights in the use of both the radio frequencies allocated to various space radiocommunication services and the geostationary-satellite orbit and other satellite orbits for these services,

taking into account

that the radio-frequency spectrum and the geostationary-satellite orbit and other satellite orbits are limited natural resources and should be most effectively and economically used,

resolves

1 that the registration with the Radiocommunication Bureau of frequency assignments for space radiocommunication services and their use do not provide any permanent priority for any individual country or groups of countries and do not create an obstacle to the establishment of space systems by other countries;

2 that, accordingly, a country or a group of countries having registered with the Bureau frequencies for their space radiocommunication services need to take all practicable measures to facilitate the use of new space systems by other countries or groups of countries, in particular those of developing countries and least developed countries, so desiring;

3 that *resolves* 1 and 2 of this Resolution shall be taken into account by the administrations and the Bureau.

RESOLUTION 4 (REV.WRC-03)

Period of validity of frequency assignments to space stations using the geostationary-satellite and other satellite orbits[1]

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that rational and efficient use must be made of the frequency spectrum and the geostationary-satellite orbit and that account should be taken of the provisions of Resolution **2 (Rev.WRC-03)** relating to the use by all countries, with equal rights and equitable access to the frequency bands and the associated satellite orbits for space radiocommunication services;

b) that limiting the period of validity of frequency assignments to space stations using the geostationary-satellite orbit and other satellite orbits is a concept which would promote the attainment of these objectives;

c) that amortizing the considerable investments made in connection with the development of space radiocommunications is a heavy burden for all administrations and that these investments should be spread over a predetermined and realistic period;

d) that every effort should be made to encourage administrations in a position to do so to develop techniques designed to improve the utilization of the frequency spectrum and the geostationary-satellite orbit and other satellite orbits with a view to increasing the total radiocommunication facilities available to the world community;

e) that an experimental procedure to gain experience from application of the new concept of notifying the period of validity of an assignment in space radiocommunication was introduced by WARC-79 and has been used by the Radiocommunication Bureau and administrations since then but that it is not possible to impose on administrations a statutory period identical in all cases;

f) that administrations should be left to propose the period of validity themselves in the light of their operational service requirements and of the common interest, however the period of validity shall take into account, *inter alia*, the operational lifetime of the satellite systems, including space and earth stations, and the type of service provided,

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[1] This Resolution does not apply to the frequency bands covered by the Allotment Plan contained in Appendix **30B**.

resolves

1 that, until this Resolution is reviewed by the next competent world radiocommunication conference, frequency assignments to space radiocommunication stations located on the geostationary-satellite and other satellite orbits, noting *considering e)* and *f)*, shall not be considered perpetual and shall be dealt with as follows:

1.1 a frequency assignment to a space station[2] shall be deemed definitively discontinued after the expiry of the period of operation shown on the assignment notice, reckoned from the date on which the assignment was brought into service. This period shall be limited to that for which the satellite network was designed. The Bureau shall then invite the notifying administration to take steps to cancel the assignment. If the Bureau receives no reply within three months following the expiry of the period of operation, it shall insert a symbol in the Remarks Column of the Master Register to indicate that the assignment is not in conformity with this Resolution;

1.2 if a notifying administration which wishes to extend the period of operation originally shown on the assignment notice of a frequency assignment of an existing space station[2] informs the Bureau accordingly more than three years before the expiry of the period in question and if all other basic characteristics of that assignment remain unchanged, the Bureau shall amend as requested the period of operation originally recorded in the Master Register and publish that information in a special section of the Bureau's International Frequency Information Circular (BR IFIC);

1.3 if, at least three years before the expiry of the period of operation recorded in the Master Register of a frequency assignment to an existing space station[2], an administration initiates the coordination procedure specified in No. **9.7** to bring into service a new space station using the same assigned frequency and the same orbital position but with different technical characteristics, and if the Bureau finds after the notification that the new assignment conforms with the provisions of No. **11.31** and does not increase, in relation to the preceding assignment, the probability of interference to the detriment of a frequency assignment recorded in the Master Register or involved in the coordination procedure, the new assignment shall be given a favourable finding and shall be entered in the Master Register;

1.4 a notifying administration which wishes to modify a basic characteristic of a frequency assignment of a space station[2] recorded in the Master Register shall initiate, in any case other than those covered by *resolves* 1.2 and 1.3, the appropriate modification procedure in accordance with the provisions of Nos. **11.43A** to **11.46**;

2 that, for the application of the provisions of *resolves* 1.1 above, the information concerning the period of validity of frequency assignments to space stations shall be notified in addition to that contained in Appendix **4**;

3 that the application of this Resolution shall not prejudge in any way the decisions of future radiocommunication conferences,

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[2] The expression "space station" may apply to more than one satellite provided that only one satellite is in operation at any particular moment and that the stations installed on board successive satellites have identical basic characteristics.

invites ITU-R

to undertake studies with respect to the implementation of this Resolution,

invites the next competent world radiocommunication conference

to take cognizance of the results of ITU-R studies undertaken as a result of this Resolution and take action, as appropriate,

instructs the Secretary-General

to bring this Resolution to the attention of the Council.

RESOLUTION 5 (REV.WRC-23)

Technical cooperation with the developing countries in the study of propagation in tropical and similar areas

The World Radiocommunication Conference (Dubai, 2023),

having noted

that the assistance provided for the developing countries by the Union in the field of telecommunications in cooperation with other United Nations specialized agencies, such as the United Nations Development Programme (UNDP), augurs well for the future,

aware

a) of the fact that the developing countries, particularly those in tropical and similar areas, (including the area referred to as zone C in the Final Acts of the Regional Administrative Conference for the Planning of VHF/UHF Television Broadcasting in the African Broadcasting Area and Neighbouring Countries (Geneva, 1989 and Geneva, 2006), the Red Sea, East Mediterranean, etc.), require adequate knowledge of radio wave propagation in their territories in order to make rational and economical use of the radio-frequency spectrum;

b) of the importance of propagation in radiocommunications;

c) of the importance of the work of ITU-T and ITU-R Study Groups for the development of telecommunications in general and radiocommunications in particular,

considering

a) the need for the developing countries themselves to study telecommunications in general and propagation in particular in their territories, this being the best means of enabling them to acquire telecommunication techniques and to plan their systems effectively and in conformity with the special conditions in the tropical areas;

b) the scarcity of resources available in these countries,

resolves to instruct the Secretary-General

1 to offer the assistance of the Union to developing countries in the tropical areas which endeavour to carry out national propagation studies in order to improve and develop their radiocommunications;

2 to assist these countries, if necessary with the collaboration of international and regional organizations such as the Asia-Pacific Broadcasting Union (ABU), Arab States Broadcasting Union (ASBU), African Telecommunication Union (ATU) and the African Union of Broadcasting (AUB) which may be concerned, in carrying out national propagation measurement programmes, including collecting appropriate meteorological data, on the basis of ITU-R Recommendations and Questions in order to improve the use of the radio-frequency spectrum;

3 to arrange funds and resources for this purpose from the UNDP or other sources in order to enable the Union to provide the countries concerned with adequate and effective technical assistance for the purpose of this Resolution,

resolves to instruct the Director of the Radiocommunication Bureau

to include this activity in the operational plan, within existing budgetary resources of the Sector,

invites administrations

to submit the results of these propagation measurements to ITU-R for consideration in its studies,

invites the Council

to follow the progress made in carrying out programmes of propagation measurements and the results achieved, and to take any action that it considers necessary.

RESOLUTION 7 (REV.WRC-19)

Development of national radio-frequency management

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that the Radio Regulations contain, *inter alia*, procedures for the coordination, notification and registration of frequencies which specify the rights and obligations of Member States;

b) that the application of the above-mentioned procedures necessitates an appropriate radio-frequency management unit in each Member State;

c) that the existence of such a unit helps Member States to safeguard their rights and to discharge their obligations under the Radio Regulations;

d) that the application of the Radio Regulations through the agency of such units is in the interest of the international community as a whole,

noting

that such a unit requires an adequate number of suitably qualified staff,

noting further

that the administrations of many developing countries need to create or to strengthen such a unit, appropriate to their administrative structure, with responsibility for the application of the Radio Regulations at the national and international levels,

resolves

1 that meetings shall be organized between representatives of the Radiocommunication Bureau and the personnel involved in frequency management matters from administrations of developing and developed countries;

2 that such meetings shall be aimed at designing standard structures suitable for administrations of developing countries and include discussions concerning the establishment and operation of radio-frequency management units;

3 that such meetings should also identify the particular needs of developing countries in establishing such units, and the means required to meet those needs,

recommends

that developing countries, when planning the use of funds, particularly those received from international sources, make provision for participation in these meetings as well as taking appropriate action for the introduction and development of such units,

invites the ITU Council

to take the necessary measures for the organization of such meetings,

instructs the Secretary-General

1 to circulate this Resolution to all Member States, drawing their attention to its importance;

2 to circulate the results of such meetings, particularly to the developing countries;

3 to inform the developing countries of the types of assistance ITU can provide in setting up the desired structure,

instructs the Director of the Radiocommunication Bureau

to include this activity in the Operational Plan, within existing budgetary resources of the Sector,

draws the attention of the next plenipotentiary conference

1 to the particular problems identified in this Resolution;

2 to the need for prompt and effective action to resolve them;

3 to the need to take all practicable measures to ensure that resources are made available for this purpose.

RESOLUTION 8 (WRC-23)

Tolerances for certain orbital characteristics of space stations deployed as part of non-geostationary-satellite orbit systems in the fixed-satellite, broadcasting-satellite or mobile-satellite service

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that WRC-19 invited the ITU Radiocommunication Sector (ITU-R) to study, as a matter of urgency, tolerances for certain orbital characteristics of non-geostationary-satellite orbit (non-GSO) space stations of the fixed-satellite service (FSS), the broadcasting-satellite service (BSS) and the mobile-satellite service (MSS) to account for the potential differences between the notified and deployed orbital characteristics for the inclination of the orbital plane, the altitude of the apogee of the space station, the altitude of the perigee of the space station and the argument of the perigee of the orbital plane;

b) that satellites on highly-elliptical orbits and highly-inclined orbits having an apogee altitude greater than 15 000 km and an orbital inclination between 35° and 145° have significant orbital precession rates and, consequently, restrictive orbital-keeping requirements and correction of orbital parameters may lead to a reduction of such satellites' lifetime and to frequent replacement;

c) that design considerations (including the impact of atmospheric drag[1] characteristics of the altitude chosen and solar cycle effects for systems at altitudes lower than 600 km); maintaining separation between satellites in the same and other systems to ensure safe flight operations and minimize the risk of collisions; and other operational considerations can lead to notifying administrations needing to operate some space stations in orbital planes with some deviation from the notified orbital planes for their non-GSO systems;

d) that significant deviations between the operational orbital plane(s) of a non-GSO system and the notified orbital plane(s) for those systems as recorded in the Master International Frequency Register (MIFR) could negatively impact the efficient use of orbit and spectrum resources;

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[1] Atmospheric drag is the atmospheric force acting opposite to the relative motion of an object. Atmospheric drag is important for a space station as it hinders the space station exiting the atmosphere, and also pulls orbital satellites back towards Earth over time.

e) that it is important, for consideration of instances where a non-GSO system operates with orbital planes that deviate from the system's notified orbital planes, that there is a mechanism developed for determining that such operation does not now and will not in the future result in the space stations of the non-GSO system causing more interference or claiming a higher need for protection than would have been the case if the operational orbital planes exactly matched the notified orbital planes for the system;

f) that adherence to a transparent approach to the question of orbital tolerances is desirable, as it reduces uncertainty with respect to the deployment of non-GSO systems,

recognizing

a) that Nos. **11.44C** and **11.49.2** require the deployment of satellites on notified orbital planes;

b) that No. **13.6** is applicable to non-GSO systems with frequency assignments in the frequency bands and services to which this Resolution applies;

c) that orbital tolerances should ensure an adequate level of operational flexibility for non-GSO system operations, while ensuring that the interference environment into other systems and services is not degraded;

d) that orbit and spectrum resources are a shared resource, and this Resolution does not preclude coordination requests or notification filings under Articles **9** and **11** for other non-GSO systems at the same altitude and tolerance,

noting

that for the purpose of this Resolution:

– the term "frequency assignments" is understood to refer to frequency assignments to a space station of a non-GSO system;

– the term "notified orbital plane" means an orbital plane of the non-GSO system, as provided to the Bureau in the most recent notification information for the system's frequency assignments, that possesses the general characteristics of items:

  - A.4.b.4.a, the angle of inclination of the orbital plane of the space station;
  - A.4.b.4.d, the altitude of the apogee of the space station;
  - A.4.b.4.e, the altitude of the perigee of the space station;
  - A.4.b.4.i, the argument of the perigee of the orbit of the space station (only for orbits whose altitudes of the apogee and perigee are different);
  - A.4.b.4.r, the distance to the apogee of the space station; and
  - A.4.b.4.s, the distance to the perigee of the space station;

  in Table A of Annex 2 to Appendix **4**;

– the term "observed distance to the apogee" refers to the distance in kilometres from the centre of the Earth to the deployed space station at its apogee;

– the term "observed distance to the perigee" refers to the distance in kilometres from the centre of the Earth to the deployed space station at its perigee;

– the term "tolerances" refers to deviations between the value notified and/or recorded for the orbital characteristics as referred to in this *noting* and those observed for the actual deployment of satellites of the non-GSO FSS, BSS or MSS system under consideration,

resolves

1 that this Resolution applies to frequency assignments to non-GSO systems, for orbital planes having an orbital eccentricity[2] less than 0.5 and an apogee altitude less than 15 000 km notified as part of a non-GSO FSS, BSS or MSS system subject to Resolution **35 (Rev.WRC-23)**;

2 that, for frequency assignments to which *resolves* 1 applies, and for which information concerning the bringing into use or bringing back into use, or the deployment information under Resolution **35 (Rev.WRC-23)**, has been provided to the Bureau prior to 1 January 2025, the notifying administration shall communicate to the Bureau the required information regarding the system's deployed space stations in accordance with Annex 1 to this Resolution no later than 1 April 2025 and include in that submission, for each orbital plane and without submitting a modification to the notification information, the information under Appendix **4** data items A.4.b.4.r and A.4.b.4.s (distances to the apogee and perigee of the space station);

3 that, for frequency assignments to which *resolves* 1 applies, and for which information concerning the bringing into use or bringing back into use of the frequency assignments is provided to the Bureau on or after 1 January 2025, the notifying administration shall communicate to the Bureau the required information regarding the system's deployed space station(s) in accordance with Annex 1 to this Resolution at the same time as the notifying administration informs the Bureau of the bringing into use of applicable frequency assignments under No. **11.44C** or the bringing back into use of applicable frequency assignments under No. **11.49.2**, and, for each orbital plane, include in that submission, if not already provided, and without submitting a modification to the notification information, the information under Appendix **4** data items A.4.b.4.r and A.4.b.4.s (distances to the apogee and perigee of the space station);

4 that, for frequency assignments to which *resolves* 1 applies, and which retain the remark in the MIFR entry that was added under *resolves* 5*b)* of Resolution **35 (Rev.WRC-23)**, and for which deployment information under Resolution **35 (Rev.WRC-23)** is provided to the Bureau on or after 1 January 2025, the notifying administration shall communicate to the Bureau the required information regarding the system's deployed space stations in accordance with Annex 1 to this Resolution at the same time as the notifying administration communicates to the Bureau the required information under *resolves* 7 or 8, as applicable, from Resolution **35 (Rev.WRC-23)**;

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2 The eccentricity e is equal to: $e = \left(R_a - R_p\right) / \left(R_a + R_p\right)$

where:

R_a: distance between the centre of the Earth and the space station at apogee
R_p: distance between the centre of the Earth and the space station at perigee.

5 that, for frequency assignments to which *resolves* 1 applies, and for which a modification to the characteristics of the notified or recorded frequency assignments has been submitted pursuant to *resolves* 11*c)* of Resolution **35 (Rev.WRC-23)**, the notifying administration shall communicate to the Bureau the required information regarding the system's deployed space stations in accordance with Annex 1 to this Resolution within 30 days after notification information reflecting the modified characteristics is published in the Radiocommunication Bureau International Frequency Information Circular (BR IFIC) (Part II-S);

6 that, based on the latest notification information published in the BR IFIC (Part II-S, if available, or Part I-S if Part II-S is not available), and for each space station reported to have been deployed and operated, when:

a) the magnitude of the difference between the observed and the notified distances to the apogee of the space station and between the observed and the notified distances to the perigee of the space station is 70 km or less (for a notified altitude of the apogee/notified altitude of the perigee of 2 000 km or less) or of 5% in km or less (for a notified altitude of the apogee/notified altitude of the perigee greater than 2 000 km); and

b) the magnitude of the difference between the observed and the notified angle of inclination of the orbital plane of the space station is 2° or less (for a notified altitude of the apogee/notified altitude of the perigee of 2 000 km or less), or 3° or less (for a notified altitude of the apogee/notified altitude of the perigee greater than 2 000 km),

the notifying administration shall provide as part of its report under Annex 1 to this Resolution in accordance with *resolves* 2, 3, 4 or 5, as appropriate, an explanation of why there is a difference between the observed and the notified values for the orbital characteristics of the space station;

7 that, based on the latest notification information published in the BR IFIC (Part II-S, if available, or Part I-S if Part II-S is not available), and for each space station reported to have been deployed and operated, when one or both of the following conditions apply:

a) the magnitude of the difference between the observed and the notified distances to the apogee of the space station or between the observed and the notified distances to the perigee of the space station is between 70 km and 100 km (for a notified altitude of the apogee/notified altitude of the perigee of 2 000 km or less)[3] or between 5% and 10% in km (for a notified altitude of the apogee/notified altitude of the perigee greater than 2 000 km)[4];

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[3] This *resolves* applies if the magnitude of the difference between the observed and notified distances to the apogee is between 70 km and 100 km while the magnitude of the difference between the observed and notified distances to the perigee is less than 70 km, as well as if the magnitude of the difference between the observed and notified deviation of the distance to the apogee is less than 70 km and the magnitude of the difference between the observed and notified distances to the perigee is between 70 km and 100 km.

[4] This *resolves* applies if the magnitude of the difference between the observed and notified distances to the apogee is between 5% and 10% in km while the magnitude of the difference between the observed and notified distances to the perigee is below 5% in km, as well as if the magnitude of the difference between the observed and notified distances to the apogee is below 5% in km and the magnitude of the difference between the observed and notified distances to the perigee is between 5% and 10% in km.

b) the magnitude of the difference between the observed and the notified angle of inclination of the orbital plane of the space station is between 2° and 3° (for a notified altitude of the apogee/notified altitude of the perigee of 2 000 km or less), or between 3° and 4° (for a notified altitude of the apogee/notified altitude of the perigee greater than 2 000 km),

the notifying administration shall provide as part of its report under Annex 1 to this Resolution in accordance with *resolves* 2, 3, 4 or 5, as appropriate, an explanation of why there is a difference between the observed and the notified values for the orbital characteristics of the space station and a technical demonstration confirming that a difference between the observed and the notified distances to the apogee of the space station or a difference between the observed and the notified distances to the perigee of the space station greater than 70 km but less than or equal to 100 km (for a notified altitude of the apogee/notified altitude of the perigee of 2 000 km or less) or greater than 5% but less than or equal to 10% in km (for a notified altitude of the apogee/notified altitude of the perigee greater than 2 000 km), as applicable, does not result in any increased interference protection requirements as compared to those requirements for operation in accordance with the notified orbital characteristics for the space station under consideration;

8 that, upon receipt of the required information submitted in accordance with *resolves* 2, 3, 4 or 5 above, the Bureau shall promptly make that information available "as received" on the ITU website;

9 that, if the information to be provided in any Annex 1 submission in accordance with *resolves* 2, 3, 4 or 5 above shows a difference between the observed and notified/recorded distances to the apogee or perigee of the space station, or a difference between the observed and notified/recorded angles of inclination of the orbital plane of the space station, that is greater than the values specified in *resolves* 7 above, the notifying administration shall also submit to the Bureau, no later than the deadline for the Annex 1 submissions in accordance with *resolves* 2, 3, 4 or 5 above, modifications to the characteristics of the notified or recorded frequency assignments reflecting the revised orbital parameters; a failure to provide such a modification will result in the frequency assignments subject to this *resolves* 9 not being considered as brought into use under No. **11.44C** or brought back into use under No. **11.49.2**, or counted towards a milestone under the procedures in Resolution **35 (Rev.WRC-23)**;

10 that, where a notifying administration has communicated to the Bureau the required information regarding the system's deployed space stations in accordance with Annex 1 to this Resolution under *resolves* 4 or 5 (in reference to *resolves* 11*c)* of Resolution **35 (Rev.WRC-23)**, and where *resolves* 9 of this Resolution does not apply), the notifying administration shall ensure that its notification information aligns with the fully-deployed system, and that any such modification be considered under *resolves* 16 below;

11 that, for any space stations in non-GSO systems with frequency assignments subject to this Resolution that have either been brought into use under No. **11.44C** or brought back into use under No. **11.49.2**, or where the space stations themselves have been counted towards a milestone under the procedures in Resolution **35 (Rev.WRC-23)**:

a) the maximum allowed difference between the observed distance to the apogee or perigee of the space station and the distances to the apogee or perigee of a space station previously declared under this Resolution is 30 km;

b) the maximum allowed difference between the observed angle of inclination of the orbital plane of the space station and the angle of inclination of the orbital plane of a space station previously declared under this Resolution is 2° (for a notified altitude of the apogee/notified altitude of the perigee of 2 000 km or less), or 3° (for a notified altitude of the apogee/notified altitude of the perigee greater than 2 000 km);

for purposes of this *resolves* 11, the tolerance required can be maintained as against any notified orbital plane in the system or against any distance to the apogee and perigee previously declared under this Resolution if different than a notified orbital plane;

12 that any space station deployed as part of a non-GSO FSS, BSS or MSS system subject to this Resolution that has been counted towards a milestone under the procedures in Resolution **35 (Rev.WRC-23)** for systems that have not completed the milestone process shall be considered in the deployment information submitted under *resolves* 7 or 8 of Resolution **35 (Rev.WRC-23)**, as applicable, for any subsequent milestone submission if the tolerances referred to in *resolves* 11 above have not been exceeded for a maximum of 60 consecutive days;

13 that any space station deployed as part of a non-GSO FSS, BSS or MSS system subject to this Resolution that has completed the milestone process in *resolves* 6 or *resolves* 7 to 18 of Resolution **35 (Rev.WRC-23)** shall not exceed the tolerances referred to in *resolves* 11 above for a maximum of 60 consecutive days;

14 that, for any space stations under *resolves* 12 or 13 above that have exceeded the maximum allowed differences in *resolves* 11 above for more than 60 consecutive days, the notifying administration shall provide the Bureau with the information in Annex 1 to this Resolution for these space stations only within 30 days after the end of that 60-day period (unless *resolves* 15 below is applied) and, within 90 days after the end of that 60-day period, submit modifications to the characteristics of the notified or recorded frequency assignments reflecting the revised parameters;

15 that, instead of applying the procedure in *resolves* 14 of this Resolution, if the notifying administration has informed the Bureau before the end of the 60-day period that it is temporarily discontinuing use of the frequency assignments, it may, within 3 years after the initiation of the discontinued use, inform the Bureau of the resumption of use within the maximum allowed differences in *resolves* 11, subject to the condition that the space stations with those frequency assignments cannot be counted towards any milestone submission under Resolution **35 (Rev.WRC-23)** prior to such resumption;

16 that, upon receipt of the modifications to the characteristics of the notified or recorded frequency assignments as referred to in *resolves* 10, the Bureau shall:

a) promptly make this information available "as received" on the ITU website;

b) conduct an examination for compliance with Nos. **11.43A/11.43B**, as appropriate;

c) for the purpose of No. **11.43B**, retain the original dates of entry of the frequency assignments in the MIFR, in the modifications submitted pursuant to *resolves* 10, if:

i) the Bureau reaches a favourable finding under No. **11.31**; and

ii) the modifications are limited to any Appendix **4** data item A.4.b.4 except Appendix **4** data item A.4.b.4.b (i.e. the number of satellites in the orbital plane) and any Appendix **4** data items A.14, A.4.b.6.a and A.4.b.7; and

iii) the notifying administration provides a commitment stating that the characteristics as modified will not cause more interference or require more protection than the characteristics provided in the latest notification information published in Part I-S of the BR IFIC for the frequency assignments (see Appendix **4** data item A.39.a);

d) publish the information provided and its findings under No. **11.43B** in the BR IFIC;

17 that the Bureau shall, no later than 45 days before any deadline for submission by a notifying administration under *resolves* 2, 3, 4, 5 or 14, send a reminder to the notifying administration to provide the information required;

18 that, if a notifying administration fails to communicate the information required under *resolves* 2, 3, 4, 5 or 14, as appropriate, the Bureau shall promptly send the notifying administration a reminder asking the administration to provide the required information within 30 days from the date of that reminder from the Bureau;

19 that, if a notifying administration fails to provide information after the reminder sent under *resolves* 18, the Bureau shall send the notifying administration a second reminder asking it to provide the required information within 15 days from the date of the second reminder;

20 that, if a notifying administration fails to provide the required information under resolves 2, 3, 4, 5 or 14, as appropriate, following the reminders under resolves 18 and 19, the Bureau shall:

a) continue to take the entry in the MIFR into account when conducting its examinations, until the Radio Regulations Board confirms that *resolves* 20 *b)* shall apply;

b) no longer consider the frequency assignments in subsequent examinations under Nos. **9.36**, **11.32** or **11.32A** and inform administrations having frequency assignments subject to Sub-Section IA of Article **9** that those assignments shall not cause harmful interference to, or claim protection from, other frequency assignments recorded in the MIFR with a favourable finding under No. **11.31**;

21 that, if information provided by a notifying administration under *resolves* 4 or 5 of this Resolution results in frequency assignments not retaining their original dates of entry in the MIFR after application of *resolves* 9 or 14 of this Resolution, those space stations with altitude or inclination deviations that caused this result shall not be included in the total number of space stations deployed as part of the system for purposes of the milestone submission under Resolution **35 (Rev.WRC-23)** with which the information under *resolves* 4 or 5 of this Resolution is associated,

further resolves

to apply the provisions of this Resolution on a provisional basis as from 1 January 2025 pending review by a future competent conference,

instructs the Radiocommunication Bureau

1 to take the necessary actions to implement this Resolution and to report on any difficulties it or administrations encounter in the implementation or application of this Resolution to future world radiocommunication conferences;

2 not to revisit or review, in connection with submissions from administrations under this Resolution, any prior confirmations that frequency assignments subject to this Resolution have been brought into use or brought back into use or any prior milestone determinations under Resolution **35 (Rev.WRC-23)**;

3 to develop tools, including a naming convention applicable to large non-GSO systems complying with this Resolution, to help with implementation of this Resolution,

invites the ITU Radiocommunication Sector

to continue studies with a view to identifying a methodology or methodologies for determining whether specific changes to a notified orbital plane will cause more interference or require more protection than the characteristics provided in the latest notification information published in the BR IFIC (Part II-S, if available, or Part I-S if Part II-S is not available) for the frequency assignments.

ANNEX 1 TO RESOLUTION 8 (WRC-23)

Information to be submitted about the deployed space stations

A Satellite system information

1) Name of the satellite system;

2) Name of the notifying administration;

3) Country symbol;

4) Reference to the advance publication information or the request for coordination, or the notification information, if available;

5) Total number of space stations deployed into each notified orbital plane of the satellite system with the capability of transmitting or receiving the frequency assignments;

6) Orbital plane number indicated in the latest notification information published in the Radiocommunication Bureau International Frequency Information Circular (BR IFIC) (Part II-S, if available, or Part I-S if Part II-S is not available) for the frequency assignments into which each space station is deployed.

B Space station characteristics for each space station deployed

1) Name of the space station;

2) Orbital plane number with which the space station is associated and, for information purposes, the initial phase angle of the space station in the orbital plane;

3) Observed distance to the apogee and observed distance to the perigee of the space station, and observed angle of inclination of the orbital plane of the space station.

C Commitment of non-interference/non-protection

By providing a submission under this Annex, the notifying administration commits that the operation of its notified frequency assignments using the orbital characteristics of the submission that are in deviation from the notified orbital plane(s) will not cause more interference or require more protection than would otherwise be the case for operation in accordance with the characteristics provided in the latest notification information published in the BR IFIC (Part II-S, if available, or Part I-S if Part II-S is not available) for the frequency assignments to the non-geostationary-satellite system.

RESOLUTION 10 (REV.WRC-2000)

Use of two-way wireless telecommunications by the International Red Cross and Red Crescent Movement

The World Radiocommunication Conference (Istanbul, 2000),

considering

a) that the worldwide humanitarian operations carried out by the International Red Cross and Red Crescent Movement − composed of the International Committee of the Red Cross, the International Federation of Red Cross and Red Crescent Societies and national Red Cross and Red Crescent societies − are of great importance and often indispensable;

b) that in such circumstances normal communication facilities are frequently overloaded, damaged, completely interrupted or not available;

c) that it is necessary to facilitate by all possible measures the reliable intervention of these national and international organizations;

d) that rapid and independent contact is essential to the intervention of these organizations;

e) that for the efficient and safe conduct of their humanitarian operations, these organizations rely heavily on two-way wireless telecommunication facilities, and particularly on an extensive HF and VHF radio network,

resolves to urge administrations

1 to take account of the possible needs of the International Red Cross and Red Crescent Movement for two-way wireless telecommunication means when normal communication facilities are interrupted or not available;

2 to assign to these organizations the minimum number of necessary working frequencies in accordance with the Radio Regulations;

3 to take all practicable steps to protect such communications from harmful interference.

RESOLUTION 12 (REV.WRC-23)

Assistance and support to Palestine

The World Radiocommunication Conference (Dubai, 2023),

recalling

a) the Charter of the United Nations and the Universal Declaration of Human Rights;

b) the terms of Resolution 67/19 of the United Nations General Assembly (UNGA), which decides "to accord to Palestine" non-member observer State status in the United Nations;

c) UNGA Resolution 72/240, which recognizes the Palestinian people's right to permanent sovereignty over their natural resources, specifically land, water, energy and other natural resources, in the occupied Palestinian territory, including East Jerusalem;

d) Resolution 32 (Kyoto, 1994) of the ITU Plenipotentiary Conference, on technical assistance to Palestine for the development of telecommunications;

e) Resolution 125 (Rev. Bucharest, 2022), Resolution 125 (Rev. Dubai, 2018), Resolution 125 (Rev. Busan, 2014), Resolution 125 (Rev. Guadalajara, 2010), Resolution 125 (Rev. Antalya, 2006) and Resolution 125 (Marrakesh, 2002) of the Plenipotentiary Conference, on assistance and support to Palestine for infrastructure development and capacity building in the telecommunication and information technology sector;

f) Resolution 99 (Rev. Dubai, 2018), Resolution 99 (Rev. Busan, 2014) and Resolution 99 (Rev. Guadalajara, 2010) of the Plenipotentiary Conference, on the status of Palestine in ITU;

g) Resolution 18 (Rev. Kigali, 2022), Resolution 18 (Rev. Buenos Aires, 2017), Resolution 18 (Rev. Dubai, 2014) and Resolution 18 (Rev. Hyderabad, 2010) of the World Telecommunication Development Conference (WTDC), on special technical assistance to Palestine;

h) Resolution 9 (Rev. Kigali, 2022), Resolution 9 (Rev. Buenos Aires, 2017) and Resolution 9 (Rev. Dubai, 2014) of WTDC, which recognize that it is the sovereign right of every State to manage spectrum use within its territories;

i) Nos. 6 and 7 of the ITU Constitution indicating among the purposes of the Union "to promote the extension of the benefits of the new telecommunication technologies to all the world's inhabitants" and "to promote the use of telecommunication services with the objective of facilitating peaceful relations",

considering

a) that the Constitution and ITU Convention are designed to strengthen peace and security in the world for the development of international cooperation and better understanding among the peoples concerned;

b) Resolution 125 (Rev. Bucharest, 2022), which recognizes that ITU's policy of assistance to Palestine for the development of its telecommunication sector has been efficient but has not yet fulfilled its goals due to the prevailing situation,

considering further

a) the need to continue assisting Palestine to manage, similar to ITU administrations, its radio spectrum resources required to advance the economic and social development of Palestine;

b) that the frequency assignments and frequency spectrum management requirements of Palestine must be respected and safeguarded in accordance with the provisions and resolutions of ITU and international law in this regard;

c) the right of Palestine to manage and plan its own spectrum resources in accordance with the Interim Agreement and the provisions of the Radio Regulations and the various resolutions adopted by global and regional radiocommunication assemblies and conferences;

d) The Israeli-Palestinian Interim Agreement signed between the parties,

mindful

of the fundamental principles contained in the Constitution,

noting with concern

the restrictions and difficulties related to the current situation in Palestine, preventing access to telecommunication means, services and applications, which constitute a continuing obstacle for the telecommunication sector in Palestine,

welcomes

1 the recent bilateral agreement elaborated through the JTC by concerned parties on 27 December 2022, for assignment of frequencies which will enable the deployment of IMT-Advanced and IMT-2020 technologies in Palestine,

2 the commitment of concerned parties to advance efforts to facilitate the entry of necessary equipment for the construction and operation of telecommunication networks for use by Palestinian operators;

3 the continued support of ITU, including its Secretary-General, in achieving the goals of this Resolution,

urges Member States

including concerned parties, to make every effort with a view to facilitating the acquisition and deployment of the equipment needed by Palestine for the establishment of their networks,

resolves

1 to continue to provide assistance to Palestine, through the ITU Radiocommunication Sector and in collaboration with the ITU Telecommunication Development Sector, pursuant to the relevant ITU resolutions and decisions, in particular in the areas of capacity building, spectrum management and frequency assignment, with a view to enabling Palestine to manage and exploit its radio spectrum;

2 to enable Palestine to modernize its telecommunication networks, including building and operating 4G and 5G networks, through support and technical assistance;

3 that Palestine should operate its telecommunication networks, including building and operating 4G and 5G networks, through support and technical assistance;

4 to urgently empower Palestine, through assistance provided to it, in order to ensure that Palestine is able to obtain and manage the necessary frequencies for microwave links, which are considered essential to the operation of 4G and 5G services, and identify mechanisms to ensure that Palestine is able to exploit the additional bands needed for new, modern mobile telecommunication networks, such as IMT-2020 in accordance with the Interim Agreement;

5 to enable Palestine to urgently extend, install, own, manage and operate optical fibre broadband telecommunication networks (and optical fibre links) between governorates and major cities to ensure a more robust digital transformation in Palestine in accordance with the Interim Agreement;

6 to support Palestine in obtaining VHF and UHF frequencies for fixed and mobile telecommunication services;

7 to enable Palestine to obtain FM frequencies for the broadcasting service;

8 to instruct the Director of the Radiocommunication Bureau to ensure the implementation of this Resolution,

urges concerned parties

1 to make all possible efforts to achieve the following:

i) facilitation of the import and deployment of equipment for the implementation of the agreement signed on 27 December 2022 with respect to the operation of 4G and 5G services, for the Palestinian operators in accordance with the Interim Agreement;

ii) enabling the establishment of Palestine's own international access networks including satellite earth stations, submarine cables, optical fibre and microwave systems in accordance with the Interim Agreement,

instructs the Director of the Radiocommunication Bureau

1 to take appropriate measures within the mandate of the Radiocommunication Bureau, in cooperation with the respective Sectors, in order to assist in the implementation of this Resolution;

2 to report to the next world radiocommunication conference on progress achieved in the implementation of this Resolution;

3 to ensure support and assistance in the mobilization and development of financial and human resources and capacity building for the radiocommunication sector in Palestine through innovation and financing in various fields;

4 to assist in the delivery of telecommunication networks and Internet services to remote areas (and all health centres in Palestine);

5 to assist in the implementation of projects of the three ITU Bureaux, including the regional initiatives,

instructs the Secretary-General

1 to ensure the implementation of this Resolution and to submit an annual report to the ITU Council on progress made in implementing this Resolution;

2 to coordinate the activities carried out by the three ITU Sectors in accordance with *resolves* above, to ensure that the Union's action in favour of Palestine is as effective as possible, and to report on the matter to the Council on the progress achieved on these issues.

RESOLUTION 13 (REV.WRC-97)

Formation of call signs and allocation of new international series

The World Radiocommunication Conference (Geneva, 1997),

considering

the increasing demand for call signs justified by the increased number of Member States and by the increased requirements of countries which are already Member States,

believing

that call signs already in use should, as far as possible, not be changed,

noting

a) that the former call-sign series formed of three letters, or a figure and two letters, having been exhausted, a new series has been introduced formed of a letter, a figure and a letter; but in no case may the figure be 0 or 1;

b) that the method referred to in *noting a)* is not applicable to series beginning with one of the following letters: B, F, G, I, K, M, N, R, W,

resolves

1 that the Director of the Radiocommunication Bureau shall continue to urge administrations:

1.1 to make maximum use of the possibilities of the series at present allocated, in order to avoid, as far as possible, further requests;

1.2 to review the call-sign assignments they have already made from their present allocations, with a view to releasing any series and placing them at the disposal of the Union;

2 that the Director of the Radiocommunication Bureau shall, upon request, furnish advice to administrations on the means of effecting the greatest economy, which should be the rule, in the use of a series of call signs;

3 that if, nevertheless, before the next competent world radiocommunication conference, it appears that all the possibilities of the present system of forming call signs will be exhausted, the Director of the Radiocommunication Bureau shall:

3.1 explore the possibility of extending the present allocations of international call-sign series by lifting the limitation on use of the letter “Q” and the digits “0” and “1”;

3.2 issue a circular-letter:

3.2.1 explaining the position;

3.2.2 urging administrations to send in their proposals for possible solutions;

4 that, from the information thus submitted, the Director of the Radiocommunication Bureau shall prepare a report, together with his comments and suggestions, for submission to the next competent world radiocommunication conference.

RESOLUTION 14 (WRC-23)

Studies on development of regulatory measures, and implementability thereof, to limit the unauthorized operations of non-geostationary-satellite orbit (non-GSO) earth stations in the fixed-satellite service (FSS) and mobile-satellite service (MSS) and associated issues related to the service area of non-GSO FSS and MSS satellite systems

The World Radiocommunication Conference (Dubai, 2023)

considering

a) the active implementation of non-geostationary-satellite orbit (non-GSO) systems in the fixed-satellite service (FSS) and mobile-satellite service (MSS) with a global service area;

b) reports to the Radio Regulations Board (RRB) from administrations regarding the presence of unauthorized transmissions of transmitting earth stations of non-GSO FSS and MSS systems within their territory;

noting

a) that Article **18** specifies the requirements for licensing the operation of stations within any given territory;

b) that No. **18.1** provides that no transmitting station may be established or operated by a private person or by any enterprise without a licence issued in an appropriate form and in conformity with the provisions of the Radio Regulations by or on behalf of the government of the country to which the station in question is subject;

c) that administrations involved in the provision of satellite services, including notifying administrations of satellite networks or systems, are subject to Article **18**;

d) that Resolution **22 (Rev.WRC-23)**, on measures to limit unauthorized uplink transmissions from earth stations, resolves that the operation of transmitting earth stations within the territory of an administration shall be carried out only if authorized by that administration;

e) that Resolution **25 (Rev.WRC-23)**, on operation of global satellite systems for personal communications, *resolves* that administrations licensing global satellite systems and stations intended to provide public personal communications by means of fixed, mobile or transportable terminals shall ensure, when licensing these systems and stations, that they can be operated only from the territory or territories of administrations having authorized such service and stations in compliance with Articles **17** and **18**, in particular No. **18.1**;

f) that Resolution 219 (Bucharest, 2022) of the Plenipotentiary Conference encourages Member States, when authorizing non-GSO systems, to take all necessary actions to avoid unacceptable interference to GSO and other non-GSO systems, as well as to other radio services of other administrations, and to ensure the efficient use of radio-frequency spectrum and associated satellite orbit resources; to this effect, the necessary regulatory frameworks need to be developed for the operation of non-GSO systems;

g) that No. **15.5** *b)* provides that "radiation in and reception from unnecessary directions shall be minimized by taking the maximum practical advantage of the properties of directional antennas whenever the nature of the service permits";

h) that earth stations may be equipped with devices allowing geolocation as well as cessation of emissions in the Earth-to-space direction,

recognizing

a) that the ITU Constitution recognizes the sovereign right of each Member State to regulate its telecommunications;

b) that Member States have the sovereign right to license the use of non-GSO systems in their territories and that radiation in and reception from unnecessary directions shall be minimized;

c) that Member States may wish to exclude its territory from the service area of the non-GSO satellite system;

d) that unauthorized use of non-GSO FSS and MSS earth stations is prohibited,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

1 studies on regulatory measures to limit the unauthorized operations of non-GSO FSS and MSS earth stations in the Earth-to-space direction in order to address and cease such operations, taking into account technical and operational aspects, as appropriate;

2 studies on regulatory measures, taking into account *recognizing c)* with regard to non-GSO FSS and MSS satellite systems, and the implementability of such measures, without adversely affecting the provision of service in the rest of the service area of the non-GSO satellite system,

invites administrations

to participate actively in the studies and provide the information required for the studies listed under *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* by submitting contributions to ITU Radiocommunication Sector,

resolves to invite the 2027 world radiocommunication conference

to consider the results of the studies under *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* above and take appropriate action.

RESOLUTION 15 (REV.WRC-03)

International cooperation and technical assistance in the field of space radiocommunications

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that a large number of Member States are not in a position to take immediate advantage of satellite techniques for the development of their telecommunication services;

b) that such Member States would benefit immensely through the technical assistance programmes sponsored by the Union,

recognizing

a) that international satellite-communication systems are subject to the Convention and Regulations of the Union and that they permit participation of all countries including, in particular, the developing countries, in space communication systems;

b) that a number of problems need to be solved in order that the developing countries may participate effectively in international space communication systems and integrate these systems with their national telecommunication networks,

resolves to instruct the Director of the Radiocommunication Bureau

to include this activity in the Operational Plan, within existing budgetary resources of the Sector,

invites the Council

1 to draw the attention of administrations to the means by which they may avail themselves of technical assistance in connection with the introduction of space communications;

2 to consider the most effective manner in which requests for such assistance by Member States may be formulated and presented in order to secure maximum financial and other assistance, including the allocation of the funds in the regular budget of ITU for implementing this Resolution, preferably within the budget of the Sector identified for the implementation of this Resolution;

3 to consider how best to make use of funds made available by the United Nations in accordance with its Resolution 1721 to give technical and other assistance to administrations of Member States to make effective use of space communications;

4 to consider in what way the work of the ITU-T, ITU-R and ITU-D and other organs of the Union may be utilized in the most effective way for the information and assistance of administrations of Member States in the development of space radiocommunications.

RESOLUTION 18 (REV.WRC-23)

Relating to the procedure for identifying and announcing the position of ships and aircraft of States not parties to an armed conflict

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that ships and aircraft encounter considerable risk in the vicinity of an area of armed conflict;

b) that for the safety of life and property it is desirable for ships and aircraft of States not parties to an armed conflict to be able to identify themselves and announce their position in such circumstances;

c) that radiocommunication offers such ships and aircraft a rapid means of self-identification and providing location information prior to their entering areas of armed conflict and during their passage through the areas;

d) that it is considered desirable to provide a supplementary signal and procedure for use, in accordance with customary practice, in the area of armed conflict by ships and aircraft of States representing themselves as not parties to an armed conflict,

noting

that Recommendations ITU-R M.493 and ITU-R M.1371 may include appropriate signals for the digital selective-calling systems and automatic identification systems in the maritime mobile service,

resolves

1 that the frequencies for urgency signal and messages specified in the Radio Regulations may be used by ships and aircraft of States not parties to an armed conflict for self-identification and establishing communications; the transmission will consist of the urgency or safety signals, as appropriate, described in Article **33** followed by the addition of the single word "NEUTRAL" pronounced as in French "neutral" in radiotelephony; as soon as practicable, communications shall be transferred to an appropriate working frequency;

2 that the use of the signal as described in the preceding paragraph indicates that the message which follows concerns a ship or aircraft of a State not party to an armed conflict. The message shall convey at least the following data:

a) call sign or other recognized means of identification of such ship or aircraft;

b) position of such ship or aircraft;

c) number and type of such ships or aircraft;

d) intended route;

e) estimated time en route and of departure and arrival, as appropriate;

f) any other information, such as flight altitude, radio frequencies guarded, languages and secondary surveillance radar modes and codes;

3 that the provisions of Article **33** relating to urgency and safety transmissions, and medical transports shall apply as appropriate to the use of the urgency and safety signals, respectively, by such ship or aircraft;

4 that the identification and location of ships of a State not party to an armed conflict may be effected by means of appropriate standard maritime radio equipment (for example automatic identification system (AIS) or long-range identification and tracking (LRIT)); the identification and location of aircraft of a State not party to an armed conflict may be effected by the use of the secondary surveillance radar (SSR) system in accordance with procedures to be recommended by the International Civil Aviation Organization (ICAO);

5 that the use of the signals described above would not confer or imply recognition of any rights or duties of a State not party to an armed conflict or a party to the conflict, except as may be recognized by common agreement between the parties to the conflict and a non-party;

6 to encourage parties to a conflict to enter into such agreements,

requests the Secretary-General

to communicate the contents of this Resolution to the International Maritime Organization, the International Civil Aviation Organization, the International Committee of the Red Cross, and the International Federation of Red Cross and Red Crescent Societies for such action as they may consider appropriate.

RESOLUTION 20 (REV.WRC-03)

Technical cooperation with developing countries in the field of aeronautical telecommunications

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that the allocations of the frequency bands and the provisions concerning various aeronautical mobile services have been revised several times by recent conferences;

b) that some of these frequency bands and provisions support the worldwide implementation of new aeronautical telecommunication systems;

c) that on the other hand, some of these frequency bands and provisions support existing aeronautical systems that may be affected by the revision;

d) that, as a consequence of *a)*, *b)* and *c)*, technological modernization will be necessary in order to maintain and improve the safety and regularity of international civil aviation, the accuracy and security of aeronautical radionavigation and the efficiency of distress and rescue systems;

e) that the developing countries may require assistance in improving the training of technical staff, as well as in introducing new systems, in coping with technological modernization and enhancing the operation of aeronautical telecommunications,

recognizing

a) the value of the assistance which, in conjunction with other international organizations, the Union has provided and may continue to provide to developing countries in the field of telecommunications;

b) that the original version of Resolution **20 (Mob-87)** established a good basis for the technical cooperation with developing countries in the field of aeronautical telecommunications that has been undertaken by the International Civil Aviation Organization (ICAO),

resolves to instruct the Secretary-General

1 to encourage ICAO to continue its assistance to developing countries which are endeavouring to improve their aeronautical telecommunications, in particular by providing them with technical advice for the planning, establishment, operation and maintenance of equipment, as well as help with the training of staff, essentially in matters relating to the new technologies;

2 for this purpose, to seek the continued collaboration of ICAO, the United Nations Conference for Trade and Development (UNCTAD) and other specialized agencies of the United Nations, as appropriate;

3 to continue to give special attention to seeking the aid of the United Nations Development Programme (UNDP) and other sources of financial support, to enable the Union to render sufficient and effective technical assistance in the field of aeronautical telecommunications,

invites the developing countries

so far as possible, to give a high level of priority to and include in their national programmes of requests for technical assistance projects relating to aeronautical telecommunications and to support multinational projects in that field.

RESOLUTION 22 (REV.WRC-23)

Measures to limit unauthorized uplink transmissions from earth stations

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that, in accordance with Resolution **958 (WRC-15)**[*, 1] and Resolution ITU-R 64 of the Radiocommunication Assembly, the following issues were studied:

– whether there is a need for possible additional measures in order to limit uplink transmissions of terminals to those terminals authorized in accordance with No. **18.1**;

– possible methods that will assist administrations in managing the unauthorized operation of earth station terminals deployed within their territory, as a tool to guide their national spectrum-management programme;

b) that demand has been increasing for global satellite broadband communication services throughout the world,

recognizing

a) that training and monitoring capabilities, along with ITU Reports and Handbooks, may assist national administrations in inhibiting the unauthorized uplink transmissions of earth stations and can facilitate the location and termination of unauthorized earth station transmissions which do not comply with the provisions of Article **18**;

b) that Article **18** specifies the requirements for licensing the operation of stations within any given territory;

c) that administrations involved in the provision of satellite services, including notifying administrations of satellite networks or systems, are subject to Article **18**;

d) that successful coordination of a satellite network or system does not imply licensing/authorization to provide a service within the territory of a Member State,

noting

a) that the ITU Constitution recognizes the sovereign right of each Member State to regulate its telecommunications;

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[*] *Note by the Secretariat:* This Resolution was abrogated by WRC-19.

[1] Reference to Resolution **958 (WRC-15)** is provided as background information.

b) that multiple administrations are involved in the provision of satellite services, including notifying administrations of satellite networks or systems,

resolves

1 that the operation of transmitting earth stations within the territory of an administration shall be carried out only if authorized by that administration;

2 that the notifying administration for a satellite network or system shall, to the extent practicable, limit the operation of transmitting earth stations on the territory of an administration on which they are located and operated to only those licensed or authorized by that administration;

3 that, when an administration identifies the presence of unauthorized transmitting earth station transmissions in its territories:

i) it should take all appropriate actions at its disposal to the extent of its ability to stop such unauthorized transmissions; and

ii) if the matter is not resolved, this administration may report the details of such unauthorized transmissions, if available, to the notifying administrations of the satellite networks or systems that may be associated with these unauthorized transmissions, and the notifying administrations of these satellite networks or systems shall cooperate with the reporting administration, to the maximum extent possible, in order to resolve the matter in a satisfactory and timely manner,

invites administrations

1 to take all appropriate actions to make publicly and readily available the procedures for licensing/authorizing the operation of earth stations in their territories;

2 that have identified unauthorized operation of earth stations within their territories to provide relevant information to the Radiocommunication Bureau (BR) to report such cases;

3 when requested by BR or another administration, to cooperate to the maximum extent practicable with assistance in identifying unauthorized earth stations, with monitoring or geolocation services,

instructs the Director of the Radiocommunication Bureau

1 upon receipt of information from an administration detecting an unauthorized uplink transmission from its territory, to immediately inform Member States and satellite operating agencies of the matter by appropriate means and work with the administrations involved to resolve the matter;

2 to inform the administrations on the type of assistance ITU can provide on this issue,

instructs the Secretary-General

to stress the importance and ensure the circulation of this Resolution to all Member States.

RESOLUTION 25 (REV.WRC-23)

Operation of global satellite systems for personal communications

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that, in accordance with No. 6 of its Constitution, one of the purposes of the Union is "to promote the extension of the benefits of the new telecommunication technologies to all the world's inhabitants";

b) that, to this end, the Union is fostering the use of new technologies in telecommunications and is studying questions relating to this use in the Radiocommunication and the Telecommunication Standardization Sectors;

c) that the Telecommunication Development Sector is studying questions aimed at identifying the benefits that developing countries may derive from using new technologies;

d) that, among these new technologies, some constellations of non-geostationary satellites may provide global coverage and facilitate low-cost communications;

e) that the theme "global mobile personal communications by satellite" (GMPCS) was discussed at the first World Telecommunication Policy Forum established by Resolution 2 (Kyoto, 1994) of the Plenipotentiary Conference;

f) that Council Resolution 1116 instructs the Secretary-General to act as depositary of the GMPCS Memorandum of Understanding (MoU) and its Arrangements, to act as the registry for type-approval procedures and terminal types and to authorize the use of the abbreviation "ITU" as part of the GMPCS-MoU mark;

g) Recommendations ITU-R M.1343 and ITU-R M.1480 on the essential technical requirements of GMPCS earth stations that should be used by administrations as a common technical basis facilitating the global circulation and use of such GMPCS terminals in conformity with these Recommendations,

recognizing

a) that the spectrum available to global satellite systems for personal communications is limited;

b) that successful coordination does not in any way imply licensing authorization to provide a service within the territory of a Member State,

considering further

that other countries intending to use these systems should be guaranteed that they will be operated in accordance with the Constitution, the Convention and the Administrative Regulations,

noting

a) that the Constitution recognizes the sovereign right of each State to regulate its telecommunications;

b) that the International Telecommunication Regulations "recognize the right of any Member, subject to national law and should it decide to do so, to require that administrations and private operating agencies, which operate in its territory and provide an international telecommunication service to the public, be authorized by that Member", and specifies that "within the framework of the present Regulations, the provision and operation of international telecommunication services in each relation is pursuant to mutual agreement between administrations";

c) that Article **18** specifies the authorities for licensing the operation of stations within any given territory;

d) the right of each Member State to decide on its participation in these systems, and the obligations for entities and organizations providing international or national telecommunication services by means of these systems to comply with the legal, financial and regulatory requirements of the administrations in whose territory these services are authorized,

resolves

that administrations licensing global satellite systems and stations intended to provide public personal communications by means of fixed, mobile or transportable terminals shall ensure, when licensing these systems and stations, that they can be operated only from the territory or territories of administrations having authorized such service and stations in compliance with Articles **17** and **18**, in particular No. **18.1**,

requests administrations

1 to continue cooperating with worldwide satellite system operators in improving the established arrangements for the provision of service within their territories and with the Secretary-General in implementing the GMPCS-MoU and its Arrangements;

2 to participate actively in ITU-R studies in developing and improving relevant Recommendations,

reminds operators of such systems

to take account, when contracting agreements on the operation of their systems from the territory of a country, of any potential loss of revenue that the country may suffer from a possible reduction of its international traffic existing at the time such agreements are executed.

RESOLUTION 26 (REV.WRC-23)

Footnotes to the Table of Frequency Allocations in Article 5 of the Radio Regulations

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that footnotes are an integral part of the Table of Frequency Allocations in the Radio Regulations and, as such, form part of an international treaty text;

b) that footnotes to the Table of Frequency Allocations should be clear, concise and easy to understand;

c) that footnotes should relate directly to matters of frequency allocation;

d) that, in order to ensure that footnotes allow modification of the Table of Frequency Allocations without introducing unnecessary complications, principles relating to the use of footnotes are needed;

e) that, currently, footnotes are adopted by competent world radiocommunication conferences (WRCs) and any addition, modification or deletion of a footnote is considered and adopted by the competent conference;

f) that some problems concerning country footnotes may be resolved through the application of a special agreement envisaged by Article **6**;

g) that, in certain cases, administrations are confronted with major difficulties due to inconsistencies or omissions in footnotes;

h) that, in order to keep the footnotes to the Table of Frequency Allocations up to date, there should be clear and effective guidelines for additions, modifications and deletions of footnotes,

noting

a) that some footnotes have been developed and revised under relevant agenda items of WRCs, while footnotes which are not related to those agenda items were considered by previous WRCs, as described in Annex 1 to this Resolution, under the standing agenda item referred to in *further resolves* 2;

b) that, under certain circumstances and on a purely exceptional basis, previous WRCs considered proposals for the addition of country names to existing footnotes which were not related to the case mentioned in *further resolves* 1;

c) that previous conferences also received proposals for the addition of new country footnotes not related to any agenda items, and that these proposals were not accepted;

d) that administrations need sufficient time to examine the potential consequences of changes to footnotes to the Table of Frequency Allocations;

e) the importance of coordination between countries before a WRC to agree on changes related to country footnotes,

resolves

1 that, wherever possible, footnotes to the Table of Frequency Allocations should be confined to altering, limiting or otherwise changing the relevant allocations rather than dealing with the operation of stations, assignment of frequencies or other matters;

2 that the Table of Frequency Allocations should include only those footnotes which have international implications for the use of the radio-frequency spectrum;

3 that new footnotes to the Table of Frequency Allocations should only be adopted in order to:

a) achieve flexibility in the Table of Frequency Allocations;

b) protect the relevant allocations in the body of the Table and in other footnotes in accordance with Section II of Article **5**;

c) introduce either transitional or permanent restrictions on a new service to achieve compatibility; or

d) meet the specific requirements of a country or area when it is impracticable to satisfy such needs otherwise within the Table of Frequency Allocations;

4 that footnotes serving a common purpose should be in a common format, and, where possible, be grouped into a single footnote with appropriate references to the relevant frequency bands,

further resolves

1 that any addition of a new footnote or modification of an existing footnote should be considered by a WRC only when:

a) the agenda of that WRC explicitly includes the frequency band to which the proposed additional or modified footnote relates; or

b) the frequency bands to which the desired additions or modifications of the footnote belong are considered during WRC and WRC decides to make a change in those frequency bands; or

c) the addition or modification of footnotes is specifically included in the agenda of WRC as a result of the consideration of proposals submitted by one or more interested administration(s);

2 that recommended agendas for future WRCs should include a standing agenda item which would allow for the consideration of proposals by administrations for deletion of country footnotes, or country names in footnotes, if no longer required[1];

[1] See also Annex 1 to this Resolution.

3 that in cases not covered by *further resolves* 1 and 2, proposals for new footnotes or modification of existing footnotes could exceptionally be considered by a WRC if they concern corrections of obvious omissions, inconsistencies, ambiguities or editorial errors and have been submitted to ITU as stipulated in No. 40 of the General Rules of conferences, assemblies and meetings of the Union,

urges administrations

1 to review footnotes periodically and to propose the deletion of their country footnotes or of their country names from footnotes, as appropriate;

2 to take account of *further resolves* above in making proposals to WRCs in relation to footnotes or country names in footnotes;

3 to submit their proposals to a WRC in the cases addressed by *further resolves* 1, under the relevant agenda items of the conference, as appropriate (see Section B of Annex 1 to this Resolution);

4 to submit their proposals under the WRC standing agenda item described in *further resolves* 2 to the second session of the corresponding conference preparatory meeting for information only, if available, to allow for discussion with affected administrations.

ANNEX 1 TO RESOLUTION 26 (REV.WRC-23)

Previous world radiocommunication conferences (WRCs) have recognized that the scope of the WRC standing agenda item described in *further resolves* 2 of this Resolution is only related to requests from administrations to delete their country footnotes or to have their country name deleted from footnotes, if no longer required. However, previous WRCs have also received proposals on the addition of country names to existing footnotes and on the addition of new country footnotes.

It is recognized that it is not the intention of WRCs to encourage the addition of country names to existing footnotes.

Taking into account the decisions of WRC-12, WRC-15 and WRC-19 on the same subject, it is suggested that future WRCs may apply a similar approach to previous WRCs.

Future WRCs may consider the following guidance derived from the above-mentioned decisions.

A) The work of WRC on proposals submitted under the standing agenda item described in *further resolves* 2 of this Resolution may be based on the following:

i) Under certain circumstances, on a purely exceptional basis and if justified, proposals for the addition of country names to existing footnotes may be considered by WRCs, but their acceptance is subject to the express condition that there are no objections from affected countries.

ii) Should a WRC decide to accept submissions of additional proposals for the addition of country names to existing footnotes based on the proposals received, it may establish a deadline for such further contributions to WRC.

iii) A deadline may also be established for proposals on the deletion of country names, if appropriate, taking into account that administrations require sufficient time to analyse the proposals.

iv) Proposals for the addition of new country footnotes which are not related to agenda items of a WRC or cases described in *further resolves* 1 of this Resolution should not be considered.

B) The proposals on additions of country names to existing footnotes or new country footnotes in the cases addressed by *further resolves* 1 of this Resolution are to be treated under the relevant agenda item of the WRC, as appropriate.

Administrations are urged to submit their proposals under relevant agenda items of the WRC.

Proposals for additions which do not fall within the categories referred to in *further resolves* 1 of this Resolution may be considered under the standing agenda item described in *further resolves* 2 of this Resolution and are subject to the principles mentioned in A) above.

RESOLUTION 27 (REV.WRC-19)

Use of incorporation by reference in the Radio Regulations

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that the Voluntary Group of Experts (VGE) on simplification of the Radio Regulations proposed the transfer of certain texts of the Radio Regulations to other documents, especially to the ITU Radiocommunication Sector (ITU-R) Recommendations, using the incorporation by reference procedure;

b) that the principles of incorporation by reference were adopted by WRC-95 and revised by subsequent conferences;

c) that, in some cases, there are provisions in the Radio Regulations containing references which fail to distinguish adequately whether the status of the referenced text is mandatory or non-mandatory;

d) that all texts of ITU-R Recommendations incorporated by reference are published in a volume of the Radio Regulations;

e) that, taking into account the rapid evolution of technology, ITU-R may revise the ITU-R Recommendations containing text incorporated by reference at short intervals;

f) that, following revision of an ITU-R Recommendation containing text incorporated by reference, the reference in the Radio Regulations shall continue to apply to the earlier version until such time as a competent world radiocommunication conference (WRC) agrees to incorporate the new version;

g) that it would be desirable that texts incorporated by reference reflect the most recent technical developments,

noting

a) that references to Resolutions or Recommendations of a WRC require no special procedures, and are acceptable for consideration, since such texts will have been agreed by a WRC;

b) that administrations need sufficient time to examine the potential consequences of changes to ITU-R Recommendations containing text incorporated by reference and would therefore benefit greatly from being advised, as early as possible, of which ITU-R Recommendations have been revised and approved during the elapsed study period or at the Radiocommunication Assembly (RA) preceding WRC,

resolves

1 that, for the purposes of the Radio Regulations, the term “incorporation by reference” shall only apply to those references intended to be mandatory;

2 that the text incorporated by reference shall have the same treaty status as the Radio Regulations themselves;

3 that the reference shall be explicit, specifying the specific part of the text (if appropriate) and the version or issue number;

4 that, where a mandatory reference to an ITU-R Recommendation, or parts thereof, is included in the *resolves* of a WRC Resolution, which is itself cited in a provision or footnote of the Radio Regulations using mandatory language (i.e. "shall"), the ITU-R Recommendation or parts thereof shall also be considered as incorporated by reference;

5 that texts which are of a non-mandatory nature or which refer to other texts of a non-mandatory nature shall not be considered for incorporation by reference;

6 that, when considering the introduction of new cases of incorporation by reference, such incorporation shall be kept to a minimum and made by applying the following criteria:

6.1 only texts which are relevant to a specific WRC agenda item may be considered;

6.2 where the relevant texts are brief, the referenced material should be placed in the body of the Radio Regulations rather than using incorporation by reference;

6.3 the guidance contained in Annex 1 to this Resolution shall be applied in order to ensure that the correct method of reference for the intended purpose is employed;

7 that the text to be incorporated by reference shall be submitted for adoption by a competent WRC and the procedure described in Annex 2 to this Resolution shall be applied for approving the incorporation by reference of ITU-R Recommendations or parts thereof;

8 that existing references to ITU-R Recommendations shall be reviewed to clarify whether the reference is mandatory or non-mandatory in accordance with Annex 1 to this Resolution;

9 that ITU-R Recommendations, or parts thereof, incorporated by reference at the conclusion of each WRC, and a cross-reference list of the regulatory provisions, including footnotes and Resolutions, incorporating such ITU-R Recommendations by reference, shall be collated and published in a volume of the Radio Regulations (see Annex 2 to this Resolution);

10 that if, between WRCs, a text incorporated by reference (e.g. an ITU-R Recommendation) is updated, the reference in the Radio Regulations shall continue to apply to the earlier version incorporated by reference until such time as a competent WRC agrees to incorporate the new version; the mechanism for considering such a step is given in the *further resolves* part of this Resolution,

further resolves

1 that each RA shall communicate to the next WRC a list of the ITU-R Recommendations containing text incorporated by reference in the Radio Regulations which have been revised and approved during the elapsed study period;

2 that, on this basis, WRC is invited to examine those revised ITU-R Recommendations, and decide whether or not to update the corresponding references in the Radio Regulations;

3 that, if WRC decides not to update the corresponding references, the currently referenced version shall be maintained in the Radio Regulations;

4 to invite future WRCs to include a standing agenda item on examination of the revised ITU-R Recommendations in accordance with *further resolves* 1 and 2 of this Resolution,

instructs the Director of the Radiocommunication Bureau

1 to bring this Resolution to the attention of RA and the radiocommunication study groups;

2 to identify the provisions and footnotes of the Radio Regulations containing references to ITU-R Recommendations and make suggestions on any further action to the second session of the Conference Preparatory Meeting (CPM) for its consideration and inclusion in the CPM Report;

3 to identify the provisions and footnotes of the Radio Regulations containing references to WRC Resolutions that contain references to ITU-R Recommendations, and make suggestions on any further action to the second session of CPM for its consideration and inclusion in the CPM Report;

4 to provide the second session of CPM with a list, for inclusion in the CPM Report, of those ITU-R Recommendations containing texts incorporated by reference that have been revised or approved since the previous WRC, or that may be revised in time for the next WRC,

invites administrations

1 to submit proposals to future conferences, taking into account the CPM Report, in order to clarify the status of references, where ambiguities remain regarding the mandatory or non-mandatory status of the references in question, with a view to amending those references:

i) that appear to be of a mandatory nature, identifying such references as being incorporated by reference by using clear linking language in accordance with Annex 1 to this Resolution;

ii) that are of a non-mandatory character, so as to refer to “the most recent version” of the Recommendations;

2 to participate actively in the work of the radiocommunication study groups and the RA on revision of those Recommendations to which mandatory references are made in the Radio Regulations;

3 to examine any indicated revisions of ITU-R Recommendations containing text incorporated by reference and to prepare proposals on possible updating of relevant references in the Radio Regulations.

ANNEX 1 TO RESOLUTION 27 (REV.WRC-19)

Application of incorporation by reference

When introducing new cases of incorporation by reference in the provisions of the Radio Regulations or reviewing existing cases of incorporation by reference, administrations and ITU-R should address the following factors in order to ensure that the correct method of reference is employed for the intended purpose, according to whether each reference is mandatory (i.e. incorporated by reference) or non-mandatory:

Mandatory references

1 Mandatory references shall use clear linking language, i.e. “shall”.

2 Mandatory references shall be explicitly and specifically identified, e.g. “Recommendation ITU-R M.541-8”.

3 If the intended reference material is, as a whole, unsuitable as treaty-status text, the reference shall be limited to just those portions of the material in question which are of a suitable nature, e.g. “Annex A to Recommendation ITU-R Z.123-4”.

Non-mandatory references

4 Non-mandatory references or ambiguous references that are determined to be of a non-mandatory character (i.e. not incorporated by reference) shall use appropriate language, such as “should” or “may”. This appropriate language may refer to “the most recent version” of a Recommendation. Any appropriate language may be changed at any future WRC.

ANNEX 2 TO RESOLUTION 27 (REV.WRC-19)

Procedures applicable by WRC for approving the incorporation by reference of ITU-R Recommendations or parts thereof

During the course of each WRC, a list of the ITU-R Recommendations incorporated by reference, and a cross-reference list of the regulatory provisions, including footnotes and Resolutions, incorporating such ITU-R Recommendations by reference, shall be developed and maintained by the committees. These lists shall be published as a conference document in line with developments during the conference.

Following the end of each WRC, the Radiocommunication Bureau and the General Secretariat will update the volume of the Radio Regulations which serves as the repository of ITU-R Recommendations incorporated by reference in line with developments at the conference as recorded in the above-mentioned document.

RESOLUTION 32 (REV.WRC-23)

Regulatory procedures for frequency assignments to non-geostationary-satellite networks or systems identified as short-duration mission not subject to the application of Section II of Article 9

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that some non-geostationary (non-GSO) satellites with short-duration missions have, to date, been operating for their entire mission duration without being notified or recorded;

b) that successful and timely development and operation of non-GSO networks or systems with short-duration missions may require regulatory procedures which take account of the short development cycle, short lifetimes and typical missions of such satellites, and therefore the application of certain provisions of Articles **9** and **11** may need to be adapted to take account of the nature of these satellites;

c) that these satellites typically have a short (one to two years) development time and are low cost, often using off-the-shelf components;

d) that the operational lifetime of these satellites generally ranges from several weeks up to not more than three years;

e) that non-GSO satellites with short-duration missions utilize low-Earth orbits;

f) that non-GSO satellites with short-duration missions are being used for a wide variety of applications, including remote sensing, space weather research, upper atmosphere research, astronomy, communications, technology demonstration and education, and therefore may operate under various radiocommunication services;

g) that advances in the field of satellite technology have resulted in non-GSO satellites with short-duration missions becoming a means for developing countries to become involved in space activities,

considering further

a) that the application of provisions of Articles **9** and **11** to frequency assignments to non-GSO networks or systems identified as short-duration mission as prescribed in this Resolution should not adversely or otherwise affect the regulatory treatment of other systems;

b) that the application of any modified regulatory procedure should not change the sharing status with respect to networks and systems not applying the modified regulatory procedure, both terrestrial and space, in frequency bands which may be used by non-GSO systems with short-duration missions,

recognizing

a) that Resolution ITU-R 68 seeks to improve awareness and increase knowledge on existing regulatory procedures for small satellites;

b) that non-GSO networks or systems operating in frequency bands not subject to Section II of Article **9** are, irrespective of the period of validity of their associated frequency assignments, subject to Nos. **9.3** and **9.4**;

c) that non-GSO systems with short-duration missions are not to be used for safety-of-life services,

noting

a) Report ITU-R SA.2312, on characteristics, definitions and spectrum requirements of nanosatellites and picosatellites, as well as systems composed of such satellites;

b) that No. **22.1** states that "Space stations shall be fitted with devices to ensure immediate cessation of their radio emissions by telecommand, whenever such cessation is required under the provisions of these Regulations" (see also Appendix **4** data item A.24.a),

resolves

1 that this Resolution shall apply only to non-GSO networks or systems identified by the notifying administration as effecting short-duration missions and corresponding to the following criteria:

1.1 the network or system shall operate under any space radiocommunication service on frequency assignments that are not subject to the application of Section II of Article **9**;

1.2 the maximum period of operation and validity of frequency assignments of a non-GSO network or system identified as short-duration mission shall not exceed three years from the date of bringing into use of the frequency assignments (see the Annex to this Resolution for the definition of date of bringing into use for such networks or systems), without any possibility of extension, after which the recorded assignments shall be cancelled;

1.3 the total number of satellites in a non-GSO network or system identified as short-duration mission shall not exceed 10 satellites[1];

2 that non-GSO networks or systems corresponding to *resolves* 1 of this Resolution shall comply with the conditions for use of the frequency band that is allocated to the service within which they operate;

3 that non-GSO networks or systems identified as short-duration mission using spectrum allocated to the amateur-satellite service shall operate in accordance with the definition of the amateur-satellite service as contained in Article **25**;

[1] The typical mass of each satellite should not normally exceed 100 kg.

4 that non-GSO networks or systems with short-duration missions shall have the capability to cease transmitting immediately in order to eliminate harmful interference;

5 that, for the purpose of this Resolution, a non-GSO network or system identified as short-duration mission shall have a single launch date associated with the first launch (in the case of systems with multiple launches) and that launch date shall be defined as the date on which the first satellite of the non-GSO network or system with a short-duration mission is placed into its notified orbital plane,

instructs the Director of the Radiocommunication Bureau

1 to expedite the online publication of notices "as received" for such networks or systems, in addition to the normal publication of notices;

2 to provide the necessary assistance to administrations in the implementation of this Resolution,

invites administrations

1 to avoid heavily used frequency bands when assigning frequencies to a non-GSO network or system with a short-duration mission;

2 to exchange information associated with non-GSO networks or systems identified as short-duration mission and to make every possible effort to resolve interference that may be unacceptable to existing or planned satellite networks or systems, including those with short-duration missions;

3 to provide their comments on the application of No. **9.3**, upon receipt of the International Frequency Information Circular of the Radiocommunication Bureau (BR IFIC) containing information published under No. **9.2B**, as soon as possible within a period of four months from the date of publication of the BR IFIC, and to communicate to the notifying administration, with a copy to the Bureau, these comments on the particulars of the potential interference to its existing or planned systems.

ANNEX TO RESOLUTION 32 (REV.WRC-23)

Application of the provisions of Articles 9 and 11 for non-geostationary-satellite networks and systems identified as short-duration mission

1 The general provisions of the Radio Regulations shall apply to non-geostationary-satellite (non-GSO) networks or systems identified as short-duration mission with the following exceptions/additions/amendments.

2 When submitting advance publication information under No. **9.1**, administrations shall submit the orbital characteristics (Appendix **4** data item A.4.b.4) planned at the early development stage of the satellite project.

3 In the application of No. **9.1**, the notification information cannot be communicated to the Radiocommunication Bureau (BR) at the same time, and can only be submitted after the launch of a satellite in the case of a network or of the first satellite in the case of a system with multiple launches.

4 Notices relating to notification for the recording of frequency assignments to non-GSO networks or systems identified as short-duration mission shall be communicated to BR only after the launch of a satellite in the case of a satellite network or of the first satellite in the case of a system requiring multiple launches, and not later than two months after the date of bringing into use. This provision applies instead of No. **11.25** for frequency assignments to non-GSO networks or systems with short-duration missions (see also the Rules of Procedure associated with this Resolution). Irrespective of the date of receipt of the notified characteristics of the non-GSO network or system with a short-duration mission under this Resolution, the maximum period of validity of frequency assignments of the system shall not exceed the time-limit in *resolves* 1.2 of this Resolution. At the expiry date of the period of validity, as described in *resolves* 1.2 of this Resolution, BR shall publish a suppression of the related Special Section.

5 Any frequency assignments to non-GSO networks or systems identified as short-duration mission for which the notice referred to in § 4 reaches the Bureau more than two months after the date of bringing into use shall bear a remark in the Master Register to indicate that they are not in conformity with § 4 of the Annex to Resolution **32 (Rev.WRC-23)**.

6 In addition to the application of No. **11.36**, BR shall publish the characteristics of the system together with the findings under No. **11.31** in its International Frequency Information Circular (BR IFIC) and on its website within no more than four months from the date of receipt of complete information under No. **11.28**. When BR is not in a position to comply with the time-limit referred to above, it shall periodically so inform the notifying administration, giving the reasons therefor.

7 In the application of No. **11.44**, the date of bringing into use of a non-GSO network or system identified as short-duration mission shall be defined as the launch date of a satellite in the case of a non-GSO network or of the first satellite in the case of a non-GSO system requiring multiple launches (see *resolves* 5 of this Resolution).

8 Nos. **11.43A**, **11.43B** and **11.49** shall not apply to frequency assignments to non-GSO networks or systems identified as short-duration mission.

RESOLUTION 34 (REV.WRC-19)

Establishment of the broadcasting-satellite service in Region 3 in the frequency band 12.5-12.75 GHz and sharing with space and terrestrial services in Regions 1, 2 and 3

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

that WARC-79 allocated the frequency band 12.5-12.75 GHz to the broadcasting-satellite service (BSS) for community reception in Region 3,

recognizing

that, under Resolution **507 (Rev.WRC-19)**, the ITU Council may wish to empower a future competent radiocommunication conference to establish a plan for the BSS in the frequency band 12.5-12.75 GHz in Region 3,

resolves

1 that, until such time as a plan may be established for the BSS in the frequency band 12.5-12.75 GHz in Region 3, the relevant provisions of Article **9** shall continue to apply to coordination between stations in the BSS in Region 3 and:

a) space stations in the BSS and the fixed-satellite service (FSS) in Regions 1, 2 and 3;

b) terrestrial stations in Regions 1, 2 and 3;

2 that the ITU Radiocommunication Sector (ITU-R) shall study urgently the technical provisions which may be appropriate for sharing between stations in the BSS in Region 3 and:

a) space stations in the BSS and FSS in Regions 1 and 2;

b) terrestrial stations in Regions 1 and 2;

3 that, until such time as technical provisions are developed by ITU-R and accepted by administrations concerned under Resolution **703 (Rev.WRC-07)**, sharing between space stations in the BSS in Region 3 and terrestrial services in Regions 1, 2 and 3 shall be based on the following criteria, as appropriate:

a) the power flux-density at the Earth's surface produced by emissions from a space station in the BSS in Region 3 for all conditions and for all methods of modulation shall not exceed the limits given in Annex 5 of Appendix **30**;

b) in addition to *resolves* 3 *a)* above, the provisions of Article **21** (Table **21-4**) shall apply in the countries mentioned in Nos. **5.494** and **5.496**;

c) the limits given in *resolves* 3 *a)* and *b)* above may be exceeded on the territory of any country provided the administration of that country has so agreed.

RESOLUTION 35 (REV.WRC-23)

A milestone-based approach for the implementation of frequency assignments to space stations in a non-geostationary-satellite system in specific frequency bands and services

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that filings for frequency assignments to non-geostationary-satellite (non-GSO) systems composed of hundreds to thousands of non-GSO satellites have been received by ITU since 2011, in particular in frequency bands allocated to the fixed-satellite service (FSS) or the mobile-satellite service (MSS);

b) that design considerations, availability of launch vehicles to support multiple satellite launches and other factors mean that notifying administrations may require longer than the regulatory period stipulated in No. **11.44** to complete implementation of the non-GSO systems referred to in *considering a)*;

c) that any discrepancies between the deployed number of orbital planes/satellites per orbital plane of a non-GSO system and the Master International Frequency Register (Master Register) have, to date, not significantly impinged upon the efficient use of the orbit/spectrum resource in any frequency band used by non-GSO systems;

d) that the bringing into use and recording in the Master Register of frequency assignments to space stations in non-GSO systems by the end of the seven-year regulatory period referred to in No. **11.44** do not require confirmation by the notifying administration of the deployment of all the satellites associated with these frequency assignments;

e) that ITU Radiocommunication Sector studies on the issue have shown that the adoption of a milestone-based approach will provide a regulatory mechanism to help ensure that the Master Register reasonably reflects the actual deployment of such non-GSO systems in certain frequency bands and services, and improve the efficient use of the orbit/spectrum resource in those frequency bands and services;

f) that, in defining the timeline and objective criteria for the milestone-based approach, there is a need to seek a balance between the prevention of spectrum warehousing, the proper functioning of coordination mechanisms and the operational requirements related to the deployment of a non-GSO system;

g) that adherence to fixed milestone periods is desirable, as this creates certainty with respect to the deployment of non-GSO systems,

recognizing

a) that the bringing into use of frequency assignments to non-GSO systems is addressed in Article **11**;

b) that any regulatory mechanism for management of frequency assignments to non-GSO systems in the Master Register should not impose an unnecessary burden;

c) that the number of orbital planes in a non-GSO system (item A.4.b.1) and the number of satellites in each orbital plane (item A.4.b.4.b) are among the notified required characteristics as specified in Appendix **4**;

d) that No. **13.6** is applicable to non-GSO systems with frequency assignments that were confirmed to have been brought into use prior to 1 January 2021 in the frequency bands and services to which this Resolution applies;

e) that, for frequency assignments to non-GSO systems brought into use and having reached the end of the period referred to in No. **11.44** prior to 1 January 2021 in the frequency bands and services to which this Resolution applies, affected notifying administrations should be given either the opportunity to confirm completion of the deployment of satellites in accordance with the Appendix **4** characteristics of their recorded frequency assignments or sufficient time to complete deployment in accordance with this Resolution;

f) that No. **11.49** addresses the suspension of recorded frequency assignments to a space station of a satellite network or to space stations of a non-GSO system,

recognizing further

that this Resolution relates to those aspects of non-GSO systems to which *resolves* 1 applies with regard to the notified required characteristics as specified in Appendix **4**, and the conformity of the notified required characteristics of the non-GSO systems, other than those referred to in *recognizing c)* above, is outside the scope of this Resolution,

noting

that for the purpose of this Resolution:

– the term "frequency assignments" is understood to refer to frequency assignments to a space station of a non-GSO system;

– the term "notified orbital plane" means an orbital plane of the non-GSO system, as provided to the Radiocommunication Bureau (BR) in the most recent notification information for the system's frequency assignments, that possesses the general characteristics of items:

  – A.4.b.4.a, the inclination of the orbital plane of the space station;

  – A.4.b.4.d, the altitude of the apogee of the space station;

  – A.4.b.4.e, the altitude of the perigee of the space station; and

  – A.4.b.4.i, the argument of the perigee of the orbit of the space station (only for orbits whose altitudes of the apogee and perigee are different)

  in Table A of Annex 2 to Appendix **4**;

– the term “total number of satellites” is understood to mean the sum of the various values of Appendix **4** data item A.4.b.4.b associated with the notified orbital planes in the most recent notification information submitted to BR,

resolves

1 that this Resolution applies to frequency assignments to non-GSO systems brought into use in accordance with Nos. **11.44** and **11.44C**, in the frequency bands and for the services listed in the Table below:

TABLE

Frequency bands and services for application of the milestone-based approach

Frequency bands (GHz)	**Space radiocommunication services**		
	Region 1	**Region 2**	**Region 3**
10.70-11.70	FIXED-SATELLITE (space-to-Earth) FIXED-SATELLITE (Earth-to-space)	FIXED-SATELLITE (space-to-Earth)	
11.70-12.50	FIXED-SATELLITE (space-to-Earth)		
12.50-12.70	FIXED-SATELLITE (space-to-Earth) FIXED-SATELLITE (Earth-to-space)	FIXED-SATELLITE (space-to-Earth)	BROADCASTING-SATELLITE FIXED-SATELLITE (space-to-Earth)
12.70-12.75	FIXED-SATELLITE (space-to-Earth) FIXED-SATELLITE (Earth-to-space)	FIXED-SATELLITE (Earth-to-space)	BROADCASTING-SATELLITE FIXED-SATELLITE (space-to-Earth)
12.75-13.25	FIXED-SATELLITE (Earth-to-space)		
13.75-14.50	FIXED-SATELLITE (Earth-to-space)		
17.30-17.70	FIXED-SATELLITE (space-to-Earth) FIXED-SATELLITE (Earth-to-space)	None	FIXED-SATELLITE (Earth-to-space)
17.70-17.80	FIXED-SATELLITE (space-to-Earth) FIXED-SATELLITE (Earth-to-space)	FIXED-SATELLITE (space-to-Earth)	FIXED-SATELLITE (space-to-Earth) FIXED-SATELLITE (Earth-to-space)
17.80-18.10	FIXED-SATELLITE (space-to-Earth) FIXED-SATELLITE (Earth-to-space)		
18.10-19.30	FIXED-SATELLITE (space-to-Earth)		
19.30-19.60	FIXED-SATELLITE (space-to-Earth) FIXED-SATELLITE (Earth-to-space)		
19.60-19.70	FIXED-SATELLITE (space-to-Earth) (Earth-to-space)		

Frequency bands (GHz)	Space radiocommunication services		
	Region 1	Region 2	Region 3
19.70-20.10	FIXED-SATELLITE (space-to-Earth) Mobile-satellite (space-to-Earth)	FIXED-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth)	FIXED-SATELLITE (space-to-Earth) Mobile-satellite (space-to-Earth)
20.10-20.20	FIXED-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth)		
27.00-27.50		FIXED-SATELLITE (Earth-to-space)	
27.50-29.50	FIXED-SATELLITE (Earth-to-space)		
29.50-29.90	FIXED-SATELLITE (Earth-to-space) Mobile-satellite (Earth-to-space)	FIXED-SATELLITE (Earth-to-space) MOBILE-SATELLITE (Earth-to-space)	FIXED-SATELLITE (Earth-to-space) Mobile-satellite (Earth-to-space)
29.90-30.00	FIXED-SATELLITE (Earth-to-space) MOBILE-SATELLITE (Earth-to-space)		
37.50-38.00	FIXED-SATELLITE (space-to-Earth)		
38.00-39.50	FIXED-SATELLITE (space-to-Earth)		
39.50-40.50	FIXED-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth)		
40.50-42.50	FIXED-SATELLITE (space-to-Earth) BROADCASTING-SATELLITE		
47.20-50.20	FIXED-SATELLITE (Earth-to-space)		
50.40-51.40	FIXED-SATELLITE (Earth-to-space)		

2 that, for frequency assignments to which *resolves* 1 applies, and for which the end of the seven-year regulatory period specified in No. **11.44** is on or after 1 January 2021, the notifying administration shall communicate to BR the required deployment information in accordance with Annex 1 to this Resolution no later than 30 days after the end of the regulatory period specified in No. **11.44** or 30 days after the end of the bringing-into-use period in No. **11.44C**, whichever comes later;

3 that, for frequency assignments to which *resolves* 1 applies, and for which the end of the seven-year regulatory period specified in No. **11.44** has expired prior to 1 January 2021, the notifying administration shall communicate to BR the required deployment information in accordance with Annex 1 to this Resolution no later than 1 February 2021;

4 that, for the purposes of this Resolution, all references to 100% of the total number of satellites indicated in the latest notification information shall mean either 100% of the filed satellites (counting the number of satellites in each notified orbital plane), or 100% of the filed satellites minus one satellite;

5 that, upon receipt of the required deployment information submitted in accordance with *resolves* 2 or 3 above, BR shall:

a) promptly make this information available “as received” on the ITU website;

b) add a remark to the Master Register entry, if available, or to the latest notification information, as appropriate, stating that the assignments are subject to the application of *resolves* 7 to 18 of this Resolution if the number of satellites communicated to BR under *resolves* 2 or 3 above is less than 100% of the total number of satellites indicated in the latest notification information published in its International Frequency Information Circular (BR IFIC) (Part I-S) or in the latest notification information received by BR, as appropriate, for the frequency assignments; and

c) publish the results of action taken pursuant to *resolves* 5*b)* above in the BR IFIC and on the ITU website;

6 that, if the number of satellites communicated to BR under *resolves* 2 or 3 above is 100% of the total number of satellites indicated in the Master Register in Part II-S of the BR IFIC, if available, or in the latest notification information published in the BR IFIC (Part I-S) for the frequency assignments, *resolves* 7 to 18 of this Resolution are not applicable;

7 that, for the frequency assignments to which *resolves* 2 applies, the notifying administration shall communicate to BR the required deployment information in accordance with Annex 1 to this Resolution as of the expiry of the milestone periods mentioned in subsections *a*) through *c*) below (see also *resolves* 9):

a) no later than 30 days after the expiry of the two-year period after the end of the seven-year regulatory period referred to in No. **11.44**;

b) no later than 30 days after the expiry of the five-year period after the end of the seven-year regulatory period referred to in No. **11.44**;

c) no later than 30 days after the expiry of the seven-year period after the end of the seven-year regulatory period referred to in No. **11.44**;

8 that, for frequency assignments to which *resolves* 3 applies, the notifying administration shall communicate to BR the complete deployment information in accordance with Annex 1 to this Resolution as of 1 January of the years mentioned in subsections *a)* through *c)* below (see also *resolves* 9):

a) no later than 1 February 2023 (corresponding to 30 days after the expiry of the two-year period after 1 January 2021);

b) no later than 1 February 2026 (corresponding to 30 days after the expiry of the five-year period after 1 January 2021);

c) no later than 1 February 2028 (corresponding to 30 days after the expiry of the seven-year period after 1 January 2021);

9 that, for purposes of *resolves* 7 and 8:

a) BR shall process the deployment information required to be submitted under *resolves* 7*a)*/8*a)* or 7*b)*/8*b),* as appropriate*,* at any point during the relevant period, if the notifying administration reports that the total number of satellites required to be deployed as of the end of that milestone period has been achieved;

b) BR shall process, at any time, a report from the notifying administration stating that the total number of satellites deployed as a part of the system is 100% of the total number of satellites indicated in the Master Register in Part II-S of the BR IFIC, if available, or in the latest notification information published in the BR IFIC (Part I-S) for the frequency assignments;

c) if the total number of satellites deployed as part of the system during any relevant milestone period is greater than the number of satellites that remain deployed as part of the system as of the expiry of the relevant milestone period, BR shall take into account the total number of satellites deployed during the period that has been reported by the notifying administration if:

i) the notifying administration includes a detailed explanation of the circumstances which led to having the reduced number of satellites deployed as of the expiry of that milestone period with the complete deployment information in accordance with Annex 1 to this Resolution; and

ii) the notifying administration provides an indication of whether any of the satellites no longer counted as of the expiry of the relevant milestone period have been or will be used to satisfy milestone obligations associated with frequency assignment(s) of any other non-GSO system(s) subject to this Resolution and, if so, how many satellites and the identity of the non-GSO system(s) in question;

d) the notifying administration shall provide with its reporting under *resolves* 7 or 8, as appropriate, an indication of whether any of the satellites counted as of the expiry of the relevant milestone period have been used to satisfy milestone obligations associated with frequency assignment(s) of any other non-GSO system(s) subject to this Resolution and, if so, how many satellites and the identity of the non-GSO system(s) in question;

10 that, upon receipt of the required deployment information submitted in accordance with *resolves* 7 or 8, BR shall:

a) promptly make this information available “as received” on the ITU website;

b) conduct an examination of the information provided for compliance with the minimum number of satellites to be deployed as prescribed for each period in *resolves* 11*a)*, 11*b)* or 11*c)*, as appropriate;

c) modify the Master Register entry, if available, or the latest notification information, as appropriate, for the frequency assignments to the system to remove the remark added in accordance with *resolves* 5*b)*, stating that the assignments are subject to the application of this Resolution if the number communicated to BR under *resolves* 7 or 8 is 100% of the total number of satellites indicated in the Master Register entry for the non-GSO system;

d) publish this information and its findings in the BR IFIC and make that information available on the ITU website as soon as possible;

11 that the notifying administration shall also submit to BR, no later than 90 days after the expiry of each of the milestone periods referred to in *resolves* 7 or 8, as appropriate, the modifications to the characteristics of the notified or recorded frequency assignments if the number of space stations declared as deployed:

a) under *resolves* 7*a)* or 8*a),* as appropriate, is less than 10% of the total number of satellites (rounded down to the lower integer) indicated in the latest notification information published in Part I-S of the BR IFIC for the frequency assignments; in this case, the modified total number of satellites shall not be greater than 10 times the number of space stations declared as deployed under *resolves* 7*a)* or 8*a)*;

b) under *resolves* 7*b)* or 8*b),* as appropriate, is less than 50% of the total number of satellites (rounded down to the lower integer) indicated in the latest notification information published in Part I-S of the BR IFIC for the frequency assignments; in this case, the modified total number of satellites shall not be greater than two times the number of space stations declared as deployed under *resolves* 7*b)* or 8*b)*;

c) under *resolves* 7*c)* or 8*c),* as appropriate, is less than 100% of the total number of satellites indicated in the latest notification information published in Part I-S of the BR IFIC for the frequency assignments; in this case, the modified total number of satellites shall not be greater than the number of space stations declared as deployed under *resolves* 7*c)* or 8*c)*;

12 that *resolves* 11*a)* shall not apply for frequency assignments for which the end of the seven-year regulatory period in No. **11.44** is before 28 November 2022, provided that the notifying administration submits the complete information listed in Annex 2 to this Resolution to BR by 1 March 2023, and a favourable determination is made by the Radio Regulations Board (RRB) or WRC-23;

13 that BR shall, no later than 45 days before any deadline for submission by a notifying administration under *resolves* 2, 3, 7*a)*, 7*b),* 7*c),* 8*a)*, 8*b),* 8*c)*, 19, 20 or 21 send a reminder to the notifying administration to provide the information required;

14 that, upon receipt of the modifications to the characteristics of the notified or recorded frequency assignments as referred to in *resolves* 11 or 21:

a) BR shall promptly make this information available "as received" on the ITU website;

b) BR shall conduct an examination for compliance with the maximum number of satellites as per *resolves* 11*a)*, 11*b)* or 11*c)* and Nos. **11.43A/11.43B**, as appropriate;

c) BR, for the purpose of No. **11.43B**, shall retain the original dates of entry of the frequency assignments in the Master Register if:

i) BR reaches a favourable finding under No. **11.31**; and

ii) the modifications are limited to reduction of the number of orbital planes (Appendix **4** data item A.4.b.2) and modifications to the longitude of the ascending node (Appendix **4** data item A.4.b.4.j) associated with the remaining orbital planes, or reduction of the number of space stations per plane (Appendix **4** data item A.4.b.4.b) and modifications of the initial phase angle of the space stations (Appendix **4** data item A.4.b.4.h) within planes; and

iii) the notifying administration provides a commitment stating that the characteristics as modified will not cause more interference or require more protection than the characteristics provided in the latest notification information published in Part I-S of the BR IFIC for the frequency assignments (see Appendix **4** data item A.23.a);

d) for modifications submitted under *resolves* 11, BR shall ensure the remark stating that the assignments are subject to the application of this Resolution as defined in *resolves* 7 or 8 is retained until the milestone process in *resolves* 7 to 18 of this Resolution is complete;

e) BR shall publish the information provided and its findings in the BR IFIC;

15 that, if a notifying administration fails to communicate the information required under *resolves* 2, 3, 7*a)*, 7*b), 7c)*, 8*a)*, 8*b), 8c), 11a)*, 11*b), 11c)*, 19, 20 or 21, as appropriate, BR shall promptly send to the notifying administration a reminder asking the administration to provide the required information within 30 days from the date of this reminder from BR;

16 that, if a notifying administration fails to provide information after the reminder sent under *resolves* 15, BR shall send to the notifying administration a second reminder asking it to provide the required information within 15 days from the date of the second reminder;

17 that, if a notifying administration fails to provide the required information:

a) under *resolves* 2 or 3, as appropriate, following the reminders under *resolves* 15 and 16, BR shall continue to take the entry in the Master Register into account when conducting its examinations until the decision is made by RRB to cancel the entry;

b) under *resolves* 7*a)*, 7*b), 7c)*, 8*a)*, 8*b), 8c)*, 11*a)*, 11*b), 11c)*, 19, 20 or 21, as appropriate, following the reminders under *resolves* 15 and 16, BR shall:

i) modify the entry by suppressing the notified orbital parameters of all satellites not listed in the last complete deployment information submitted under *resolves* 2, 3, 7, 8, 19 or 20, as appropriate; and

ii) no longer consider the frequency assignments under subsequent examinations under Nos. **9.36**, **11.32** or **11.32A**, and inform administrations having frequency assignments subject to subsection IA of Article **9** that those assignments shall not cause harmful interference to, or claim protection from, other frequency assignments recorded in the Master Register with a favourable finding under No. **11.31**;

18 that the suspension of the use of frequency assignments in accordance with No. **11.49** at any point prior to the end of a milestone period as specified in *resolves* 7*a)*, 7*b), 7c), 8a)*, 8*b)* or 8*c)* of this Resolution, as applicable, shall not alter or reduce the requirements associated with any of the remaining milestones as derived from *resolves* 7*a)*, 7*b), 7c), 8a)*, 8*b)* or 8*c)*, as appropriate;

19 that the notifying administration for a non-GSO system that has completed the milestone process described in this Resolution, including application of *resolves* 10*c)* by BR, and for systems to which *resolves* 6 applies, shall communicate to BR the required deployment information in accordance with Annex 1 to this Resolution no later than 30 days after the expiry of the 11-year period after the end of the seven-year regulatory period referred to in No. **11.44** (for frequency assignments to which *resolves* 2 applies) or no later than 1 February 2032 (corresponding to 30 days after the expiry of the 11-year period after 1 January 2021) (for frequency assignments to which *resolves* 3 applies);

20 that the notifying administration for a non-GSO system that has provided deployment information under *resolves* 19 shall, no later than 30 days after the expiry of a four-year period from the due date of the submission under *resolves* 19, and every four years thereafter, communicate to BR the required deployment information in accordance with Annex 1 to this Resolution;

21 that, if the number of satellites reported pursuant to *resolves* 19 or 20 is less than:

$$X = N \cdot 50\% \qquad \text{for} \qquad N \leq 340$$

$$X = N - 67 \cdot \log(N) \qquad \text{for } 340 < N \leq 4\,950$$

$$X = N \cdot 95\% \qquad \text{for} \qquad N > 4\,950$$

where N is the total number of satellites in the non-GSO system indicated in the Master Register in Part II-S of the BR IFIC, if available, or in the latest notification information published in the BR IFIC (Part I-S) for the frequency assignments, and if the number of satellites deployed remains less than X in the formula above on the due date of the subsequent report under *resolves* 20, the notifying administration shall submit modifications to the characteristics of the notified or recorded frequency assignments to align with the number of space stations declared as deployed no later than 90 days after the due date of the subsequent report;

22 that, for a non-GSO system that has completed the milestone process described in this Resolution, including application of *resolves* 10*c)* by BR, and for systems to which *resolves* 6 applies, if the number of satellites considered as part of the system falls below the total number of satellites indicated in the Master Register in Part II-S of the BR IFIC, if available, or in the latest notification information published in the BR IFIC (Part I-S) for the frequency assignments, the notifying administration shall, for information purposes only:

a) provide a report to BR, on an annual basis as of the completion of the milestone process, within 30 days of the anniversary, containing the date when this event, or events, began, and a general explanation of the event(s) for each affected satellite;

b) provide to BR, either as part of the annual report under *resolves* 22*a)*, or with the next report under *resolves* 19 or 20, whichever comes first, the date or dates on which each affected satellite was restored to operational status or replaced;

23 that BR shall:

a) make any information reported under *resolves* 22*a)* and 22*b)* available on its website; and

b) include a report of its activities and data gathered under *resolves* 22 to the relevant ITU-R study group and a future competent conference(s),

further resolves

to apply *resolves* 19 to 23 above on a provisional basis as of 1 January 2025 pending review by a future competent conference,

instructs the Radiocommunication Bureau

1 to take the necessary actions to implement this Resolution;

2 to report any difficulties it encounters in the implementation of this Resolution to future competent world radiocommunication conferences;

3 to continue to identify and report on specific frequency bands in specific services for which there may be a problem similar to that which resulted in the creation of this Resolution, as early as possible, but not later than the penultimate meeting of the responsible group prior to the second session of the conference preparatory meeting,

invites the ITU Radiocommunication Sector

to continue studies with a view to confirming the suitability and regulatory implementation of the post-milestone procedure set out in *resolves* 19 to 21 above, and to recommend appropriate action under Resolution **86 (Rev.WRC-07)**.

ANNEX 1 TO RESOLUTION 35 (REV.WRC-23)

Information to be submitted about the deployed space stations

A Satellite system information

1) Name of the satellite system

2) Name of the notifying administration

3) Country symbol

4) Reference to the advance publication information or the request for coordination, or the notification information, if available

5) Total number of space stations deployed into each notified orbital plane of the satellite system with the capability of transmitting or receiving the frequency assignments

6) Orbital plane number indicated in the latest notification information published in Part I-S of the BR IFIC for the frequency assignments into which each space station is deployed.

B Launch information to be provided for each deployed space station

1) Name of the launch vehicle provider

2) Name of the launch vehicle

3) Name and location of the launch facility

4) Launch date.

C Space station characteristics for each space station deployed

1) Frequency bands from the notification information in which the space station can transmit or receive

2) Orbital characteristics of the space station (altitude of the apogee and perigee, inclination, and argument of the perigee)

3) Name of the space station.

ANNEX 2 TO RESOLUTION 35 (REV.WRC-23)

Information to be provided by the notifying administration pursuant to *resolves* 12

1) Reference to notification information already submitted

2) Current deployment and operational information

3) Report indicating efforts made and detailing status of coordination with systems or networks

4) Clear evidence of a binding agreement for the manufacture or procurement of a sufficient number of satellites to meet the milestone obligation in *resolves* 7*b)* or 8*b)*, as appropriate

5) Clear evidence of a binding agreement to launch a sufficient number of satellites to meet the milestone obligation in *resolves* 7*b)* or 8*b)*, as appropriate.

NOTE – The manufacturing or procurement agreement should identify the contract milestones leading to the completion of manufacture or procurement of satellites required, and the launch agreement should identify the launch window, launch site and launch service provider.

The information required under this Annex shall be submitted in the form of a written commitment by the responsible administration, including manufacturer or launch provider letters or declarations, and evidence of guaranteed funding arrangements for the implementation of the project, where possible.

The notifying administration is responsible for authenticating the evidence of agreement.

RESOLUTION 40 (REV.WRC-19)

Use of one space station to bring frequency assignments to geostationary-satellite networks at different orbital locations into use within a short period of time

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that the use of the same space station to bring frequency assignments to geostationary-satellite (GSO) networks located at different orbital locations into use within a short period of time could lead to inefficient use of spectrum/orbit resources;

b) that there are legitimate reasons why a notifying administration may need to move a space station from one orbital position to a new orbital position, and this should not be constrained,

noting

a) that WRC-12 recognized that the issue of using one space station to bring frequency assignments at different orbital locations into use within a short period of time was not the intent for its adoption of Nos. **11.44**, **11.44.1**, **11.44B** and **11.49**;

b) that, with respect to cases where an administration brings into use frequency assignments at a given orbital location using an already in-orbit satellite, and pending completion of ITU Radiocommunication Sector studies, WRC-12 requested the Radiocommunication Bureau (BR) to make an enquiry to that administration as to the last previous orbital location/frequency assignments brought into use with that satellite and make such information available;

c) that the procedures of Article **14** are available to administrations in cases where information required under *resolves* below may not be available to the notifying administration,

recognizing

a) that administrations may bring into use or bring back into use a frequency assignment to a GSO network using one of its own space stations or a space station under the responsibility of another administration;

b) that the absence of a GSO space station capable of transmitting and receiving the frequency assignments at a notified orbital position, due to the relocation of an in-orbit satellite to a new orbital position, can lead to either the suspension or the cancellation of those frequency assignments in some cases,

resolves

1 that, when informing BR of the bringing into use, or bringing back into use after suspension, of a frequency assignment to a space station in a GSO network, the notifying administration shall indicate to BR whether or not this action has been accomplished with a space station that has previously been used to bring into use, or resume the use of, frequency assignments at a different orbital location within the three years prior to the date of submission of this information;

2 that, in cases where a notifying administration informs BR, pursuant to *resolves* 1 above, that it has brought into use, or resumed the use after suspension of, a frequency assignment to a space station in a GSO network with a space station that has previously been used to bring into use, or resume the use of, frequency assignments at a different orbital location within three years prior to the date of submission of this information, the notifying administration shall also indicate, for that same three-year period:

i) the last orbital location where the space station was used to bring into use, or resume the use of, frequency assignments;

ii) the satellite network(s) with which the frequency assignments in *resolves* 2i) above were associated;

iii) the date on which the space station was no longer maintained at the orbital location in *resolves* 2i) above;

3 that, if the information is not provided by the notifying administration under *resolves* 1 and 2 above, as appropriate, BR shall consult the notifying administration requesting the missing information;

4 that, if the notifying administration fails to provide the missing information within 30 days from BR's request under *resolves* 3 above, BR shall immediately send a reminder requesting the missing information;

5 that, from 1 January 2018, if the notifying administration fails to provide the missing information within 15 days after BR's reminder under *resolves* 4 above, BR shall consider that the frequency assignments to the GSO network have not been brought into use, or brought back into use, and shall so inform the notifying administration,

instructs the Radiocommunication Bureau

to make available the information provided in *resolves* 1 and 2 on the ITU website[1] within 30 days of its receipt.

[1] https://www.itu.int/net/ITU-R/space/snl/sat_relocation/index.asp.

RESOLUTION 42 (REV.WRC-19)

Use of interim systems in Region 2 in the broadcasting-satellite and fixed-satellite (feeder-link) services in Region 2 for the frequency bands covered by Appendices 30 and 30A

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that the Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2 (Geneva, 1983) prepared a Plan for the broadcasting-satellite service in the frequency band 12.2-12.7 GHz and a Plan for the associated feeder links in the frequency band 17.3-17.8 GHz with provisions for implementing interim systems in accordance with Resolution 2 (Sat-R2);

b) that, in the implementation of their assignments in the Plans, administrations of Region 2 may find it more appropriate to adopt a phased approach and initially use characteristics different from those appearing in the appropriate Region 2 Plan;

c) that some administrations of Region 2 may cooperate in the joint development of a space system with a view to covering two or more service areas from the same orbital position or to using a beam which would encompass two or more service areas;

d) that some administrations of Region 2 may cooperate in the joint development of a space system with a view to covering two or more feeder-link service areas from the same orbital position or to using a beam which encompasses two or more feeder-link service areas;

e) that interim systems shall not adversely affect the Plans nor hamper the implementation and evolution of the Plans;

f) that the number of assignments to be used in an interim system shall not in any case exceed the number of assignments appearing in the Region 2 Plan which are to be suspended;

g) that the interim systems shall not in any case use orbital positions that are not in the Region 2 Plan;

h) that an interim system shall not be introduced without the agreement of all administrations whose space and terrestrial services are considered to be affected;

i) that WRC-2000 revised the Regions 1 and 3 downlink and feeder-link Plans and established Lists together with regulatory procedures, protection criteria and calculation methods for sharing between services in the frequency bands of Appendices **30** and **30A**;

j) that WRC-03 modified the regulatory procedures, protection criteria and calculation methods for sharing between services in the frequency bands of Appendices **30** and **30A**,

resolves

that administrations and the Radiocommunication Bureau shall apply the procedure contained in the Annex to this Resolution, so long as Appendices **30** and **30A** remain in force.

ANNEX TO RESOLUTION 42 (REV.WRC-19)

1 An administration or a group of administrations in Region 2 may, after successful application of the procedure contained in this Annex and with the agreement of the affected administrations, use an interim system during a specified period not exceeding ten years in order:

1.1 For an interim system in the broadcasting-satellite service

a) to use an increased equivalent isotropically radiated power (e.i.r.p.) in any direction relative to that appearing in the Region 2 Plan provided that the power flux-density (pfd) does not exceed the limits given in Annex 5 to Appendix **30**;

b) to use modulation characteristics[1] different from those appearing in the Annexes to the Region 2 Plan and resulting in an increased probability of harmful interference or in a wider assigned bandwidth;

c) to change the coverage area by displacing the boresight, or by increasing the major or minor axis, or by rotating them from an orbital position which shall be one of the corresponding orbital positions appearing in the Region 2 Plan;

d) to use a coverage area appearing in the Region 2 Plan or a coverage area encompassing two or more coverage areas appearing in the Region 2 Plan from an orbital position which shall be one of the corresponding positions appearing in the Region 2 Plan;

e) to use a polarization different from that in the Region 2 Plan.

1.2 For an interim feeder-link system

a) to use an increased e.i.r.p. in any direction relative to that appearing in the Region 2 feeder-link Plan;

b) to use modulation characteristics[1] different from those appearing in the Annexes to the Plan and resulting in an increased probability of harmful interference or in a wider assigned bandwidth;

c) to change the feeder-link beam area by displacing the boresight, or by increasing the major or minor axis, or by rotating them in relation to an orbital position which shall be one of the corresponding orbital positions appearing in the Region 2 feeder-link Plan;

d) to use a feeder-link beam area appearing in the Region 2 feeder-link Plan or a feeder-link beam area encompassing two or more feeder-link beam areas appearing in the Region 2 feeder-link Plan in relation to an orbital position which shall be one of the corresponding orbital positions appearing in the Region 2 feeder-link Plan;

e) to use a polarization different from that in the Region 2 feeder-link Plan.

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[1] For example, modulation with sound channels frequency-multiplexed within the bandwidth of a television channel, digital modulation of sound and television signals, or other pre-emphasis characteristics.

2 In all cases, an interim system shall correspond to assignments in the appropriate Region 2 Plan; the number of assignments to be used in an interim system shall not in any case exceed the number of assignments appearing in the Region 2 Plan which are to be suspended. During the use of an interim system, the use of the corresponding assignments in the Region 2 Plan is suspended; they shall not be brought into use before the cessation of the use of the interim system. However, the suspended assignments, but not the interim system's assignments, of an administration shall be taken into account when other administrations apply the procedure of Article 4 of Appendix **30** or of Article 4 of Appendix **30A**, as appropriate, in order to modify the Region 2 Plan or to include new or modified assignments in the Regions 1 and 3 List, or the procedure of this Annex in order to bring an interim system into use. The assignments of interim systems shall not be taken into account in applying the procedure of Article 6 or Article 7 of Appendix **30** and the procedure of Article 6 or Article 7 of Appendix **30A**.

3 As a specific consequence of § 2 above, Region 2 interim system assignments shall not obtain protection from, or cause harmful interference to, new or modified assignments appearing in the Regions 1 and 3 List following the successful application of the procedure of Article 4 of Appendix **30** or of Article 4 of Appendix **30A**, as appropriate, even if the assignment modification procedure is concluded and the assignments become operational within the time-limits specified in § 4 *a)*.

4 When an administration proposes to use an assignment in accordance with § 1, it shall communicate to the Radiocommunication Bureau (BR) the information listed in Appendix **4** not earlier than eight years but, preferably, not later than two years before the date of bringing into use. An assignment shall lapse if it is not brought into use by that date. The administration shall also indicate:

a) the maximum specified period during which the interim assignment is intended to remain in use;

b) the assignments in the Region 2 Plans the use of which will remain suspended for the duration of the use of the corresponding interim assignment;

c) the names of the administrations with which an agreement for the use of the interim assignment has been reached, together with any comment relating to the period of use so agreed and the names of administrations with which an agreement may be required but has not yet been reached.

5 Administrations are considered to be affected as follows:

5.1 For an interim system in the broadcasting-satellite service

a) an administration of Region 2 is considered to be affected if any overall equivalent protection margin of one of its assignments in the Region 2 Plan, calculated in accordance with Annex 5 to Appendix **30** including the cumulative effect of all interim uses during the maximum specified period of use of the interim system, but excluding the corresponding suspended assignments (§ 4 *b)*), becomes negative or a former negative value is made more negative;

b) an administration of Region 1 or 3 is considered to be affected if it has an assignment which is in conformity with the Regions 1 and 3 Plan contained in Appendix **30** or with the List or in respect of which proposed new or modified assignments have been received by BR in accordance with the provisions of Article 4 of that Appendix with a necessary bandwidth which falls within the necessary bandwidth of the proposed interim assignment and the appropriate limits of § 3 of Annex 1 to Appendix **30** are exceeded;

c) an administration of Region 1 or 3 is considered to be affected if it has a frequency assignment in the fixed-satellite service which is recorded in the Master Register or which has been coordinated or is being coordinated under the provisions of No. **9.7** or under Article 7 of Appendix **30** or which has been published in accordance with No. **9.2B** and the appropriate limits of § 6 of Annex 1 to Appendix **30** are exceeded;

d) an administration of Region 1 or 3 is considered to be affected if, although having no frequency assignment in the appropriate Regions 1 and 3 Plan or List in the channel concerned, it nevertheless would receive on its territory a power flux-density value which exceeds the limits given in § 4 of Annex 1 to Appendix **30** as a result of the proposed interim assignment, or if it has such an assignment for which its associated service area does not cover the whole of the territory of the administration, and in its territory outside that service area the pfd from the interim system space station exceeds the above-mentioned limits;

e) an administration of Region 2 is considered to be affected if, although having no frequency assignment in the appropriate Region 2 Plan in the channel concerned, it nevertheless would receive on its territory a pfd value which exceeds the limits given in § 4 of Annex 1 to Appendix **30** as a result of the proposed interim assignment, or if it has such an assignment for which its associated service area does not cover the whole of the territory of the administration, and in its territory outside that service area the power flux-density from the interim system space station exceeds the above-mentioned limits;

f) an administration of Region 3 is considered to be affected if it has a frequency assignment to a space station in the broadcasting-satellite service in the frequency band 12.5-12.7 GHz with a necessary bandwidth any portion of which falls within the necessary bandwidth of the proposed assignment, and which:

– is recorded in the Master Register; *or*

– has been coordinated or is being coordinated under the provisions of Articles **9** to **14**; *or*

– appears in a Region 3 Plan to be adopted at a future radiocommunication conference, taking account of modifications which may be introduced subsequently in accordance with the Final Acts of that conference,

and the limits of § 3, Annex 1 to Appendix **30** are exceeded.

5.2 For interim feeder-link systems

a) an administration of Region 2 is considered to be affected if any overall equivalent protection margin of one of its assignments in the Plan, calculated in accordance with Annex 3 to Appendix **30A** including the cumulative effect of all interim uses during the maximum specified period of use of the interim system, but excluding the corresponding suspended assignment(s) (§ 4 *b)*), becomes negative or a former negative value is made more negative;

b) an administration in Region 1 or 3 is considered to be affected if it has an assignment for feeder links in the fixed-satellite service (Earth-to-space), any portion of the necessary bandwidth of which falls within the necessary bandwidth of the proposed assignment, which is in conformity with the feeder-link Plan or List for Regions 1 and 3, or in respect of which proposed new or modified assignments in the List have already been received by BR in accordance with the provisions of Article 4 of Appendix **30A** and for which the limits set out in § 5 of Annex 1 to Appendix **30A** are exceeded.

6 BR shall publish in a Special Section of its International Frequency Information Circular (BR IFIC) the information received under § 4, together with the names of the administrations which BR has identified in applying § 5.

7 When BR finds that the suspended assignment of an administration having an interim system is not affected, it shall examine the projected interim system with respect to the interim system of that administration and if there is an incompatibility, it shall request the two administrations concerned to adopt any measures that may enable the new interim system to be operated.

8 BR shall send a telegram to the administrations listed in the Special Section of the BR IFIC, drawing their attention to the information it contains and shall send them the results of its calculations.

9 Any administration not listed in the special section which considers that its planned interim assignment may be affected shall so inform the administration responsible for the interim system and BR, and the two administrations shall endeavour to resolve the difficulty before the proposed date of bringing the interim assignment into use.

10 An administration which has not sent its comments either to the administration seeking agreement or to BR within a period of four months following the date of the BR IFIC referred to in § 6 shall be understood as having agreed to the proposed interim use.

11 On the expiry of four months following the date of publication of the BR IFIC referred to in § 6, BR shall review the matter, and, depending on the results obtained, shall inform the administration proposing the interim assignment that:

a) it may notify its proposed use under Article 5 of Appendix **30** or Article 5 of Appendix **30A**, as appropriate, if no agreement is required or the required agreement has been obtained from the administrations concerned. In this case BR shall update the Interim List;

b) it may not bring into use its interim system before having obtained the agreement of the administrations affected, either directly or by applying the procedure described in Article 4 of Appendix **30** or Article 4 of Appendix **30A**, as appropriate, as a means of obtaining that agreement.

12 BR shall include all the interim assignments in an Interim List in two parts, one each for the broadcasting-satellite service and the feeder-link assignments, and shall update it in accordance with this Annex. The Interim List shall be published together with the Region 2 Plans but does not constitute part of them.

13 One year prior to the expiry of the interim period, BR shall draw the attention of the administration concerned to this fact and request it to notify in due time the deletion of the assignment from the Master Register and the Interim List.

14 If, notwithstanding the reminders by BR, an administration does not reply to its request sent in application of § 13, BR shall, at the termination of the interim period:

a) enter a symbol in the Remarks Column of the Master Register to indicate the lack of response and that the entry is for information only;

b) not take that assignment into account in the Interim List;

c) inform the administrations concerned and affected of its action.

15 When an administration confirms the termination of the use of the interim assignment, BR shall delete the assignment concerned from the Interim List and the Master Register. Any corresponding assignment in the Plan(s), suspended earlier, may then be brought into use.

16 An administration which considers that its interim system may continue to be used after the expiry of the interim period may extend it by not more than four years and to this effect shall apply the procedure described in this Annex.

17 When an administration applies the procedure in accordance with § 16, but is unable to obtain the agreement of one or more affected administrations, BR shall indicate this situation by inserting an appropriate symbol in the Master Register. Upon receipt of a complaint of harmful interference, the administration shall immediately cease operation of the interim assignment.

18 When an administration, having been informed of a complaint of harmful interference, does not cease transmission within a period of thirty days after the receipt of complaint, BR shall apply the provisions of § 14.

RESOLUTION 49[1] (REV.WRC-23)

Administrative due diligence applicable to some satellite radiocommunication services

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that Resolution 18 (Kyoto, 1994) of the Plenipotentiary Conference instructed the Director of the Radiocommunication Bureau (BR) to initiate a review of some important issues concerning international satellite network coordination and to make a preliminary report to WRC-95 and a final report to WRC-97;

b) that the Director of BR provided a comprehensive report to WRC-97, including a number of recommendations for action as soon as possible and for identifying areas requiring further study;

c) that one of the recommendations in the Director's report to WRC-97 was that administrative due diligence should be adopted as a means of addressing the problem of reservation of orbit and spectrum capacity without actual use;

d) that experience may need to be gained in the application of the administrative due diligence procedures adopted by WRC-97, and that several years may be needed to see whether administrative due diligence measures produce satisfactory results;

e) that new regulatory approaches may need to be carefully considered in order to avoid adverse effects on networks already going through the different phases of the procedures;

f) that Article 44 of the ITU Constitution sets out the basic principles for the use of the radio-frequency spectrum and the geostationary-satellite and other satellite orbits, taking into account the needs of developing countries,

considering further

a) that WRC-97 decided to reduce the regulatory time-frame for bringing a satellite network into use;

b) that WRC-2000 considered the results of the implementation of the administrative due diligence procedures and prepared a report to the 2002 Plenipotentiary Conference in response to Resolution 85 (Minneapolis, 1998) of the Plenipotentiary Conference,

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[1] This Resolution does not apply to satellite networks or satellite systems of the broadcasting-satellite service in the frequency band 21.4-22 GHz in Regions 1 and 3.

resolves

that the administrative due diligence procedure contained in Annex 1 to this Resolution shall be applied for a satellite network or satellite system of the fixed-satellite service, mobile-satellite service or broadcasting-satellite service for which the request for coordination under No. **9.30**, or for which the request for modifications of the Region 2 Plan under Article 4, § 4.2.1 *b)* of Appendices **30** and **30A** that involve the addition of new frequencies or orbital positions, or for which the request for modifications of the Region 2 Plan under Article 4, § 4.2.1 *a)* of Appendices **30** and **30A** that extend the service area to another country or countries in addition to the existing service area, or for which the request for additional uses in Regions 1 and 3 under § 4.1 of Article 4 of Appendices **30** and **30A**, or for which the submission under Appendix **30B** is received, with the exception of submissions of new Member States seeking the acquisition of their respective national allotments[2] for inclusion in the Appendix **30B** Plan,

further resolves

that the procedures in this Resolution are in addition to the provisions under Article **9** or **11** of the Radio Regulations or Appendix **30**, **30A** or **30B**, as applicable, and, in particular, do not affect the requirement to coordinate under those provisions (Appendices **30** and **30A**) in respect of extending the service area to another country or countries in addition to the existing service area,

instructs the Director of the Radiocommunication Bureau

to report to future competent world radiocommunication conferences on the results of the implementation of the administrative due diligence procedure.

ANNEX 1 TO RESOLUTION 49 (REV.WRC-23)

1 Any satellite network or satellite system of the fixed-satellite service, mobile-satellite service or broadcasting-satellite service with frequency assignments that are subject to coordination under Nos. **9.7**, **9.11**, **9.12**, **9.12A** and **9.13** shall be subject to these procedures.

2 Any request for modifications of the Region 2 Plan under the relevant provisions of Article 4 of Appendices **30** and **30A** that involve the addition of new frequencies or orbital positions or for modifications of the Region 2 Plan under the relevant provisions of Article 4 of Appendices **30** and **30A** that extend the service area to another country or countries in addition to the existing service area or request for additional uses in Regions 1 and 3 under the relevant provisions of Article 4 of Appendices **30** and **30A** shall be subject to these procedures.

3 Any submission of information under Article 6 of Appendix **30B**, with the exception of submissions of new Member States seeking the acquisition of their respective national allotments[3] for inclusion in the Appendix **30B** Plan, shall be subject to these procedures.

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[2] See § 2.3 of Appendix **30B**.

[3] See § 2.3 of Appendix **30B**.

4 For any satellite network subject to § 1 above, administrations shall send to the Radiocommunication Bureau (BR) no later than 30 days following the end of the period established as a limit to bringing into use in No. **11.44**, the due diligence information relating to the identity of the satellite network, the spacecraft manufacturer and the launch service provider specified in Annex 2 to this Resolution.

5 An administration requesting a modification of the Region 2 Plan or additional uses in Regions 1 and 3 under Appendices **30** and **30A** under § 2 above shall send to BR no later than 30 days following the end of the period established as a limit to bringing into use in accordance with the relevant provisions of Article 4 of Appendix **30** and the relevant provisions of Article 4 of Appendix **30A**, the due diligence information relating to the identity of the satellite network, the spacecraft manufacturer and the launch service provider specified in Annex 2 to this Resolution.

6 An administration applying Article 6 of Appendix **30B** under § 3 above shall send to BR no later than 30 days following the end of the period established as a limit to bringing into use in § 6.1 of that Article, the due diligence information relating to the identity of the satellite network, the spacecraft manufacturer and the launch service provider specified in Annex 2 to this Resolution.

7 The information to be submitted in accordance with § 4, 5 or 6 above shall be signed by an authorized official of the notifying administration or of an administration that is acting on behalf of a group of named administrations.

8 On receipt of the due diligence information under § 4, 5 or 6 above, BR shall promptly examine that information for completeness. If the information is found to be complete, BR shall publish the complete information in a special section of its International Frequency Information Circular (BR IFIC) within 30 days.

9 If the information is found to be incomplete, BR shall immediately request the administration to submit the missing information. In all cases, the complete due diligence information shall be received by BR within the appropriate time period specified in § 4, 5 or 6 above.

10 Six months before expiry of the period specified in § 4, 5 or 6 above and if the administration responsible for the satellite network has not submitted the due diligence information under § 4, 5 or 6 above, BR shall send a reminder to the responsible administration.

11 If the complete due diligence information is not received by BR within the time limits specified in § 4, 5 or 6, as appropriate, the networks covered by § 1, 2 or 3 above shall be cancelled by BR. The provisional recording in the Master International Frequency Register shall be deleted by BR after it has informed the concerned administration. BR shall publish this information in the BR IFIC.

With respect to the request for modification of the Region 2 Plan or for additional uses in Regions 1 and 3 under Appendices **30** and **30A** under § 2 above, the modification shall lapse if the complete due diligence information is not submitted in accordance with § 5.

With respect to the request for application of Article 6 of Appendix **30B** under § 3 above, the network shall also be deleted from the Appendix **30B** List if the complete due diligence information is not submitted in accordance with § 6. When an allotment under Appendix **30B** is converted into an assignment, the assignment shall be reinstated in the Plan in accordance with § 6.33 *c)* of Article 6 of Appendix **30B**.

12 When an administration has completely fulfilled the due diligence procedure but has not completed coordination, this does not preclude the application of No. **11.41** by that administration.

ANNEX 2 TO RESOLUTION 49 (REV.WRC-23)

A Identity of the satellite network

a) Identity of the satellite network

b) Name of the administration

c) Country symbol

d) Reference to the request for modification of the Region 2 Plan or for additional uses in Regions 1 and 3 under Appendices **30** and **30A**; or reference to the information processed under Article 6 of Appendix **30B**

e) Reference to the request for coordination (not applicable for Appendices **30**, **30A** and **30B**)

f) Frequency band(s)

g) Name of the operator

h) Name of the satellite

i) Orbital characteristics.

B Spacecraft manufacturer*

a) Name of the spacecraft manufacturer

b) Date of execution of the contract

c) Contractual "delivery window"

d) Number of satellites procured.

C Launch services provider

a) Name of the launch vehicle provider

b) Date of execution of the contract

c) Launch or in-orbit delivery window

d) Name of the launch vehicle

e) Name and location of the launch facility.

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* NOTE – In cases where a contract for satellite procurement covers more than one satellite, the relevant information shall be submitted for each satellite.

RESOLUTION 55 (REV.WRC-23)

Electronic submission of, and communications on, notice forms for satellite networks, earth stations and radio astronomy stations and reports of harmful interference affecting space services

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that submission of notices for all satellite networks, earth stations and radio astronomy stations in electronic format would further facilitate the tasks of the Radiocommunication Bureau (BR) and of administrations, and would accelerate the processing of these notices;

b) that the volume of advance publication information, coordination requests, notifications and filings under Appendices **30**, **30A** and **30B** for satellite networks or systems has been steadily increasing in recent years;

c) that a significant amount of effort is required to maintain the relevant databases;

d) that a paperless electronic approach to the submission of satellite network filings and comments, if required, would make this information readily accessible to all and would limit the workload for administrations and BR in the processing of these filings;

e) that the use of electronic means of communication in an integrated online platform for administrative correspondence related to advance publication, coordination and notification of satellite networks, earth stations and radio astronomy stations would facilitate the tasks of BR and of administrations, with the potential to improve efficiency and the coordination and notification process by reducing the amount of duplicated correspondence,

recognizing

a) that, should the processing delays related to the coordination and notification procedures extend beyond the periods specified in Articles **9** and **11**, as well as in Appendices **30**, **30A** and **30B**, administrations may be faced with a shortened time window in which to effect coordination;

b) that administrations could use the time freed by a reduction in administrative correspondence to effect coordination;

c) that BR has successfully implemented the ITU online e-Communications and e-Submission of Satellite Network Filings platforms in response to Resolutions of previous world radiocommunication conferences;

d) that, since 1 August 2018, all satellite network filings are submitted to BR through the e-Submission of Satellite Network Filings platform;

e) that, since 23 October 2019, all correspondence relating to the submission of, and commenting on, satellite network filings has been able to be communicated through the e-Communications platform;

f) that, since 1 September 2018, reports of harmful interference affecting space services have been submitted by administrations through the ITU Satellite Interference Reporting and Resolution System (SIRRS) implemented by BR for this purpose,

resolves

1 that, as from 3 June 2000, all notices (AP4/II and AP4/III), radio astronomy notices (AP4/IV) and API (AP4/V and AP4/VI) and due diligence information (Resolution **49 (Rev.WRC-23)**) for satellite networks and earth stations submitted to BR pursuant to Articles **9** and **11** shall be submitted in electronic format compatible with the BR electronic notice form capture software (SpaceCap);

2 that, as from 17 November 2007, all notices for satellite networks, earth stations and radio astronomy stations submitted to BR pursuant to Articles **9** and **11**, as well as to Appendices **30** and **30A** and Resolution **49 (Rev.WRC-23)**, shall be submitted in electronic format compatible with the BR electronic notice form capture software (SpaceCap and SpaceCom);

3 that, as from 1 June 2008, all notices for satellite networks and earth stations submitted to BR pursuant to Appendix **30B** shall be submitted in electronic format compatible with the BR electronic notice form capture software (SpaceCap);

4 that, as from 1 July 2009, comments/objections submitted to BR in accordance with Nos. **9.3** and **9.52** with respect to Nos. **9.11** to **9.14** and **9.21** of Article **9**, or in accordance with § 4.2.10, 4.2.13 or 4.2.14 of Appendices **30** and **30A** with respect to modification to the Region 2 Plan and use of the guardbands under Article 2A of those Appendices in Region 2, shall be submitted in electronic format compatible with the BR electronic notice form capture software (SpaceCom);

5 that, as from 18 February 2012, all requests for inclusion or exclusion submitted to BR under No. **9.41** of Article **9** shall be submitted in electronic format compatible with the BR electronic notice form capture software (SpaceCom);

6 that, since 3 June 2000, all graphical data associated with the submissions addressed in *resolves* 1, 2 and 3 should be submitted in graphics data format compatible with BR's data capture software (graphical interference management system (GIMS));

7 that all information indicated in *resolves* 1 to 6 above, in Annexes 1 and 2 to Resolution **35 (Rev.WRC-23)**, in Annex 2 to Resolution **552 (Rev.WRC-23)** and in the Attachment to Resolution **553 (Rev.WRC-23)** under §§ 8 and 9 shall be submitted to BR, using the e-Submission of Satellite Network Filings platform;

8 that administrative correspondence between administrations and BR related to the advance publication, coordination, notification and recording processes, including correspondence related to Appendices **30**, **30A** and **30B**, for satellite networks, earth stations and radio astronomy stations shall be communicated, whenever possible, using the e-Communications platform;

9 that reports of harmful interference affecting space services and associated correspondence exchanged between administrations and BR in accordance with Article **15** and No. **13.2** shall be submitted, whenever possible, using the SIRRS platform and following the guidance provided in the most recent version of Recommendation ITU-R SM.2149;

10 that, wherever the words "telegram", "telex" or "fax" are inserted in provisions related to the advance publication, coordination, notification and recording processes for satellite systems or networks, earth stations and radio astronomy stations, including the provisions contained in Appendices **30**, **30A** and **30B** and related Resolutions, the e-Communications platform shall be used instead;

11 that other, traditional means of communication can be used in the case of difficulty encountered in applying *resolves* 8, 9 and 10,

instructs the Radiocommunication Bureau

1 to make available coordination requests and notifications referred to in *resolves* 1 "as received" within 30 days of receipt on its website;

2 to provide administrations with the latest versions of the capture and validation software and any necessary technical means, training and manuals, along with any assistance requested by administrations to enable them to comply with *resolves* 1 to 4 above;

3 to integrate the validation software with the capture software to the extent practicable;

4 to continue to develop and improve the e-Submission of Satellite Network Filings, e-Communications and SIRRS platforms to meet the needs of the Radio Regulations with respect to the submission of, and commenting on, satellite network filings, as well as the associated correspondence.

RESOLUTION 63 (REV.WRC-12)

Protection of radiocommunication services against interference caused by radiation from industrial, scientific and medical (ISM) equipment

The World Radiocommunication Conference (Geneva, 2012),

considering

a) that ISM applications are defined under RR No. **1.15** as "operation of equipment or appliances designed to generate and use locally radio-frequency energy for industrial, scientific, medical, domestic or similar purposes, excluding applications in the field of *telecommunications*";

b) that ISM equipment may be situated in locations where outward radiation cannot always be avoided;

c) that there is an increasing amount of ISM equipment working on various frequencies throughout the spectrum;

d) that in some cases a considerable part of the energy may be radiated by ISM equipment outside its working frequency;

e) that Recommendation ITU-R SM.1056 recommends to administrations the use of International Special Committee on Radio Interference (CISPR) Publication 11 as a guide for ISM equipment to protect radiocommunication services, but that CISPR 11 does not yet fully specify radiation limits for all frequency bands;

f) that Report ITU-R SM.2180 introduces the interference analysis method and the radiation limits of ISM equipment developed by CISPR, and that the emission limits, which have been developed to protect analogue radiocommunication systems, may not provide protection to digital radiocommunication systems;

g) that certain digital radiocommunication systems use receivers that may be more sensitive to interference from ISM equipment;

h) that some radio systems, especially those using low field strengths, may suffer interference caused by radiation from ISM equipment, a risk which is unacceptable particularly in the case of systems belonging to radionavigation or other safety services;

i) that, in order to limit the risks of interference to specified parts of the spectrum:

– the preceding Radio Conferences of Atlantic City, 1947, and Geneva, 1959, designated some frequency bands within which the radiocommunication services must accept harmful interference produced by ISM equipment;

– WARC-79 accepted an increase in the number of bands to be designated for ISM equipment, but only on the condition that limits of radiation from such equipment be specified within the bands newly designated for worldwide use and outside all the bands designated for ISM equipment;

j) that the variety and evolution of digital technologies used in digital radiocommunication systems suggest a need for continuous review of CISPR Publication 11,

resolves

that, to ensure that radiocommunication services are adequately protected, studies are required on the limits to be imposed on the radiation from ISM equipment, within and outside the frequency bands designated in the Radio Regulations for this use,

invites ITU-R

1 to provide the necessary characteristics and protection criteria for relevant digital radiocommunication systems in order to enable CISPR to review and update, as needed, the limits on radiation from ISM equipment;

2 to continue, in collaboration with CISPR, its studies relating to radiation from ISM equipment, within and outside the frequency bands designated in the Radio Regulations for this use, in order to ensure adequate protection of radiocommunication services, including digital radiocommunication systems, with priority being given to the completion of studies which would permit CISPR to define limits in Publication CISPR 11 on radiation from ISM equipment inside all the bands designated in the Radio Regulations for the use of such equipment,

instructs the Director of the Radiocommunication Bureau

to bring this Resolution to the attention of CISPR.

RESOLUTION 72 (REV.WRC-19)

World and regional preparations for world radiocommunication conferences

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that the regional telecommunication organizations continue to coordinate their preparations for world radiocommunication conferences (WRCs);

b) that many common proposals have been submitted to previous WRCs from administrations participating in the preparations of regional telecommunication organizations;

c) that this consolidation of views at regional level, together with the opportunity for interregional discussions prior to WRCs, has eased the task of reaching a common understanding and saved time during past WRCs;

d) that the burden of preparation for future WRCs is likely to increase;

e) that there is consequently great benefit to the Member States of coordination of preparations at world level and at regional level;

f) that the success of future WRCs will depend on greater efficiency of regional coordination and interaction at interregional level prior to future WRCs, including possible face-to-face meetings between regional telecommunication organizations;

g) that there is a need for overall coordination of the interregional consultations,

recognizing

a) *resolves* 2 of Resolution 80 (Rev. Marrakesh, 2002) of the Plenipotentiary Conference;

b) *resolves* 3 of Resolution 80 (Rev. Marrakesh, 2002):

"to encourage both formal and informal collaboration in the interval between conferences with a view to resolving differences on items already on the agenda of a conference or new items",

noting

that the plenipotentiary conferences have resolved that the Union should continue to develop stronger relations with regional telecommunication organizations,

resolves to invite the regional telecommunication organizations

1 to continue their preparations for WRCs, including the possible convening of joint meetings of regional telecommunication organizations formally and informally;

2 to provide the Radiocommunication Bureau with a document containing the latest version of their views, positions and/or proposals under the agendas of WRCs at the earliest stage after each regional meeting in order to be published on the website of the related WRC,

invites administrations

to participate actively in the preparations of their regional telecommunication organizations for WRCs and join, to the extent possible, the regional common proposals,

instructs the Director of the Radiocommunication Bureau

1 to publish the documents mentioned in *resolves to invite the regional telecommunication organizations* 2 on the website of each WRC immediately after receiving such documents;

2 to continue consulting the regional telecommunication organizations on the means by which assistance can be given to their preparations for future WRCs in the following areas:

– organization of regional preparatory meetings;

– organization of information sessions, preferably before and after the second session of the Conference Preparatory Meeting (CPM), including presentation of the chapters of the CPM Report;

– identification of major issues to be resolved by the forthcoming WRC;

– facilitation of regional and interregional formal and informal meetings, with the objective of reaching a possible convergence of interregional views on major issues;

3 to submit a report on the results of such consultations to each WRC,

invites the Director of the Telecommunication Development Bureau

to collaborate with the Director of the Radiocommunication Bureau in implementing this Resolution.

RESOLUTION 74 (REV.WRC-03)

Process to keep the technical bases of Appendix 7 current

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that Appendix **7** provides the method for the determination of the coordination area of an earth station, and the assumed technical coordination parameters for unknown terrestrial stations or earth stations;

b) that the technical coordination parameters are contained in Tables 7, 8 and 9 of Annex 7 to Appendix **7**;

c) that the technical coordination parameter tables are based on Recommendation ITU-R SM.1448;

d) that ITU-R studies on methods for the determination of the coordination area of an earth station are continuing, and the conclusions of these studies could lead to revision of Appendix **7**; these methods under study are:

– methods considering the cumulative impact in determining the coordination areas for high-density earth stations (fixed and mobile);

– methods to address the modelling of VHF/UHF frequencies for percentages of time less than 1%;

– methods to address propagation mode (1) water vapour density for both radio climatic Zones B and C;

– refinements to propagation mode (2) to address elevation angle dependency and the displacement of the centre of the propagation mode (2) contour from the coordinating earth station;

e) that the technical coordination parameter tables may also need to be modified when changes are made to the Table of Frequency Allocations at future world radiocommunication conferences (WRCs), or due to changes in technology or in applications;

f) that the technical coordination parameter tables do not include values for all the necessary parameters of certain space radiocommunication services and terrestrial radiocommunication services sharing frequency bands with equal rights,

recognizing

a) that Recommendation ITU-R SM.1448 was developed by ITU-R as a basis for the revision of Appendix **7**;

b) that there is a need for future WRCs to keep Appendix **7** current with the latest techniques and to ensure protection of other radiocommunication services sharing the same frequency bands with equal rights, particularly through revision of the tables of technical coordination parameters,

invites ITU-R

1 to continue its study, as required, of the technical bases used for determination of the coordination area of an earth station, including recommended values for the missing entries in the tables of technical coordination parameters (Annex 7 to Appendix **7**);

2 to maintain the relevant ITU-R texts in a format which would facilitate the future revision of Appendix **7**;

3 to assess the significance of changes to the technical bases,

resolves

1 that when ITU-R concludes, based on its studies of the methods in *considering d)* for determination of the coordination area of an earth station and/or the values of technical coordination parameters, that a revision of Appendix **7** is warranted, the matter shall be brought to the attention of the Radiocommunication Assembly;

2 that, if the Radiocommunication Assembly confirms the improvements of the methods in *considering d)* for determination of the coordination area of an earth station and/or the values of technical coordination parameters which have been presented by ITU-R, the Director of the Radiocommunication Bureau shall identify the matter in the Director's report to the following WRC,

invites

1 WRCs, when presented with any significant changes through the Director's report, to consider the revision of Appendix **7** in light of the recommendation of the Radiocommunication Assembly, pursuant to *resolves* 1 and 2 above;

2 each WRC, when modifying the Table of Frequency Allocations, to consider any consequential changes that may be required to the technical coordination parameters of Annex 7 to Appendix **7** and, if necessary, request ITU-R to study the matter.

RESOLUTION 76 (REV.WRC-23)

Protection of geostationary fixed-satellite service and geostationary broadcasting-satellite service networks from the maximum aggregate equivalent power flux-density produced by multiple non-geostationary fixed-satellite service systems in frequency bands where equivalent power flux-density limits have been adopted

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that WRC-97 adopted, in Article **22**, provisional equivalent power flux-density (epfd) limits to be met by non-geostationary (non-GSO) fixed-satellite service (FSS) systems in order to protect geostationary-satellite (GSO) FSS and GSO broadcasting-satellite service (BSS) networks in parts of the frequency range 10.7-30 GHz;

b) that WRC-2000 revised Article **22** to ensure the limits contained therein provide adequate protection to GSO networks without placing undue constraints on any of the systems and services sharing these frequency bands;

c) that WRC-2000 decided that a combination of single-entry validation, single-entry operational and, for certain antenna sizes, single-entry additional operational epfd limits, contained in Article **22**, along with the aggregate limits in Tables 1A to 1D as contained in Annex 1 to this Resolution, which apply to non-GSO FSS systems, protects GSO networks in these frequency bands;

d) that these single-entry validation limits have been derived from aggregate epfd masks contained in Tables 1A to 1D, assuming a maximum effective number of non-GSO FSS systems of 3.5;

e) that the aggregate interference caused by all co-frequency non-GSO FSS systems in these frequency bands into GSO FSS networks should not exceed the aggregate epfd limits in Tables 1A to 1D;

f) that to achieve the objective in *considering e)*, administrations of non-GSO FSS systems would need to establish collaboration through consultation meetings;

g) that WRC-97 decided, and WRC-2000 confirmed, that non-GSO FSS systems in the frequency bands in question are to mutually coordinate the use of frequencies in these frequency bands under the provisions of No. **9.12**;

h) that the orbital characteristics of such systems are likely to be inhomogeneous;

i) that, as a result of this likely inhomogeneity, the aggregate epfd levels from multiple non-GSO FSS systems will not be directly related to the actual number of systems sharing a frequency band, and the number of such systems operating co-frequency is likely to be small;

j) that the possible misapplication of single-entry limits should be avoided,

recognizing

a) that non-GSO FSS systems are likely to need to implement interference mitigation techniques to mutually share frequencies;

b) that, on account of the use of such interference mitigation techniques, it is likely that the number of non-GSO systems will remain small, as will the aggregate interference caused by non-GSO FSS systems into GSO networks;

c) that, notwithstanding *considering d)* and *e)* and *recognizing b)*, there may be instances where the aggregate interference from non-GSO systems could exceed the interference levels given in Tables 1A to 1D;

d) that administrations operating GSO networks may wish to ensure that the aggregate epfd produced by all operating co-frequency non-GSO FSS systems in the frequency bands referred to in *considering a)* above into GSO FSS and/or GSO BSS networks does not exceed the aggregate interference levels given in Tables 1A to 1D,

noting

a) that Recommendation ITU-R S.1588 provides methodologies for calculating aggregate downlink epfd produced by multiple non-GSO FSS systems into a GSO FSS network;

b) that, given *considering j)*, some non-GSO FSS systems use multiple filings, which may be submitted by more than one administration,

resolves

1 that administrations operating or planning to operate non-GSO FSS systems, for which coordination or notification information, as appropriate, was received after 21 November 1997, in the frequency bands referred to in *considering a)* above, individually or in collaboration, shall take all possible steps, including, if necessary, by means of appropriate modifications to their systems, to ensure that the aggregate interference into GSO FSS and GSO BSS networks caused by such systems operating co-frequency in these frequency bands does not cause the aggregate power levels given in Tables 1A to 1D to be exceeded (see No. **22.5K**);

2 that, in the event that the aggregate interference levels in Tables 1A to 1D are exceeded, administrations operating non-GSO FSS systems in these frequency bands shall take all necessary measures expeditiously to reduce the aggregate epfd levels to the limits given in Tables 1A to 1D, or to higher levels where those levels are acceptable to the affected GSO administration (see No. **22.5K**);

3 that, in order to fulfil the requirements in *resolves* 1, administrations operating or planning to operate non-GSO FSS systems shall, on a regular basis (e.g. yearly), hold a consultation meeting to determine the level of aggregate interference caused to GSO FSS or GSO BSS networks from non-GSO FSS systems and determine the necessary measures to ensure compliance with the required level for protecting GSO FSS and GSO BSS networks;

4 that administrations engaged in consultation meetings, when developing agreements to carry out their obligations under *resolves* 1 and 2 above, shall establish mechanisms to ensure that all administrations are given full visibility of the process and its outcome and the aggregate interference allowance into GSO FSS or GSO BSS networks is shared fairly among non-GSO FSS systems;

5 that those administrations participating in the consultation meeting shall designate one administration that shall communicate to the Radiocommunication Bureau the results of any technical or operational amendment to the relevant non-GSO FSS systems following the application of *resolves* 2 above;

6 that consultation meetings to achieve the objective of *resolves* 1 and 2 shall be held after the ITU Radiocommunication Sector (ITU-R) adopts the Recommendation specified in *invites the ITU Radiocommunication Sector* 1 below, with the exception of meetings for the purpose of organizing the functioning of the consultation meetings and establishing preliminary terms of reference;

7 that administrations, when evaluating the aggregate interference into GSO FSS or GSO BSS networks under *resolves* 1, shall take into account the submission of appropriate notification information under No. **11.2** for non-GSO FSS systems and the submission of the information referred to in Resolution **35 (Rev.WRC-23)** for non-GSO FSS systems, along with the relevant information provided to the consultation meetings referred to in *considering f)*;

8 that the aggregate epfd calculations performed within the scope of the consultation meeting referred to in *resolves* 3 shall involve two assessments, one considering only the operational space stations of non-GSO FSS systems and another for information only, if needed, considering also non-GSO FSS space stations planned to be deployed before the next consultation meeting;

9 that any amendment to the relevant non-GSO FSS systems mentioned in *resolves* 7 above shall not affect the regulatory status of the affected non-GSO FSS systems, including following any modifications to their published characteristics,

invites the ITU Radiocommunication Sector

1 to continue its studies on the subject and develop, as a matter of urgency and preferably before 30 July 2027, and taking into account existing and relevant ITU-R Recommendations, a Recommendation on a suitable methodology for calculating the aggregate co-frequency epfd produced by non-GSO FSS systems and accurately modelling non-GSO FSS operations in the frequency bands referred to in *considering a)* above into GSO FSS and GSO BSS networks, which may be used to determine whether the systems are in compliance with the aggregate power levels given in Tables 1A to 1D, taking into account relevant elements of Recommendations ITU-R S.1588 and ITU-R S.1503, as appropriate;

2 to develop, as a matter of urgency and preferably before 30 July 2027, a Recommendation on a suitable methodology to adapt the operation of co-frequency non-GSO FSS systems in the frequency bands referred to in *considering a)* above to ensure that the aggregate power levels given in Tables 1A to 1D are met;

3 to continue to verify, as a matter of urgency, the effectiveness of the provisions defined in this Resolution and, if needed, to study and analyse possible amendments to those provisions,

instructs the Director of the Radiocommunication Bureau

1 to participate in the consultation meetings mentioned in *resolves* 3 to 9 and to observe carefully the results of the epfd calculation mentioned in *resolves* 3;

2 to publish in the Radiocommunication Bureau International Frequency Information Circular the information referred to in *resolves* 5 and *instructs the Director of the Radiocommunication Bureau* 1;

3 to report to WRC-27, and to subsequent world radiocommunication conferences, on the implementation of this Resolution;

4 to examine the possibility, if needed, of developing software that can be used to calculate the epfd level mentioned under *resolves* 1,

invites the 2027 world radiocommunication conference

to review the report on the implementation of this Resolution and to take any necessary action, as appropriate,

invites administrations

1 to participate in the discussions and determinations mentioned under *resolves* 5, as appropriate;

2 to provide to the Bureau, and to all participants in the consultation meetings, access to software developed, taking into consideration the methodology referred to in *invites the ITU Radiocommunication Sector* 1, to calculate the epfd level mentioned under *resolves* 2.

ANNEX 1 TO RESOLUTION 76 (REV.WRC-23)

TABLE 1A[1, 2, 3]

Limits on aggregate epfd↓ radiated by non-GSO FSS systems in certain frequency bands

Frequency band (GHz)	epfd↓ (dB(W/m²))	Percentage of time during which epfd↓ may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern[4]
10.7-11.7 in all Regions 11.7-12.2 in Region 2 12.2-12.5 in Region 3 12.5-12.75 in Regions 1 and 3	−170 −168.6 −165.3 −160.4 −160 −160	0 90 99 99.97 99.99 100	40	60 cm Recommendation ITU-R S.1428
	−176.5 −173 −164 −161.6 −161.4 −160.8 −160.5 −160 −160	0 99.5 99.84 99.945 99.97 99.99 99.99 99.9975 100	40	1.2 m Recommendation ITU-R S.1428
	−185 −184 −182 −168 −164 −162 −160 −160	0 90 99.5 99.9 99.96 99.982 99.997 100	40	3 m [5] Recommendation ITU-R S.1428
	−190 −190 −166 −160 −160	0 99 99.99 99.998 100	40	10 m [5] Recommendation ITU-R S.1428

[1] For certain GSO FSS receive earth stations, see also Nos. **9.7A** and **9.7B**.

[2] In addition to the limits shown in Table 1A, the following aggregate epfd↓ limits apply to all antenna sizes greater than 60 cm in the frequency bands listed in Table 1A:

100% of the time epfd↓ (dB(W/(m² · 40 kHz)))	Latitude (North or South) (degrees)
−160	0 ≤ | Latitude | ≤ 57.5
−160 + 3.4(57.5 − | Latitude |)/4	57.5 < | Latitude | ≤ 63.75
−165.3	63.75 < | Latitude |

[3] For each reference antenna diameter, the limit consists of the complete curve on a plot which is linear in decibels for the epfd↓ levels and logarithmic for the time percentages, with straight lines joining the data points.

[4] For this Table, reference patterns in Recommendation ITU-R S.1428 shall be used only for the calculation of interference from non-GSO FSS systems into GSO FSS systems.

[5] The values for the 3 m and 10 m antennas are applicable only for the methodology referred to *invites the ITU Radiocommunication Sector* 1.

TABLE 1B[1, 2, 3]

Limits on aggregate epfd↓ radiated by non-GSO FSS systems in certain frequency bands

Frequency band (GHz)	epfd↓ (dB(W/m^2))	Percentage of time during which epfd↓ may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern[4]
17.8-18.6	−170 −170 −164 −164	0 90 99.9 100	40	1 m Recommendation ITU-R S.1428
	−156 −156 −150 −150	0 90 99.9 100	1 000	
	−173 −173 −166 −164 −164	0 99.4 99.9 99.92 100	40	2 m Recommendation ITU-R S.1428
	−159 −159 −152 −150 −150	0 99.4 99.9 99.92 100	1 000	
	−180 −180 −172 −164 −164	0 99.8 99.8 99.992 100	40	5 m Recommendation ITU-R S.1428
	−166 −166 −158 −150 −150	0 99.8 99.8 99.992 100	1 000	

[1] For certain GSO FSS receive earth stations, see also Nos. **9.7A** and **9.7B**.

[2] For each reference antenna diameter, the limit consists of the complete curve on a plot which is linear in decibels for the epfd↓ levels and logarithmic for the time percentages, with straight lines joining the data points.

[3] A non-GSO system shall meet the limits of this Table in both the 40 kHz and the 1 MHz reference bandwidths.

[4] For this Table, reference patterns in Recommendation ITU-R S.1428 shall be used only for the calculation of interference from non-GSO FSS systems into GSO FSS systems.

TABLE 1C[1, 2, 3]

Limits on aggregate epfd↓ radiated by non-GSO FSS systems in certain frequency bands

Frequency band (GHz)	epfd↓ (dB(W/m²))	Percentage of time during which epfd↓ may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern[4]
19.7-20.2	−182 −172 −154 −154	0 90 99.94 100	40	70 cm Recommendation ITU-R S.1428
	−168 −158 −140 −140	0 90 99.94 100	1 000	
	−185 −176 −165 −160 −154 −154	0 91 99.8 99.8 99.99 100	40	90 cm Recommendation ITU-R S.1428
	−171 −162 −151 −146 −140 −140	0 91 99.8 99.8 99.99 100	1 000	
	−191 −162 −154 −154	0 99.933 99.998 100	40	2.5 m Recommendation ITU-R S.1428
	−177 −148 −140 −140	0 99.933 99.998 100	1 000	
	−195 −184 −175 −161 −154 −154	0 90 99.6 99.984 99.9992 100	40	5 m Recommendation ITU-R S.1428
	−181 −170 −161 −147 −140 −140	0 90 99.6 99.984 99.9992 100	1 000	

[1] For certain GSO FSS receive earth stations, see also Nos. **9.7A** and **9.7B**.

[2] For each reference antenna diameter, the limit consists of the complete curve on a plot which is linear in decibels for the epfd↓ levels and logarithmic for the time percentages, with straight lines joining the data points.

[3] A non-GSO system shall meet the limits of this Table in both the 40 kHz and the 1 MHz reference bandwidths.

[4] For this Table, reference patterns in Recommendation ITU-R S.1428 shall be used only for the calculation of interference from non-GSO FSS systems into GSO FSS systems.

TABLE 1D[1, 2]

Limits on aggregate epfd↓ radiated by non-GSO FSS systems in certain frequency bands into 30 cm, 45 cm, 60 cm, 90 cm, 120 cm, 180 cm, 240 cm and 300 cm BSS antennas

Frequency band (GHz)	epfd↓ (dB(W/m^2))	Percentage of time during which epfd↓ may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern[3]
11.7-12.5 in Region 1 11.7-12.2 and 12.5-12.75 in Region 3 12.2-12.7 in Region 2	−160.4 −160.1 −158.6 −158.6 −158.33 −158.33	0 25 96 98 98 100	40	30 cm Recommendation ITU-R BO.1443, Annex 1
	−170 −167 −164 −160.75 −160 −160	0 66 97.75 99.33 99.95 100	40	45 cm Recommendation ITU-R BO.1443, Annex 1
	−171 −168.75 −167.75 −162 −161 −160.2 −160 −160	0 90 97.8 99.6 99.8 99.9 99.99 100	40	60 cm Recommendation ITU-R BO.1443, Annex 1
	−173.75 −173 −171 −165.5 −163 −161 −160 −160	0 33 98 99.1 99.5 99.8 99.97 100	40	90 cm Recommendation ITU-R BO.1443, Annex 1
	−177 −175.25 −173.75 −173 −169.5 −167.8 −164 −161.9 −161 −160.4 −160	0 90 98.9 98.9 99.5 99.7 99.82 99.9 99.965 99.993 100	40	120 cm Recommendation ITU-R BO.1443, Annex 1

TABLE 1D[1, 2] (*end*)

Frequency band (GHz)	epfd↓ (dB(W/m²))	Percentage of time during which epfd↓ may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern[3]
11.7-12.5 in Region 1 11.7-12.2 and 12.5-12.75 in Region 3 12.2-12.7 in Region 2	−179.5 −178.66 −176.25 −163.25 −161.5 −160.35 −160 −160	0 33 98.5 99.81 99.91 99.975 99.995 100	40	180 cm Recommendation ITU-R BO.1443, Annex 1
	−182 −180.9 −178 −164.4 −161.9 −160.5 −160 −160	0 33 99.25 99.85 99.94 99.98 99.995 100	40	240 cm Recommendation ITU-R BO.1443, Annex 1
	−186.5 −184 −180.5 −173 −167 −162 −160 −160	0 33 99.5 99.7 99.83 99.94 99.97 100	40	300 cm Recommendation ITU-R BO.1443, Annex 1

[1] For BSS antenna diameters of 180 cm, 240 cm and 300 cm, in addition to the aggregate limits shown in Table 1D, the following aggregate 100% of the time epfd↓ limits also apply:

100% of the time epfd↓ (dB(W/(m² · 40 kHz)))	Latitude (North or South) (degrees)
−160	0 ≤ | Latitude | ≤ 57.5
−160 + 3.4(57.5 − | Latitude |)/4	57.5 < | Latitude | ≤ 63.75
−165.3	63.75 < | Latitude |

[2] For each reference antenna diameter, the limit consists of the complete curve on a plot which is linear in decibels for the epfd↓ levels and logarithmic for the time percentages, with straight lines joining the data points. For BSS antenna of diameter 240 cm, in addition to the above aggregate 100% of the time epfd↓ limit, a −167 dB(W/(m² · 40 kHz)) aggregate 100% of the time operational epfd↓ limit also applies to receive antennas located in Region 2, west of 140° W, north of 60° N, pointing toward GSO BSS satellites at 91° W, 101° W, 110° W, 119° W and 148° W with elevation angles greater than 5°. This limit is implemented during a transition period of 15 years.

[3] For this Table, reference patterns in the Annex 1 to Recommendation ITU-R BO.1443 shall be used only for the calculation of interference from non-GSO FSS systems into GSO BSS systems.

RESOLUTION 80 (REV.WRC-07)

Due diligence in applying the principles embodied in the Constitution

The World Radiocommunication Conference (Geneva, 2007),

considering

a) that Articles 12 and 44 of the Constitution lay down the basic principles for the use of the radio-frequency spectrum and the geostationary-satellite and other satellite orbits;

b) that those principles have been included in the Radio Regulations;

c) that Article I of the Agreement between the United Nations and the International Telecommunication Union provides that "the United Nations recognizes the International Telecommunication Union (hereinafter called "the Union") as the specialized agency responsible for taking such action as may be appropriate under its basic instrument for the accomplishment of the purposes set forth therein";

d) that, in accordance with Nos. **11.30**, **11.31** and **11.31.2**, notices shall be examined with respect to the provisions of the Radio Regulations, including the provision relating to the basic principles, appropriate rules of procedure being developed for the purpose;

e) that WRC-97 instructed the Radio Regulations Board (RRB) to develop, within the framework of Nos. **11.30**, **11.31** and **11.31.2**, rules of procedure to be followed in order to be in compliance with the principles in No. **0.3** of the Preamble to the Radio Regulations;

f) that the Board, in accordance with Resolution **80 (WRC-97)**, submitted a report to WRC-2000 suggesting possible solutions and stating that, after examining the Radio Regulations, it had concluded that there are no provisions currently in the Radio Regulations that link the formal notification or coordination procedures with the principles stated in No. **0.3** of the Preamble to the Radio Regulations;

g) that the Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space of the United Nations General Assembly has drawn up recommendations in this respect,

noting

a) that, in accordance with the provisions of No. 127 of the Convention, the Conference may give instructions to the Sectors of the Union;

b) that, according to No. 160C of the Convention, the Radiocommunication Advisory Group (RAG) shall review any matter as directed by a conference;

c) the RRB report to WRC-2000 (see Annex 1);

d) the RRB report to WRC-03 (see Annex 2);

e) that some of the issues identified in the report referred to in *noting c)* have been resolved before WRC-07,

resolves

1 to instruct the Radiocommunication Sector, in accordance with No. 1 of Article 12 of the Constitution, to carry out studies on procedures for measurement and analysis of the application of the basic principles contained in Article 44 of the Constitution;

2 to instruct the RRB to consider and review possible draft recommendations and draft provisions linking the formal notification, coordination and registration procedures with the principles contained in Article 44 of the Constitution and No. **0.3** of the Preamble to the Radio Regulations, and to report to each future World Radiocommunication Conference with regard to this Resolution;

3 to instruct the Director of the Radiocommunication Bureau to submit to each future World Radiocommunication Conference a detailed progress report on the action taken on this Resolution,

invites

1 the other organs of the Radiocommunication Sector, in particular the RAG, to make relevant contributions to the Director of the Radiocommunication Bureau for inclusion in his report to each future World Radiocommunication Conference;

2 administrations to contribute to the studies referred to in *resolves* 1 and to the work of the RRB as detailed in *resolves* 2.

ANNEX 1 TO RESOLUTION 80 (REV.WRC-07)

RRB Report to WRC-2000

In the RRB Report to WRC-2000[1], several members of the Board noted some difficulties likely to be experienced by administrations, particularly administrations of developing countries, as follows:

– the "first-come first-served" concept restricts and sometimes prevents access to and use of certain frequency bands and orbit positions;

– a relative disadvantage for developing countries in coordination negotiations due to various reasons such as a lack of resources and expertise;

– perceived differences in consistency of application of the Radio Regulations;

– the submitting of "paper" satellites that restricts access options;

– the growing use of the bands of the Plans of Appendices **30** and **30A** by regional, multichannel systems, which may modify the main purpose of these Plans to provide equitable access to all countries;

[1] This Report can be found in Document 29 to WRC-2000.

– the considerable processing delays in the Radiocommunication Bureau are due to the very complex procedures required and the large number of filings submitted; these delays contribute to a coordination backlog of 18 months which could extend to three years and creates uncertain regulatory situations, additional delay in the coordination process that cannot be overcome by administrations, and the possible loss of the assignment because the allotted time is exceeded;

– satellite systems may already be in orbit before completion of coordination;

– statutory time-frames, such as those in No. **11.48**, may often be insufficient for developing countries to be able to complete the regulatory requirements as well as the design, construction and launch of satellite systems;

– no provisions for international monitoring to confirm the bringing into use of satellite networks (assignments and orbits).

ANNEX 2 TO RESOLUTION 80 (REV.WRC-07)

RRB Report to WRC-03

In the RRB Report to WRC-03[2], concepts to satisfy *resolves* 2 of Resolution **80 (WRC-2000)** were provided, as follows:

– special measures for countries submitting their first satellite filing:

  – on an exceptional basis, special consideration could be given to countries submitting their first filing for a satellite system, taking into account the special needs of developing countries;

  – such consideration should take into account the following:

    – impact on other administrations;

    – satellite service of the system (i.e. FSS, MSS, BSS);

    – frequency band covered by the filing;

    – system is intended to meet the direct needs of the country(s) concerned;

– extension of the regulatory time-limit for bringing into use:

  – conditions could be specified under which extensions might be granted on an exceptional basis to developing countries when they are not able to complete the regulatory date requirements, so that sufficient time for design, construction and launch of satellite systems is made available;

  – the conditions created under the previous paragraph should be included in the Radio Regulations as provisions that would allow the Radiocommunication Bureau to grant the extension.

[2] This Report can be found in Addendum 5 to Document 4 to WRC-03.

RESOLUTION 81 (REV.WRC-15)

Evaluation of the administrative due diligence procedure for satellite networks

The World Radiocommunication Conference (Geneva, 2015),

considering

a) that WRC-97 adopted Resolution **49 (WRC-97)**[*] establishing administrative due diligence procedure applicable to some satellite radiocommunication services with effect from 22 November 1997;

b) that the Plenipotentiary Conference adopted Resolution 85 (Minneapolis, 1998) on evaluation of the administrative due diligence procedure for satellite networks;

c) that Resolution 85 (Minneapolis, 1998) instructs the Director of the Radiocommunication Bureau to inform WRC-2000 about the effectiveness of the administrative due diligence procedure, in accordance with Resolution **49 (WRC-97)**[*];

d) that Resolution 85 (Minneapolis, 1998) resolves that WRC-2000 shall evaluate the results of the implementation of the administrative due diligence procedure and shall inform the next Plenipotentiary Conference, in 2002, of its conclusions in that regard;

e) the report of the Director of the Radiocommunication Bureau on the administrative due diligence procedure applicable to some satellite networks;

f) the proposals made to this Conference to strengthen the administrative due diligence procedure, and to adopt financial due diligence procedures,

noting

a) that the Bureau has not encountered any administrative difficulty in applying the provisions and in gathering and publishing information;

b) that the Bureau has taken action pursuant to *resolves* 6 of Resolution **49 (WRC-97)**[*] to cancel the submissions, and accordingly publish the related special sections, in respect of 36 satellite networks;

c) that, for all of these cancellations, the maximum (nine-year) period for bringing into use pursuant to *resolves* 1 and 2 of Resolution **51 (WRC-97)**[**] and No. **11.44** had been reached and hence the submissions would have been cancelled in any event;

d) that, when requested to provide due diligence information (triggered by the original date of bringing into use of their satellite networks), administrations have generally requested, wherever possible, extensions of the regulatory period for bringing into use up to the maximum limit authorized by the Radio Regulations;

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[*] *Note by the Secretariat:* This Resolution was revised by WRC-07, WRC-12, WRC-15, WRC-19 and WRC-23.

[**] *Note by the Secretariat:* This Resolution was abrogated by WRC-15.

e) that the effect of the administrative due diligence procedure may not, therefore, be fully apparent until at least 21 November 2003,

recognizing

that the administrative due diligence procedure has not yet had any impact on the problem of reservation of orbit and spectrum capacity without actual use,

resolves

1 that further experience is needed in the application of the administrative due diligence procedures adopted by WRC-97, and that several years may be needed to see whether the procedure produces satisfactory results;

2 that it is premature to consider the adoption, among other procedures, of any financial due diligence procedures.

RESOLUTION 85 (REV.WRC-23)

Application of Article 22 of the Radio Regulations for the protection of geostationary fixed-satellite service and broadcasting-satellite service networks from non-geostationary fixed-satellite service systems

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that WRC-2000 adopted, in Article **22**, single-entry limits applicable to non-geostationary (non-GSO) fixed-satellite service (FSS) systems in certain parts of the frequency range 10.7-30 GHz to protect geostationary-satellite (GSO) networks operating in the same frequency bands;

b) that, taking into account Nos. **22.5H** and **22.5I**, wherever the limits referred to in *considering a)* are exceeded by a non-GSO FSS system to which the limits apply without the agreement of the concerned administrations, this constitutes a violation of the obligations under No. **22.2**;

c) that Recommendation ITU-R S.1503 provides a functional description to be used in developing software tools for determining the conformity of non-GSO FSS networks with limits contained in Article **22**;

d) that there was no software tool available to the Radiocommunication Bureau for equivalent power flux-density (epfd) examinations until the publication of the Circular Letter CR/414 on 6 December 2016 informing administrations of the availability of software for implementing Recommendation ITU-R S.1503-2;

e) that the software may not adequately model certain non-GSO FSS systems and further improvements to Recommendation ITU-R S.1503 may be necessary;

f) that, before the availability of the epfd validation software, the Bureau had requested commitments from the notifying administrations that they will meet the epfd limits in Tables **22-1A**, **22-1B**, **22-1C**, **22-1D**, **22-1E**, **22-2** and **22-3**, and that under these commitments the Bureau gave qualified favourable findings to their systems;

g) that the epfd validation software based on Recommendation ITU-R S.1503-2 does not allow the Bureau to perform examinations in relation to Nos. **9.7A** and **9.7B** when earth stations communicate with GSO space stations in inclined orbits and, thus, Recommendation ITU-R S.1714 was revised to assist the Bureau with this task;

h) that, during the examination under Nos. **9.35** and **11.31**, the Bureau examines non-GSO FSS systems to ensure their compliance with the single-entry epfd limits given in Tables **22-1A**, **22-1B**, **22-1C**, **22-1D**, **22-1E**, **22-2** and **22-3**,

recognizing

that some non-GSO FSS systems are pending review of the qualified favourable findings despite the availability of epfd validation software,

resolves

1 that when the Bureau is unable to examine non-GSO FSS systems subject to Nos. **22.5C**, **22.5D** and **22.5F** under Nos. **9.35** and/or **11.31**, the notifying administration shall send to the Bureau a commitment that the non-GSO FSS system complies with the limits given in Tables **22-1A**, **22-1B**, **22-1C**, **22-1D**, **22-1E**, **22-2** and **22-3** in addition to the information submitted under Nos. **9.30** and **11.15**; a detailed technical description including the results of epfd calculations using existing epfd validation software, the results of epfd calculations using simulation software with adequate modelling of the non-GSO satellite FSS system, and identification of particular areas of the most recent version of Recommendation ITU-R S.1503 that fail to adequately model the non-GSO system shall also be provided;

1*bis* that the Bureau shall promptly make available on the ITU website the information referred to in *resolves* 1 that it has received from the administration of the non-GSO satellite system, and publish it in the Radiocommunication Bureau International Frequency Information Circular (BR IFIC);

2 that the Bureau shall issue either a qualified favourable finding under No. **9.35** or a favourable finding with a date of review under No. **11.31** with respect to the limits contained in Tables **22-1A**, **22-1B**, **22-1C**, **22-1D**, **22-1E**, **22-2** and **22-3**, if *resolves* 1 is satisfied, otherwise the non-GSO FSS system will receive a definitive unfavourable finding;

3 that, if an administration believes that a non-GSO FSS system, for which the commitment referred to in *resolves* 1 was sent, has the potential to exceed the limits given in Tables **22-1A**, **22-1B**, **22-1C**, **22-1D**, **22-1E**, **22-2** and **22-3**, it may request from the notifying administration additional information with regard to the compliance with the limits mentioned above; both administrations shall cooperate to resolve any difficulties, with the assistance of the Bureau, if so requested by either of the parties, and may exchange any additional relevant information that may be available;

4 that the Bureau shall determine coordination requirements between GSO FSS earth stations and non-GSO FSS systems under Nos. **9.7A** and **9.7B** based on bandwidth overlap, GSO FSS earth station antenna maximum isotropic gain, G/T and emission bandwidth;

5 that *resolves* 1 to 4 shall no longer be applied since, as per *considering d)*, the Bureau has communicated to all administrations via a circular letter that the epfd validation software is available and the Bureau is able to verify compliance with the limits in Tables **22-1A**, **22-1B**, **22-1C**, **22-1D**, **22-1E**, **22-2** and **22-3** and, as per *considering g)*, Recommendation ITU-R S.1714 has been revised and allows the Bureau to determine the coordination requirements between GSO FSS earth stations and non-GSO FSS systems under Nos. **9.7A** and **9.7B** based on all the conditions and criteria specified in Table 5-1 of Appendix **5**;

6 that notwithstanding *resolves* 5:

6.1 the course of actions described in *resolves* 2 and 3 (without the need to satisfy *resolves* 1) and *resolves* 4 shall continue to apply for non-GSO systems that can be adequately modelled using the existing version of the epfd validation software tool, notified after the publication of the circular letter referred to in *considering d)*, until the review of all the non-GSO FSS systems with qualified favourable findings is completed; and

6.2 *resolves* 1 to 3 and *resolves* 4, as appropriate, shall continue to apply to non-GSO systems that cannot be adequately modelled by the version of the software available until a new version of the software which adequately models the non-GSO system is made available,

invites the ITU Radiocommunication Sector

1 to amend, as a matter of urgency and taking into account the information referred to in *resolves* 1, as appropriate, the algorithm of Recommendation ITU-R S.1503 to ensure that the epfd validation software available to the Bureau for epfd examinations can adequately model non-GSO satellite FSS systems while maintaining the level of protection for GSO satellite networks in Article **22**;

2 to conduct studies, as a matter of urgency, to ensure that an indefinite application of a qualified favourable finding for a given non-GSO FSS system is avoided,

instructs the Director of the Radiocommunication Bureau

1 to encourage administrations to develop the epfd validation software;

2 to continue to review, using the available epfd validation software, the qualified favourable findings made in accordance with Nos. **9.35** and **11.31**;

3 to review, once a version of the epfd validation software that adequately models the non-GSO systems to which *resolves* 1 applies is available, the qualified favourable findings made in accordance with Nos. **9.35** and **11.31**;

4 to take the necessary actions to implement this Resolution.

RESOLUTION 86 (REV.WRC-07)

Implementation of Resolution 86 (Rev. Marrakesh, 2002) of the Plenipotentiary Conference

The World Radiocommunication Conference (Geneva, 2007),

considering

a) that the Plenipotentiary Conference (Marrakesh, 2002) discussed the application of Resolution 86 (Minneapolis, 1998) and decided to request WRC-03 to determine the scope and criteria to be used by future world radiocommunication conferences (WRCs) in the application of Resolution 86 (Rev. Marrakesh, 2002);

b) that the Plenipotentiary Conference (Antalya, 2006) invited WRC-07 to consider Resolution 86 (Marrakesh, 2002) and to report the results to the 2010 Plenipotentiary Conference,

recognizing

that the Radio Regulations Board makes suggestions to transform the content of the Rules of Procedure into a regulatory text in accordance with Nos. **13.0.1** and **13.0.2** of Article **13** of the Radio Regulations,

noting

that administrations may also wish to make proposals to transform the content of the Rules of Procedure into a regulatory text for possible inclusion in the Radio Regulations,

resolves to invite future world radiocommunication conferences

1 to consider any proposals which deal with deficiencies and improvements in the advance publication, coordination, notification and recording procedures of the Radio Regulations for frequency assignments pertaining to space services which have either been identified by the Board and included in the Rules of Procedure or which have been identified by administrations or by the Radiocommunication Bureau, as appropriate;

2 to ensure that these procedures, and the related appendices of the Radio Regulations reflect the latest technologies, as far as possible,

invites administrations

to consider, in preparing for PP-10, appropriate action with regard to Resolution 86 (Rev. Marrakesh, 2002).

RESOLUTION 95 (REV.WRC-19)

General review of the Resolutions and Recommendations of world administrative radio conferences and world radiocommunication conferences

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that it is important to keep the Resolutions and Recommendations of past world administrative radio conferences (WARCs) and world radiocommunication conferences (WRCs) under constant review, in order to keep them up to date;

b) that the reports of the Director of the Radiocommunication Bureau submitted to previous conferences provided a useful basis for a general review of the Resolutions and Recommendations of past conferences;

c) that some principles and guidelines are necessary for future conferences to treat the Resolutions and Recommendations of previous conferences which are not explicitly related to the agenda of the conference,

resolves

that recommended agendas for future WRCs should include a standing agenda item to review the Resolutions and Recommendations of previous conferences that are not related to any other agenda item of the conference with a view to:

– abrogating those Resolutions and Recommendations that have served their purpose or have become no longer necessary;

– reviewing the need for those Resolutions and Recommendations, or parts thereof, requesting ITU Radiocommunication Sector (ITU-R) studies on which no progress has been made during the last two periods between conferences;

– updating and modifying Resolutions and Recommendations, or parts thereof, that have become out of date, and to correct obvious omissions, inconsistencies, ambiguities or editorial errors and effect any necessary alignment,

invites future competent world radiocommunication conferences

1 to review the Resolutions and Recommendations of previous conferences that are related to the agenda items of the conference, other than the standing agenda item mentioned in *resolves*, under those specific agenda items, with a view to their possible revision, replacement or abrogation, and to take appropriate action;

2 at the beginning of the conference, to determine which committee within the conference has the primary responsibility to review each of the Resolutions and Recommendations of previous conferences,

instructs the Director of the Radiocommunication Bureau

1 to conduct a general review of the Resolutions and Recommendations of previous conferences and, after consultation with the Radiocommunication Advisory Group and the chairmen and vice-chairmen of the radiocommunication study groups, submit a report to the second session of the Conference Preparatory Meeting (CPM) in respect of *resolves* and *invites future competent world radiocommunication conferences* 1, including an indication of any associated agenda items;

2 to include in the above report, with the cooperation of the chairmen of the radiocommunication study groups, the progress reports of ITU-R studies on the issues which have been requested by Resolutions and Recommendations of previous conferences but which are not placed on the agendas of the forthcoming two conferences,

invites administrations

to submit contributions on the implementation of this Resolution to the second session of CPM and the conference,

invites the Conference Preparatory Meeting

to include, in its Report, the results of the general review of the Resolutions and Recommendations of previous conferences, based on the contributions by administrations to the second session of CPM and the above-mentioned Report of the Director, in order to facilitate the follow-up by the conference.

RESOLUTION 99 (REV.WRC-23)

Provisional application of certain provisions of the Radio Regulations as revised by the 2023 World Radiocommunication Conference and abrogation of certain Resolutions and Recommendations

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that this conference has, in accordance with its terms of reference, adopted a partial revision to the Radio Regulations (RR), which will enter into force on 1 January 2025;

b) that some of the provisions, as amended by this conference, need to apply provisionally before that date;

c) that, as a general rule, new and revised Resolutions and Recommendations enter into force at the time of the signing of the Final Acts of a conference;

d) that, as a general rule, Resolutions and Recommendations which a world radiocommunication conference has decided to suppress are abrogated at the time of the signing of the Final Acts of a conference,

resolves

1 that the date of entry into force of the frequency bands 1 614.4225-1 618.725 MHz or 1 616.3-1 620.38 MHz and 2 483.59-2 499.91 MHz, Nos. **5.368**, **5.372A**, **33.50**, **33.53**, as well as Appendix **15** for the frequency bands 1 614.4225-1 618.725 MHz or 1 616.3-1 620.38 MHz and 2 483.59-2 499.91 MHz is stipulated in *resolves 6* of Resolution **365 (WRC-23)**;

2 that, as of 16 December 2023, the following provisions of the Radio Regulations shall provisionally apply:

– Appendix **30**: 4.1.10d; 4.1.13*bis*; 4.1.13*ter*; 4.1.30; 4.1.31; 4.1.32; 5.1.6*bis*;

– Appendix **30A**: 4.1.10d; 4.1.13*bis*; 4.1.13*ter*; 4.1.34; 4.1.35; 4.1.36; 5.1.10*bis*;

– Appendix **30B**: 6.4*bis*; 6.15; 6.15*quat*; 6.15*quin*; 6.27*bis*; 6.29*bis*; 6.29*ter*; 8.10*bis*; 8.10*ter*,

further resolves

to abrogate the following Resolutions as of 16 December 2023:

Resolution **75 (Rev.WRC-12)**
Resolution **160 (WRC-15)**
Resolution **161 (WRC-15)**
Resolution **171 (WRC-19)**
Resolution **428 (WRC-19)**
Resolution **429 (WRC-19)**
Resolution **430 (WRC-19)**
Resolution **656 (Rev.WRC-19)**

Resolution **172 (WRC-19)**
Resolution **173 (WRC-19)**
Resolution **174 (WRC-19)**
Resolution **175 (WRC-19)**
Resolution **177 (WRC-19)**
Resolution **178 (WRC-19)**
Resolution **245 (WRC-19)**
Resolution **246 (WRC-19)**
Resolution **247 (WRC-19)**
Resolution **248 (WRC-19)**
Resolution **250 (WRC-19)**
Resolution **361 (Rev.WRC-19)**
Resolution **427 (WRC-19)**
Resolution **657 (Rev.WRC-19)**
Resolution **661 (WRC-19)**
Resolution **662 (WRC-19)**
Resolution **772 (WRC-19)**
Resolution **773 (WRC-19)**
Resolution **774 (WRC-19)**
Resolution **776 (WRC-19)**
Resolution **811 (WRC-19)**
Resolution **812 (WRC-19)**
Resolution **904 (WRC-07)**
Resolution **907 (Rev.WRC-15)**
Resolution **908 (Rev.WRC-15)**

RESOLUTION 111 (ORB-88)

Planning of the fixed-satellite service in the bands 18.1-18.3 GHz, 18.3-20.2 GHz and 27-30 GHz[1]

The World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It (Second Session − Geneva, 1988),

considering

a) that WARC Orb-85 in its Report to WARC Orb-88, requested the ITU-R to study the technical characteristics of the fixed-satellite service in the bands 18.1-18.3 GHz, 18.3-20.2 GHz and 27-30 GHz with a view to a decision on the future planning of these bands for the fixed-satellite service being taken by a future competent conference;

b) that the ITU-R concluded that it would be extremely unwise for these bands to be subject to planning at this time and that further study would be necessary,

recognizing

1 that these bands have not been exploited extensively due to technical and economic reasons, although they potentially have great capacity;

2 that the required satellite orbital spacing may be reduced, thus resulting in easier coordination between satellite networks because narrower satellite antenna beamwidths can be achieved than in the lower frequency bands;

3 that different performance criteria may well be necessary from those which currently exist for frequency bands below 15 GHz, since the propagation characteristics are different,

resolves

that the bands 18.1-18.3 GHz, 18.3-20.2 GHz and 27-30 GHz shall not be included in frequency bands identified for planning at this time,

invites the ITU-R

to continue its studies into the technical characteristics of the bands 18.1-18.3 GHz, 18.3-20.2 GHz and 27-30 GHz until a decision is taken by a future competent conference.

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[1] WRC-97 made editorial amendments to this Resolution.

RESOLUTION 114 (REV.WRC-15)

Compatibility between the aeronautical radionavigation service and the fixed-satellite service (Earth-to-space) (limited to feeder links of the non-geostationary mobile-satellite systems in the mobile-satellite service) in the frequency band 5 091-5 150 MHz

The World Radiocommunication Conference (Geneva, 2015),

considering

a) the current allocation of the frequency band 5 000-5 250 MHz to the aeronautical radionavigation service;

b) the requirements of both the aeronautical radionavigation and the fixed-satellite (FSS) (Earth-to-space) (limited to feeder links of non-geostationary satellite (non-GSO) systems in the mobile-satellite service (MSS)) services in the above-mentioned band,

recognizing

a) that priority must be given to the microwave landing system (MLS) in accordance with No. **5.444** and to other international standard systems of the aeronautical radionavigation service in the frequency band 5 030-5 091 MHz;

b) that, in accordance with Annex 10 of the Convention of the International Civil Aviation Organization (ICAO) on international civil aviation, it may be necessary to use the frequency band 5 091-5 150 MHz for the MLS if its requirements cannot be satisfied in the frequency band 5 030-5 091 MHz;

c) that the FSS providing feeder links for non-GSO systems in the MSS will need continuing access to the frequency band 5 091-5 150 MHz,

noting

a) that Recommendation ITU-R S.1342 describes a method for determining coordination distances between international standard MLS stations operating in the frequency band 5 030-5 091 MHz and FSS earth stations providing Earth-to-space feeder links in the frequency band 5 091-5 150 MHz;

b) the small number of FSS stations to be considered,

resolves

that administrations authorizing stations providing feeder links for non-GSO systems in the MSS in the frequency band 5 091-5 150 MHz shall ensure that they do not cause harmful interference to stations of the aeronautical radionavigation service,

invites administrations

when assigning frequencies in the frequency band 5 091-5 150 MHz to stations of the aeronautical radionavigation service or to earth stations of the FSS providing feeder links of the non-GSO systems in the MSS (Earth-to-space), to take all practicable steps to avoid mutual interference between them,

instructs the Secretary-General

to bring this Resolution to the attention of ICAO.

RESOLUTION 121 (WRC-23)

Use of the frequency band 12.75-13.25 GHz by earth stations in motion on aircraft and vessels communicating with geostationary space stations in the fixed-satellite service

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that WARC Orb-88 established an Allotment Plan for the use of the frequency bands 4 500-4 800 MHz, 6 725-7 025 MHz, 10.70-10.95 GHz, 11.20-11.45 GHz and 12.75-13.25 GHz by the fixed-satellite service (FSS);

b) that WRC-07 revised the regulatory regime governing the use of the frequency bands referred to in *considering a)* above;

c) that the objective of providing broadband mobile-satellite communications may also be met by allowing earth stations in motion (ESIMs), on aircraft (A-ESIMs) and vessels (M-ESIMs), to communicate with geostationary space stations of an FSS network in the frequency bands 12.75-13.25 GHz (Earth-to-space) and the associated downlink frequency bands of that satellite; thus, for example, the frequency bands 10.70-10.95 GHz and 11.20-11.45 GHz of Appendix **30B** may be used;

d) that the frequency band 12.75-13.25 GHz is currently allocated on a primary basis to the FSS (Earth-to-space), fixed and mobile services and on a secondary basis to the space research service (deep space) (space-to-Earth);

e) that the operation of services to which the frequency band 12.75-13.25 GHz is allocated and of services in adjacent bands needs to be protected from A-ESIMs and M-ESIMs;

f) that the frequency band 12.75-13.25 GHz (Earth-to-space) is used in the geostationary-satellite orbit (GSO) by FSS networks in accordance with the provisions of Appendix **30B** (No. **5.441**) and that there are many existing GSO FSS satellite networks operating in that frequency band;

g) that the objective of the procedures in Appendix **30B** is to guarantee, for all countries, equitable access to the GSO in the frequency bands of the FSS covered by that Appendix;

h) that regulatory provisions and interference-management mechanisms, including necessary mitigation measures and associated techniques, are required for the operation of A-ESIMs and M-ESIMs in the frequency band 12.75-13.25 GHz (Earth-to-space) to protect other services with allocations in that frequency band and adjacent frequency bands and without adversely affecting those services and their future development, taking into account the provisions of Appendix **30B** (see also *further resolves* 2 on responsibilities);

i) that, in Appendix **30B**, the frequency bands in the space-to-Earth direction corresponding to the frequency band 12.75-13.25 GHz (Earth-to-space) are 10.70-10.95 GHz and 11.20-11.45 GHz, which may be used by A-ESIMs and M-ESIMs, subject to not claiming protection from other services and applications of the FSS and other radiocommunication services to which the frequency band is allocated;

j) that there is no publicly available information on coordination agreements reached among administrations regarding GSO FSS satellite networks, except on whether coordination has been completed, which is provided to the Radiocommunication Bureau;

k) that the operation of A-ESIMs and M-ESIMs requires the establishment of one or more gateway earth station facilities in one or several countries that are within the service area of the associated satellite network and that are authorized by the administration of the territory where such earth stations are located,

considering further

a) that A-ESIMs and M-ESIMs operating within the agreed service area of the satellite network with which they communicate may provide services within the territories under the jurisdiction of multiple administrations;

b) that the operation of ESIMs within the territory under the jurisdiction of administrations mentioned in *considering further a)* above is subject to obtaining authorization from those administrations,

recognizing

a) that Article 44 of the ITU Constitution contains the basic principles for the use of the radio-frequency spectrum and the GSO and other satellite orbits, taking into account the needs of developing countries;

b) that administrations intending to authorize A-ESIMs and M-ESIMs, when establishing national licensing rules, may consider adopting other interference management procedures and/or mitigation measures than those contained in this Resolution, as long as the provisions in Annex 2 are unchanged in cross border applications;

c) that, pursuant to the relevant provisions in Appendix **30B**, the operation of ESIMs in the frequency band 12.75-13.25 GHz may only be within the service area of the Appendix **30B** network for which the explicit agreement of any administration whose territory is partially or wholly included in that service area has been obtained;

d) that § 6.16 of Article 6 of Appendix **30B** provides the opportunity to any administration at any time to request that its territory be excluded from the service area of any assignment governed by Appendix **30B**;

e) that the operation of an A-ESIM or M-ESIM associated and communicating with a space station of a given satellite network needs the earth station to be within the coordinated and agreed service area of the satellite network under the relevant provisions of Appendix **30B**;

f) that, based on the available information in the Bureau's database in May 2022, there is no contiguous regional or worldwide coordinated and agreed service area for any satellite network using the Appendix **30B** frequency band 12.75-13.25 GHz recorded in the Master International Frequency Register (MIFR);

g) that, in order for A-ESIMs and M-ESIMs to operate in the Appendix **30B** frequency band 12.75-13.25 GHz (Earth-to-space) in an efficient and operationally viable manner, having a contiguous regional or worldwide coordinated and agreed service area is an important issue to be taken into account;

h) that the administration authorizing ESIMs on the territory under its jurisdiction has the right to require that the ESIMs referred to above only use those assignments associated with GSO FSS networks which have been successfully coordinated, notified, brought into use and recorded in the MIFR with a favourable finding under § 8.11 of Article 8 of Appendix **30B**, except those arising from the application of § 6.25 of Appendix **30B**;

i) that Resolution **170 (Rev.WRC-23)** provides the procedure to enhance equitable access to frequency bands under Appendix **30B** by developing countries;

j) that the protection of current usage and future development of Appendix **30B** in the frequency band 12.75-13.25 GHz (Earth-to-space) is a fundamental issue without any adverse effect thereto;

k) that the availability of the methodology to examine conformity with the power flux-density (pfd) limits as contained in Annex 2 to this Resolution is a fundamental and crucial element;

l) that there is a need to establish regulatory, technical and recording procedures for the usage of these types of ESIM that may differ from the current FSS Appendix **30B** Plan and List recording procedures;

m) that successful implementation of this Resolution does not oblige any administration to authorize/license A-ESIMs and M-ESIMs communicating with GSO space stations in the FSS in the frequency band 12.75-13.25 GHz (Earth-to-space) to operate on the territory under its jurisdiction (see *resolves* 7);

n) that, in accordance with Appendix **30B**, the examination by the Bureau of the frequency assignments in the frequency band 12.75-13.25 GHz (Earth-to-space) is limited to the test-points on land; it is necessary to examine the compatibility of A-ESIMs and M-ESIMs using grid points generated within the entire service area of A-ESIMs and M-ESIMs submitted under Appendix **4** (see Annex 1 to this Resolution);

o) that any administration retains its right to regulate and exercise its authority within its jurisdiction, recalling the Preamble to the Constitution,

recognizing further

a) that, under *resolves* 1.1.4 below, frequency assignments to GSO A-ESIMs and M-ESIMs need to be notified to the Bureau;

b) that, for the operation of GSO A-ESIMs and M-ESIMs, notification of any frequency assignment under Annex 1 to this Resolution shall only be made by one single administration, which is the notifying administration for the GSO FSS network with which the ESIMs communicate;

c) that an administration authorizing the operation of GSO A-ESIMs and M-ESIMs within the territory under its jurisdiction may modify and/or withdraw that authorization at any time;

d) that the three elements consisting of the interference management mechanism, switching facility for on/off function and the function of the network control and monitoring centre (NCMC) and their relations with each other and sequence of actions, together with estimated time for that action/function, are needed for the proper and effective operation of GSO A-ESIMs and M-ESIMs;

e) that the operation of A-ESIMs and M-ESIMs shall comply with the provisions of No. **5.340**;

f) that, when the Appendix **30B** GSO FSS satellite network with which A-ESIMs and M-ESIMs communicate transmits in the frequency bands 10.70-10.95 GHz and 11.20-11.45 GHz, it shall operate under the levels that were coordinated and included in the List, and that these Appendix **30B** satellite transmissions shall not change to accommodate A-ESIMs and M-ESIMs,

resolves

1 that, for any A-ESIM or M-ESIM communicating with a GSO FSS space station within the frequency band 12.75-13.25 GHz (Earth-to-space) or parts thereof, the following conditions shall apply:

1.1 with respect to space services in the frequency band 12.75-13.25 GHz and adjacent bands, A-ESIMs and M-ESIMs shall comply with the following conditions:

1.1.1 the use of the frequency band 12.75-13.25 GHz (Earth-to-space) by A-ESIMs and M-ESIMs shall not result in any changes or restrictions to allotments in the Plan, assignments in the List of Appendix **30B**, and assignments recorded in the MIFR, including the assignments arising from the implementation of Resolution **170 (Rev.WRC-23)**;

1.1.2 with respect to satellite networks of other administrations, the characteristics of A-ESIMs and M-ESIMs shall remain within the envelope of typical characteristics of notified earth stations associated with the satellite networks with which these earth stations communicate, as published by the Bureau and included in its relevant International Frequency Information Circular (BR IFIC), and Annex 1 to this Resolution applies;

1.1.3 the use of A-ESIMs and M-ESIMs shall not cause any interference to Appendix **30B** allotments, assignments received by the Bureau under Article 6 either in process or yet to be processed, assignments in the List, assignments notified under Article 8 of that Appendix, and assignments recorded in the MIFR, as well as submissions under Appendix **30B**, beyond that specified in the relevant Annexes to that Appendix;

1.1.4 for the implementation of *resolves* 1.1.1, 1.1.2 and 1.1.3 above, the notifying administration for the GSO FSS network with which the above-mentioned A-ESIMs and M-ESIMs communicate shall follow the procedure in Annex 1 to this Resolution, together with the commitment that the operation of ESIMs shall be in conformity with the Radio Regulations, including this Resolution;

1.1.5 upon receipt of the notification information referred to in *resolves* 1.1.4 above, the Bureau shall process the submission in accordance with Annex 1 to this Resolution;

1.1.6 for the protection of non-GSO FSS systems operating in the frequency band 12.75-13.25 GHz, the above-mentioned A-ESIMs and M-ESIMs communicating with GSO FSS networks referred to above shall comply with the provisions contained in Annex 3 to this Resolution;

1.1.7 the notifying administration for the GSO FSS network with which the above-mentioned A-ESIMs and M-ESIMs communicate shall ensure that the operation of the A-ESIMs and M-ESIMs complies with the coordination agreements for the frequency assignments to the earth station of that GSO FSS satellite network of Appendix **30B** obtained under the relevant provisions of that Appendix;

1.1.8 the receiving part of the above-mentioned A-ESIMs and M-ESIMs in their associated frequency band shall not adversely affect the allotments in the Plan or the assignments in the List and shall not claim protection from other applications of the FSS or other radiocommunication services to which the frequency band is allocated;

1.2 with respect to the protection of terrestrial services to which the frequency band 12.75-13.25 GHz is allocated and that operate in accordance with the Radio Regulations, A-ESIMs and M-ESIMs shall comply with the following conditions:

1.2.1 transmitting GSO A-ESIMs and M-ESIMs in the frequency band 12.75-13.25 GHz (Earth-to-space) shall not cause unacceptable interference to terrestrial services to which that frequency band is allocated and that operate in accordance with the Radio Regulations, and Annex 2 to this Resolution shall apply;

1.2.2 the receiving part of the above-mentioned GSO A-ESIMs and M-ESIMs operating in the frequency bands mentioned in *recognizing further f)* shall not claim protection from terrestrial services to which those frequency bands are allocated and that are operating in accordance with the Radio Regulations;

1.2.3 the requirement not to cause unacceptable interference to terrestrial services to which the frequency band 12.75-13.25 GHz is allocated and that operate in accordance with the Radio Regulations shall be respected, irrespective of compliance with Annex 2 (see *further resolves* 7);

1.2.4 for the application of Part II of Annex 2 as referred to in *resolves* 1.2.1 above, the Bureau shall examine the characteristics of A-ESIMs with respect to conformity with the pfd limits at any point on the Earth's surface specified in Part II of Annex 2, in accordance with the methodology described in Annex 4 to this Resolution, and publish the results of such examination in the BR IFIC; in the event of non-compliance with the pfd limits set out in Part II of Annex 2, the Bureau shall formulate an unfavourable finding and return the notice to the notifying administration;

1.2.5 if an administration authorizing A-ESIMs agrees to pfd levels higher than the limits contained in Part II of Annex 2 within the territory under its jurisdiction, such agreement shall in no way affect other administrations that are not party to that agreement;

1.3 A-ESIMs and M-ESIMs communicating with GSO FSS networks shall not cause unacceptable interference to the aeronautical radionavigation service (ARNS) operating in accordance with the Radio Regulations in the frequency band 13.25-13.40 GHz;

2 that only frequency assignments of Appendix **30B** recorded in the List may be used as supporting assignments for A-ESIMs and M-ESIMs communicating with GSO FSS networks in the frequency band 12.75-13.25 GHz (Earth-to-space), if those assignments are recorded in the MIFR with a favourable finding under § 8.11 of Article 8 of Appendix **30B**;

2.1 if assignments to GSO FSS networks notified under § 6.25 of Appendix **30B** are used for the operation of the above-mentioned A-ESIMs and M-ESIMs, those assignments may be used for GSO A-ESIMs and M-ESIMs only in accordance with §§ 6.26 and 6.29 of Appendix **30B**;

2.2 for the implementation of *resolves* 2.1 above, the notifying administration for the GSO FSS network with which GSO A-ESIMs and M-ESIMs communicate shall send the Bureau a commitment that the operation shall be in conformity with *resolves* 2.1 and *further resolves* 2, 2.1 and 2.2 below;

3 that the operation of A-ESIMs and M-ESIMs communicating with GSO FSS space stations in the frequency band 12.75-13.25 GHz (Earth-to-space) shall be within the coordinated and notified service area of the GSO FSS network;

4 that, for the implementation of *resolves* 3 above, the notifying administration for the GSO FSS network with which the A-ESIMs and M-ESIMs communicate shall ensure that the necessary arrangements and switching facilities are built into the A-ESIMs and M-ESIMs to cease emissions once approaching the territory under the jurisdiction of those administrations which either are not within the notified and coordinated service area of the subject space station or have not authorized operation over their territories;

5 that any course of action taken under this Resolution have no impact on the original date of receipt of the frequency assignments of the GSO FSS satellite network with which A-ESIMs and M-ESIMs communicate, or on the coordination requirements of that satellite network;

6 that A-ESIMs and M-ESIMs shall not be used or relied upon for safety-of-life applications;

7 that the operation of A-ESIMs and M-ESIMs within territorial waters and/or airspace under the jurisdiction of another administration shall be carried out only if a licence under No. **18.1**, or the authorization of that administration, is obtained;

8 that gateway earth station facilities for A-ESIMs and M-ESIMs shall be within the service area of the satellite network associated with that gateway;

9 that, in the event that unacceptable interference caused by A-ESIMs and/or M-ESIMs is reported:

9.1 the notifying administration for the GSO FSS network with which the A-ESIMs and M-ESIMs communicate be responsible for eliminating the case of unacceptable interference; consequently, no other administration shall be held responsible for eliminating cases of unacceptable interference (see also *resolves* 9.2 below);

9.2 any authorizing administration, subject to its explicit agreement and to the extent of its ability, provide any available information that may help eliminate the case of unacceptable interference;

9.3 the administration responsible for the aircraft or vessel on which an ESIM operates shall provide, when requested, the affected administration with a point of contact to assist in identifying the notifying administration for the satellite with which the ESIM communicates, which is responsible for eliminating the case of unacceptable interference (see *resolves* 9.1 and 9.2);

10 that the notifying administration for the GSO FSS satellite network with which the GSO A-ESIMs and M-ESIMs communicate shall ensure that:

10.1 A-ESIMs and M-ESIMs employ the minimum requirements specified in Annex 5 to this Resolution;

10.2 for the operation of A-ESIMs and M-ESIMs, techniques are employed to maintain adequate pointing accuracy of the antenna towards the associated GSO FSS satellite to avoid inadvertently tracking an adjacent GSO satellite;

10.3 all necessary measures shall be taken so that A-ESIMs and M-ESIMs are subject to permanent monitoring and control by an NCMC or equivalent facility in order to comply with the provisions of this Resolution, and are capable of receiving and immediately acting upon, *inter alia*, "enable transmission" and "disable transmission" commands from the NCMC;

10.4 measures are taken so that the A-ESIMs and/or M-ESIMs do not transmit on territory under the jurisdiction of an administration, including its territorial waters and national airspace, that either is not in the coordinated and notified service area of the GSO satellite network or has not authorized their use on its territory;

10.5 a permanent point of contact shall be provided in the Appendix **4** submission under Annex 1 of this Resolution and published in the special section by the notifying administration for the GSO FSS network for the purpose of tracing any suspected cases of unacceptable interference from A-ESIMs and M-ESIMs and to immediately respond to such requests;

11 that the operation of GSO A-ESIMs and M-ESIMs, including operation of the NCMC, interference management system, and mechanism and functioning of switching facilities, be subject to the availability of the ITU-R Recommendation referred to in *invites the ITU Radiocommunication Sector* below, with the understanding that, in the meantime, *further resolves* 2, 2.1 and 2.2 strictly apply;

12 that the operation of GSO A-ESIMs and M-ESIMs under frequency assignments recorded under § 6.25 of Appendix **30B**, including operation of the NCMC, interference management system, and mechanism and functioning of switching facilities, be subject to the availability of the ITU-R Recommendation referred to in *invites the ITU Radiocommunication Sector* below, with the understanding that, in the meantime, *further resolves* 2, 2.1 and 2.2 strictly apply,

further resolves

1 that compliance with this Resolution in no way whatsoever release the notifying administration(s) from its/their obligation not to cause unacceptable interference to, or claim protection from, the incumbent services as referred to in this Resolution;

2 that the notifying administration for the GSO network, when submitting Appendix **4** information/data elements, shall send a firm, objective, actionable, measurable and enforceable commitment that, in the event of unacceptable interference being reported, it undertakes to immediately eliminate the interference or reduce it to an acceptable level;

2.1 in case of no action being taken with regard to the obligation referred to in *further resolves* 2 above, the Bureau shall send a reminder and request the notifying administration for the GSO network to comply with the requirements referred to in the commitment;

2.2 should the interference persist 30 days after the dispatch date of the above-mentioned reminder, the Bureau shall submit the case to the subsequent meeting of the Radio Regulations Board (RRB) for review and necessary actions (including suppression of the frequency assignment to the ESIM concerned), as appropriate;

3 that frequency assignments in the frequency band 12.75-13.25 GHz (Earth-to-space) used by A-ESIMs and M-ESIMs communicating with geostationary space stations in the FSS shall be notified to the Bureau under Annex 1 to this Resolution by the notifying administration for the satellite network with which the ESIMs communicate;

4 that the notifying administration for the satellite network shall ensure that A-ESIMs and M-ESIMs operate only in the territory under the jurisdiction of administrations from which authorization has been obtained, taking into account *recognizing further c)* above;

5 that, in accordance with *instructs the Director of the Radiocommunication Bureau* 4 below, the notifying administration for the Appendix **30B** FSS satellite network operating A-ESIMs and M-ESIMs, upon request by the Bureau regarding cases of unacceptable interference reported by affected administrations, shall provide the Bureau with the list of administrations that have authorized ESIM operations to communicate with that satellite network and that are potentially related to a reported case of unacceptable interference;

6 that, for the implementation of *further resolves* 2, the notifying administration responsible for the operation of GSO A-ESIMs and M-ESIMs shall also be responsible for observing and complying with all relevant regulatory and administrative provisions applicable to the operation of the above-mentioned GSO A-ESIMs and M-ESIMs, as contained in this Resolution and in the Radio Regulations;

7 that the authorization for a GSO A-ESIM or M-ESIM to operate in the territory under the jurisdiction of an administration shall in no way release the notifying administration for the satellite network with which the ESIM communicates from the obligation to comply with the provisions contained in this Resolution and in the Radio Regulations,

instructs the Director of the Radiocommunication Bureau

1 to take all necessary actions to facilitate the implementation of this Resolution;

2 to report to future world radiocommunication conferences on any difficulties or inconsistencies encountered in the implementation of this Resolution, including on whether or not the responsibilities relating to the operation of GSO A-ESIMs and M-ESIMs have been properly addressed;

3 to accelerate, to the maximum extent possible, the development and availability of the software required for implementation of the methodology contained in Annex 4 to this Resolution to examine compliance with the pfd limits in Part II of Annex 2 to this Resolution;

4 in the event of unacceptable interference:

4.1 based on information provided by the affected administration, to request the notifying administrations for satellite networks communicating with A-ESIMs and M-ESIMs that could potentially be causing unacceptable interference to promptly provide the relevant list of administrations that have authorized such ESIM operations to the affected administration;

4.2 to provide the affected administration with the list of networks potentially related to the reported case of unacceptable interference;

4.3 if a notifying administration fails to provide the information required under *instructs the Director of the Radiocommunication Bureau* 4.1 above within 45 days from the date of dispatch of the Bureau's request referred to in *instructs the Director of the Radiocommunication Bureau* 4.1, to send the notifying administration a reminder to provide the required list within 15 days from the date of that reminder;

4.4 if a notifying administration fails to provide the required information following the reminder under *instructs the Director of the Radiocommunication Bureau* 4.3 above and if the affected administration has not confirmed to the Bureau that the case of unacceptable interference has been resolved, to submit the case to the subsequent meeting of RRB for review and the necessary actions, as appropriate,

invites the ITU Radiocommunication Sector

to study, as a matter of urgency, with the objective of preparing a Recommendation to be adopted and approved in accordance with Resolution ITU-R 1, the functionalities and implementation of NCMC for ESIMs,

instructs the Secretary-General

1 to bring this Resolution to the attention of the International Maritime Organization and the International Civil Aviation Organization;

2 to bring this Resolution to the attention of the ITU Council with a view to its considering whether cost recovery should be applied to GSO A-ESIMs and M-ESIMs.

ANNEX 1 TO RESOLUTION 121 (WRC-23)

PART I

Procedure to be followed by the administrations and the Bureau for submission of the earth stations in motion on aircraft and vessels operating in the frequency band 12.75-13.25 GHz (Earth-to-space) and for the protection of allotments in the Plan, assignments in the Appendix 30B List and those submitted under Articles 6 and 7 of Appendix 30B as well as under Resolution 170 (Rev.WRC-23)

Section A – Procedure for entering assignments to earth stations in motion on aircraft and vessels in the Appendix 30B ESIM List[1]

1 When an administration, or one acting on behalf of a group of named administrations, intends to use as a supporting frequency assignment one or more Appendix **30B** assignments already included in the List and the Master international Frequency Register (MIFR) in support of the operation of earth stations in motion on aircraft (A-ESIMs) and earth stations in motion on vessels (M-ESIMs) in the frequency band 12.75-13.25 GHz, it shall send to the Radiocommunication Bureau, not earlier than eight years but preferably not later than two years before the operation of A-ESIMs and M-ESIMs, the information specified in Appendix **4**[2].

An assignment in the Appendix **30B** ESIM List shall lapse if it is not brought into use within eight years of the date of receipt by the Bureau of the relevant complete information specified above. A proposed assignment not included in the Appendix **30B** ESIM List within eight years after the date of receipt by the Bureau of the relevant complete information shall also lapse.

2 If the information received by the Bureau under § 1 is found to be incomplete, the Bureau shall immediately seek any clarification required and information not provided from the administration concerned.

3 Upon receipt of a complete notice under § 1, the Bureau shall examine it with respect to its conformity with:

a) the Table of Frequency Allocations and other provisions[3] of the Radio Regulations, except those provisions relating to conformity with the FSS Plan and the coordination procedures;

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[1] The List of assignments for earth stations in motion (ESIMs) in the frequency band 12.75-13.25 GHz in Appendix **30B**.

[2] Submissions may include only the frequency band 12.75-13.0 GHz or 13.0-13.25 GHz.

[3] The “other provisions” shall be identified and included in the Rules of Procedure.

b) Annex 3 to Appendix **30B**;

c) the on-axis equivalent isotropically radiated power (e.i.r.p.) density and off-axis e.i.r.p. density of the supporting Appendix **30B** assignment(s);

d) the service area of the supporting Appendix **30B** assignment(s) in respect of explicit agreements of those administrations whose territories are included in the service area[4]; and

e) the frequency band of the supporting Appendix **30B** assignment(s) in the List in the frequency band 12.75-13.25 GHz.

4 When the examination with respect to § 3 leads to an unfavourable finding, the relevant part of the notice shall be returned to the notifying administration with an indication of the appropriate action.

5 When the examination with respect to § 3 leads to a favourable finding, the Bureau shall use the method of Annex 4 to Appendix **30B** (see § 23) to determine administrations whose:

a) allotments in the Plan;

b) assignments which appear in the List; or

c) assignments which the Bureau has previously examined under § 6.5 of Article 6 of Appendix **30B** after receiving complete information in accordance with § 6.1 of that Article

are considered as being affected and receiving more interference than that produced by the supporting Appendix **30B** assignment(s).

6 The Bureau shall publish, in a special section of its International Frequency Information Circular (BR IFIC), the complete information received under § 1, and examined under § 5, together with the names of the affected administrations, the corresponding allotments in the Plan, assignments in the List and assignments for which the Bureau has previously received complete information in accordance with § 6.1 of Article 6 of Appendix **30B** and which it has examined under § 6.5 of that Article.

7 The Bureau shall immediately inform the administration proposing the assignment in the Appendix **30B** ESIM List, drawing its attention to the information contained in the relevant BR IFIC and the requirement to seek and obtain the agreement of those affected administrations.

8 The Bureau shall also inform each administration listed in the special section of the BR IFIC published under § 6, drawing its attention to the information it contains.

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[4] The service area may be reduced by excluding certain countries for which explicit agreement was obtained.

9 An administration that has not notified its comments either to the administration seeking agreement or to the Bureau within a period of four months following the date of the BR IFIC referred to in § 6 shall be deemed to have not agreed to the proposed assignment in respect of its allotment in the Plan, conversion of an allotment into an assignment without modification or with a modification which is within the envelope characteristics of the initial allotment, Article 7 request transferred to Article 6, submission in accordance with Resolution **170 (Rev.WRC-23)**, as appropriate, where the absence of reply/comments shall be construed as its disagreement to the request for coordination. This time-limit shall be extended for an administration that has requested the assistance of the Bureau by up to 30 days following the date on which the Bureau communicated the result of its action. In respect of its frequency assignments under Article 6 of Appendix **30B** other than those mentioned above, the same course of action outlined in § 6.10 of that Article shall apply.

10 Unless coordination is no longer required, the administration responsible for the notice published under § 6 shall seek and obtain the explicit agreement of the relevant affected administrations contained in the special section published under § 6 in respect of allotments in the Plan, conversion of an allotment into an assignment without modification or with a modification which is within the envelope characteristics of the initial allotment, an Article 7 request transferred to Article 6, a submission in accordance with Resolution **170 (Rev.WRC-23)**, as appropriate. In this specific case of explicit agreement, any request for the assistance of the Bureau shall not change it to implicit/tacit agreement.

11 If agreements have been reached in accordance with §§ 9 and 10 with administrations published under § 6, the administration responsible for the notice published under § 6 may request the Bureau to have the assignment entered into the Appendix **30B** ESIM List, indicating the final characteristics of the notice[5] together with the names of the administrations with which agreement has been reached.

12 In submitting such information, noting the requirement of § 1 of Section B, the administration may also request the Bureau to examine the submission in respect of notification under Section B.

13 If the information received by the Bureau under §§ 11 and 12 is found to be incomplete, the Bureau shall immediately seek any clarification required and information not provided from the administration concerned. The Bureau may also provide additional information in order to assist the notifying administration in complying with requirements under §§ 14, 16 and 17.

14 Upon receipt of a complete notice under § 11, the Bureau shall examine each assignment in the notice with respect to its conformity with:

a) the Table of Frequency Allocations and other provisions[6] of the Radio Regulations, except those provisions relating to conformity with the FSS Plan and the procedures for coordination;

b) Annex 3 to Appendix **30B**;

c) the service area published under § 6;

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[5] Submissions may include only the frequency band 12.75-13.0 GHz or 13.0-13.25 GHz.

[6] The “other provisions” shall be identified and included in the Rules of Procedure.

d) the on-axis e.i.r.p. density and off-axis e.i.r.p. density of the assignments published under § 6; and

e) the frequency band of the assignments published under § 6.

15 When the examination with respect to § 14 of an assignment received under § 11 leads to an unfavourable finding, the notice shall be returned to the notifying administration with an indication that subsequent resubmission under § 11 will be considered with a new date of receipt.

16 When the examination with respect to § 14 of an assignment received under § 11 leads to a favourable finding, the Bureau shall use the method described in Annex 4 to Appendix **30B** to examine if there is any administration and corresponding:

a) allotment in the Plan;

b) assignment which appears in the List at the date of receipt of the examined notice submitted under § 1;

c) assignments which the Bureau has previously examined under § 6.5 of Article 6 of Appendix **30B** after receiving complete information in accordance with § 6.1 of that Article at the date of receipt of the examined notice submitted under § 1[7],

considered as being affected and receiving more interference than that produced by the supporting Appendix **30B** assignment(s) and whose agreement has not been provided under § 11.

17 The Bureau shall determine if the cumulative interference is caused to an allotment in the Plan or an assignment in the List or an assignment for which the Bureau has received complete information in accordance with Article 6 of Appendix **30B** before the date of receipt of the complete notice under § 11. The cumulative interference shall be calculated based on Appendix 1 to Annex 4 of Appendix **30B**, taking into account assignments in the Appendix **30B** ESIM List together with assignments submitted under § 11. The cumulative interference is considered as being caused when the overall aggregate $(C/I)_{aggregate}$ value is less than that resulting from the supporting Appendix **30B** assignment(s) with a tolerance of 0.25 dB (inclusive of the 0.05 dB computational precision), except for an allotment in the Plan, an assignment stemming from the conversion of an allotment into an assignment without modification, or when the modification is within the envelope characteristics of the initial allotment, as well as assignments relating to application of Article 7 of Appendix **30B** for which the 0.05 dB computational precision is applicable.

18 In the event of a favourable finding under §§ 16 and 17, the Bureau shall enter the proposed assignment in the Appendix **30B** ESIM List and publish in a special section of the BR IFIC the characteristics of the assignment received under § 11, together with the names of administrations with which the provisions of this procedure have been successfully applied.

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[7] Similar course of action as prescribed in footnote 7*bis* of § 6.21 of Article 6 of Appendix **30B** applies.

19 When the examination under § 16 or § 17 leads to an unfavourable finding with respect to allotments in the Plan, conversion of an allotment into an assignment without modification or with a modification which is within the envelope characteristics of the initial allotment, an Article 7 request transferred to Article 6, or a submission in accordance with Resolution **170 (Rev.WRC-23)**, the Bureau shall return the notice to the notifying administration. In this case, the notifying administration undertakes not to bring into use the frequency assignments until the finding with respect to allotments in the Plan, conversion of an allotment into an assignment without modification or with a modification which is within the envelope characteristics of the initial allotment, an Article 7 request transferred to Article 6, or a submission in accordance with Resolution **170 (Rev.WRC-23)**, is favourable. The Bureau, in returning the notice to the notifying administration, shall indicate that the subsequent resubmission under § 11 will be considered with a new date of receipt.

20 When the examination under § 16 or § 17 leads to a favourable finding with respect to allotments in the Plan, conversion of an allotment into an assignment without modification or with a modification which is within the envelope characteristics of the initial allotment, an Article 7 request transferred to Article 6, a submission in accordance with Resolution **170 (Rev.WRC-23)**, but an unfavourable finding with respect to others, and if the notifying administration insists that the proposed assignment be included in the Appendix **30B** ESIM List, the Bureau shall enter the assignment provisionally in the Appendix **30B** ESIM List with an indication of those administrations whose assignments were the basis of the unfavourable finding. To this effect, the notifying administration shall include a signed commitment, indicating that the use of an assignment provisionally recorded in the Appendix **30B** ESIM List shall not cause unacceptable interference to, or claim protection from, those assignments for which agreement still needs to be obtained. The entry in the Appendix **30B** ESIM List shall be changed from provisional to definitive only if the Bureau is informed that all required agreements have been obtained.

21 Should the assignments that were the basis of the unfavourable finding not be brought into use within the period specified in § 6.1 of Article 6 of Appendix **30B** or within the extension period under § 6.31*bis* of Article 6 of Appendix **30B**, the status of the assignment in the Appendix **30B** ESIM List shall be reviewed accordingly.

22 Should unacceptable interference be caused by an assignment entered in the Appendix **30B** ESIM List under § 20 to any assignment in the List which was the basis of the disagreement, the notifying administration of the assignment entered in the Appendix **30B** ESIM List under § 20 shall, upon receipt of advice thereof, immediately eliminate this unacceptable interference.

23 For the examinations referred to in Part I and Part II, the Bureau shall generate a set of uplink grid points everywhere within the service area of the relevant assignments to A-ESIMs and M-ESIMs, assuming that A-ESIMs and M-ESIMs are located at these uplink grid points.

Section B – Procedure for notification and recording in the Master International Frequency Register of assignments to earth stations in motion on aircraft and vessels dealt with under this Resolution

1 Any assignment in the ESIM List for which the relevant procedure of Section A and Part II of this Annex has been successfully applied shall be notified to the Bureau using the relevant characteristics listed in Appendix **4**, not earlier than three years before the assignment is brought into use.

2 If the first notice referred to in § 1 has not been received by the Bureau within the required period mentioned in § 1 of Section A, the assignments in the Appendix **30B** ESIM List shall be cancelled by the Bureau after having informed the administration at least three months before the expiry of this period.

3 Notices not containing those characteristics specified in Appendix **4** as mandatory or required shall be returned with comments to help the notifying administration to complete and resubmit them, unless the information not provided is immediately forthcoming in response to an inquiry by the Bureau.

4 Complete notices shall be marked by the Bureau with their date of receipt and shall be examined in the order of their dates of receipt. Following receipt of a complete notice, the Bureau shall, as soon as possible after the date of entry of the corresponding assignment into the Appendix **30B** ESIM List or within not more than two months if the corresponding assignment has already been entered in the Appendix **30B** ESIM List, publish its contents, with any diagrams and maps and the date of receipt, in the BR IFIC, which shall constitute the acknowledgement to the notifying administration of receipt of its notice. When the Bureau is not in a position to comply with the time-limit referred to above, it shall periodically so inform the administrations, giving the reasons therefor.

5 The Bureau shall not postpone the formulation of a finding on a complete notice unless it lacks sufficient data to reach a conclusion thereon.

6 Each notice shall be examined:

6.1 with respect to its conformity with the Table of Frequency Allocations and other provisions[8] of the Radio Regulations, except those provisions relating to conformity with the FSS Plan and the procedures for coordination, which are the subject of the following subparagraph; and

[8] The "other provisions" shall be identified and included in the Rules of Procedure.

6.2 with respect to its conformity with the FSS Plan, the procedures for coordination and the associated provisions[9].

7 When the examination with respect to § 6.1 leads to a favourable finding, the assignment shall be examined further with respect to § 6.2; otherwise, the notice shall be returned with an indication of the appropriate action.

8 When the examination with respect to § 6.2 leads to a favourable finding, the ESIM assignment shall be recorded in the MIFR. When the finding is unfavourable, the notice shall be returned to the notifying administration, with an indication of the appropriate action.

9 In every case when a new ESIM assignment is recorded in the MIFR it shall, in accordance with the provisions of this Resolution, include an indication of the finding reflecting the status of the assignment. This information shall also be published in the BR IFIC.

10 A notice of a change in the characteristics of the ESIM assignment already recorded, as specified in Appendix **4**, shall be examined by the Bureau under §§ 6.1 and 6.2, as appropriate. Any changes to the characteristics of an assignment that has been recorded and confirmed as having been brought into use shall be brought into use within eight years from the date of the notification of the modification. Any changes to the characteristics of an assignment that has been recorded but not yet brought into use shall be brought into use within the period provided for in § 1 of Section A.

11 In applying the provisions of this Section, any resubmitted notice which is received by the Bureau more than six months after the date on which the original notice was returned by the Bureau shall be considered to be a new notice.

12 All frequency assignments notified in advance of their being brought into use shall be entered provisionally in the MIFR. Any frequency assignment provisionally recorded under this provision shall be brought into use no later than the end of the period provided for in § 1 of Section A. Unless the Bureau has been informed by the notifying administration of the bringing into use of the assignment, it shall, no later than 15 days before the end of the regulatory period established under § 1 of Section A, send a reminder requesting confirmation that the assignment has been brought into use within the regulatory period. If the Bureau does not receive that confirmation within 30 days following the period provided for under § 1 of Section A, it shall cancel the entry in the MIFR and the corresponding assignment in the Appendix **30B** ESIM List.

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[9] When an administration notifies any assignment with characteristics different from those entered in the Appendix **30B** ESIM List through successful application of the relevant procedure of Section A and Part II of this Annex, the Bureau shall undertake calculations to determine if the proposed new characteristics increase the interference level caused to other allotments in the Plan, assignments in the List, an assignment for which the Bureau has received complete information in accordance with § 6.1 of Article 6 of Appendix **30B** before the date of receipt of this notification, assignments in the Appendix **30B** ESIM List and an assignment for which the Bureau has received complete information in accordance with § 1 of Section A before the date of receipt of this notification. The increase of the interference due to characteristics different from those entered in the Appendix **30B** ESIM List will be checked by comparing the *C*/*I* ratios of these other allotments and assignments, which result from the use of the proposed new characteristics of the subject assignment on the one hand, and those obtained with the characteristics of the subject assignment in the Appendix **30B** ESIM List, on the other hand. This *C*/*I* calculation is performed under the same technical assumptions and conditions.

13 When the Bureau has received confirmation that the assignment in the Appendix **30B** ESIM List has been brought into use, the Bureau shall make that information available on the ITU website as soon as possible and shall publish it in the BR IFIC.

14 Wherever the use of a frequency assignment in the Appendix **30B** ESIM List is suspended for a period exceeding six months, the notifying administration shall inform the Bureau of the date on which such use was suspended. When that assignment is brought back into use, the notifying administration shall so inform the Bureau, as soon as possible. On receipt of the information sent under this provision, the Bureau shall make that information available on the ITU website as soon as possible and shall publish it in the BR IFIC. The date on which the assignment is brought back into use shall be no later than three years from the date on which the use of the frequency assignment was suspended, provided that the notifying administration informs the Bureau of the suspension within six months from the date on which the use was suspended. If the notifying administration informs the Bureau of the suspension more than six months after the date on which the use of the frequency assignment was suspended, this three-year time period shall be reduced. In this case, the amount by which the three-year period shall be reduced shall be equal to the amount of time that has elapsed between the end of the six-month period and the date that the Bureau is informed of the suspension. If the notifying administration informs the Bureau of the suspension more than 21 months after the date on which the use of the frequency assignment was suspended, the frequency assignment shall be removed from the MIFR and the Appendix **30B** ESIM List.

15 If the supporting Appendix **30B** assignment(s) is removed from the List, the corresponding ESIM assignment shall also be removed from the Appendix **30B** ESIM List and the MIFR, as appropriate.

PART II

Procedure to be followed by administrations and the Bureau for examination and protection of one earth station in motion (ESIM) with respect to other ESIMs

1 In the publication of the special section referred to in § 6 of Section A, the Bureau shall also include the names of the affected administrations, the corresponding assignments in the Appendix **30B** ESIM List and assignments for which the Bureau has previously received complete information in accordance with § 1 of Section A and which it has examined under § 5 of Section A, as appropriate.

2 In determining administrations whose assignments in the Appendix **30B** ESIM List or assignments for which the Bureau has previously received complete information in accordance with § 1 of Section A and which it has examined under § 5 of Section A are considered as being affected, the Bureau shall apply the principle of Annex 4 to Appendix **30B** and the following criteria:

a) orbital spacing as specified in § 1.2 of Annex 4;

b) Earth-to-space single-entry carrier-to-interference as specified in § 2.1 of Annex 4 or Earth-to-space single-entry carrier-to-interference (C/I) derived from the supporting Appendix **30B** assignment(s), whichever is the lowest;

c) the Earth-to-space power flux-density as specified in § 2.2 of Annex 4.

3 An administration that has not notified its comments either to the administration seeking agreement or to the Bureau within a period of four months following the date of the BR IFIC referred to in § 6 of Section A shall be deemed to have agreed to the proposed assignment. This time-limit shall be extended for an administration that has requested the assistance of the Bureau by up to 30 days following the date on which the Bureau communicated the result of its action.

4 Unless coordination is no longer required, taking into account the final characteristics of the notice in § 11 of Section A, should harmful interference be caused by an assignment included in Appendix **30B** ESIM List to any assignment in Appendix **30B** ESIM List identified in § 1 for which agreement has not been obtained, the notifying administration shall, upon receipt of advice thereof, immediately eliminate this harmful interference.

ANNEX 2 TO RESOLUTION 121 (WRC-23)

Provisions for earth stations in motion on aircraft and vessels to protect terrestrial services in the frequency band 12.75-13.25 GHz

1 The parts below contain provisions to ensure that earth stations in motion on aircraft (A-ESIMs) and earth stations in motion on vessels (M-ESIMs) do not cause unacceptable interference to terrestrial service operations when A-ESIMs and M-ESIMs operate in frequency bands overlapping with those used at any time by terrestrial services to which the frequency band 12.75-13.25 GHz is allocated and operating in accordance with the Radio Regulations (see also *resolves* 1.2 of this Resolution).

PART I

M-ESIMs

2 The notifying administration for the geostationary-satellite (GSO) network in the fixed-satellite service (FSS) with which an M-ESIM communicates shall ensure compliance of the M-ESIM operating within the frequency band 12.75-13.25 GHz, or parts thereof, with both of the following conditions for the protection of terrestrial services to which the frequency band is allocated within a coastal State:

2.1 The minimum distance from the low-water mark as officially recognized by the coastal State beyond which an M-ESIM can operate without the prior agreement of any administration is 158 km in the frequency band 12.75-13.25 GHz. Any transmissions from an M-ESIM within the minimum distance shall be subject to the prior agreement of the coastal State concerned.

2.2 The maximum M-ESIM equivalent isotropically radiated power (e.i.r.p.) spectral density towards the horizon shall be limited to 12.5 dB(W/MHz). Transmissions from an M-ESIM with higher e.i.r.p. spectral density levels towards the territory of any coastal State shall be subject to the prior agreement of the coastal State concerned.

PART II

A-ESIMs

3 The notifying administration of the GSO FSS satellite network with which an A-ESIM communicates shall ensure compliance of the A-ESIM operating within the frequency band 12.75-13.25 GHz, or parts thereof, with all of the following conditions for the protection of terrestrial services to which the frequency band is allocated:

POWER FLUX-DENSITY MASK

3.1 When within line-of-sight of the territory of an administration, and above an altitude of 3 km, the maximum power flux-density (pfd) produced at the surface of the Earth on the territory of an administration by emissions from a single A-ESIM shall not exceed:

$$\text{pfd}(\theta) = -112 \quad \text{dB(W/(m}^2 \cdot \text{14 MHz))} \quad \text{for} \quad \theta \leq 5°$$

$$\text{pfd}(\theta) = -117 + \theta \quad \text{dB(W/(m}^2 \cdot \text{14 MHz))} \quad \text{for} \quad 5° < \theta \leq 40°$$

$$\text{pfd}(\theta) = -77 \quad \text{dB(W/(m}^2 \cdot \text{14 MHz))} \quad \text{for} \quad 40° < \theta \leq 90°$$

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizon).

3.2 When within line-of-sight of the territory of an administration, and up to an altitude of 3 km, the maximum pfd produced at the surface of the Earth on the territory of an administration by emissions from a single A-ESIM shall not exceed:

$$\text{pfd}(\theta) = -123.5 \quad \text{dB(W/(m}^2 \cdot \text{MHz))} \quad \text{for} \quad \theta \leq 5°$$

$$\text{pfd}(\theta) = -128.5 + \theta \quad \text{dB(W/(m}^2 \cdot \text{MHz))} \quad \text{for} \quad 5° < \theta \leq 40°$$

$$\text{pfd}(\theta) = -88.5 \quad \text{dB(W/(m}^2 \cdot \text{MHz))} \quad \text{for} \quad 40° < \theta \leq 90°$$

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizon).

4 The maximum power in the out-of-band domain should be attenuated below the maximum output power of the A-ESIM transmitter as described in the most recent version of Recommendation ITU-R SM.1541.

5 Higher pfd levels than those provided for in §§ 3.1 and 3.2 above, produced by an A-ESIM at any point on the surface of the Earth within the territory of another administration, shall be subject to the prior agreement of that administration (see also *resolves* 1.2.5 of this Resolution).

ANNEX 3 TO RESOLUTION 121 (WRC-23)

Provisions for earth stations in motion on aircraft and vessels to protect non-geostationary-satellite systems in the fixed-satellite service in the frequency band 12.75-13.25 GHz

1 In order to protect the non-geostationary-satellite (non-GSO) systems in the fixed-satellite service (FSS) referred to in *resolves* 1.1.6 of this Resolution in the frequency band 12.75-13.25 GHz, earth stations in motion on aircraft (A-ESIMs) and earth stations in motion on vessels (M-ESIMs) communicating with geostationary-satellite (GSO) FSS satellite networks shall not exceed the following operational limits:

a) on-axis equivalent isotropically radiated power (e.i.r.p.) density of 49 dB(W/1 MHz) for a GSO A-ESIM and M-ESIM with an antenna maximum gain lower than 38.5 dBi;

b) on-axis e.i.r.p. density of 54 dB(W/1 MHz) for a GSO A-ESIM and M-ESIM with an antenna maximum gain equal to or greater than 38.5 dBi but lower than 45 dBi;

c) on-axis e.i.r.p. density of 57.5 dB(W/1 MHz) for a GSO A-ESIM and M-ESIM with an antenna maximum gain equal to or greater than 45 dBi;

d) e.i.r.p. density for any off-axis angle φ which is 3° or more off the main-lobe axis of a GSO A-ESIM and M-ESIM antenna and outside 3° of the GSO arc:

Off-axis angle	*Maximum e.i.r.p. density*	
$3° \leq \varphi \leq 31.6°$	$37 - 25 \log\varphi$	dB(W/40 kHz)
$31.6° < \varphi \leq 180°$	-0.5	dB(W/40 kHz)

2 The above levels are operational and are not examined by the Radiocommunication Bureau.

ANNEX 4 TO RESOLUTION 121 (WRC-23)

Methodology for examining the compliance of earth stations in motion on aircraft communicating with geostationary space stations in the fixed-satellite service in the frequency band 12.75-13.25 GHz with the set of power flux-density limits pre-established in Part II of Annex 2 to this Resolution at the Earth's surface

1 Overview

The methodology below is a functional description of how to conduct an examination of earth stations in motion on aircraft (A-ESIMs) operating with geostationary-satellite (GSO) networks and their conformity with the power flux-density (pfd) limits specified in Part II of Annex 2 to this Resolution.

2 A-ESIM parameters required for examination

To conduct the relevant examination of an A-ESIM and its conformity with respect to the pfd limits, the following parameters are required:

– satellite network name;

– GSO satellite longitude;

– GSO service area latitude bounds;

– GSO service area longitude bounds;

– A-ESIM peak antenna gain;

– A-ESIM minimum elevation;

– A-ESIM power density and bandwidth as given in Table 1; and

– fuselage attenuation mask expressed as a function of the angle below the horizon of the A-ESIM.

3 Examination methodology

3.1 Introduction

An A-ESIM can operate at different locations defined by latitude, longitude and altitude. This methodology determines the maximum allowable power P_j for an A-ESIM transmitter communicating with a GSO satellite network in the fixed-satellite service (FSS) to ensure compliance with the pre-established pfd limits to protect terrestrial services, at all positions, for a defined set of altitude ranges. The methodology derives P_j, taking into account the relevant loss and attenuation in the geometry considered.

The methodology then compares the computed P_j with the range of notified power for the A-ESIM emission. The minimum and maximum power values for emissions from the A-ESIM, $P_{\mathrm{min}_emission,j}$ and $P_{\mathrm{max}_emission,j}$, are calculated from the data included in the Appendix **4** notification information for the GSO satellite network with which the A-ESIM communicates and from the A-ESIM characteristics.

A-ESIMs are evaluated over a number of predefined altitude ranges in order to establish a number of P_j levels.

An examination by the Radiocommunication Bureau should apply this methodology for the defined altitude range, to determine whether an A-ESIM operating under a given GSO satellite network complies with the pre-established pfd limits to protect terrestrial services.

3.2 Parameters and geometry

Considering a hypothetical GSO FSS network, Table 1 below provides an example of emissions that are included in one group transmitting in the frequency band 12.75-13.25 GHz. Tables 2 to 4 provide additional assumptions and Figure 1 illustrates the geometry involved in the examination.

TABLE 1

Example of a group of A-ESIM emissions (with reference to relevant Appendix 4 data fields)

Emission No.	C.7.a Designation of emission	$BW_{emission}$ MHz	C.8.a.3 Minimum power density dB(W/Hz)	C.8.a.2 Maximum power density dB(W/Hz)
1	6M00G7W--	6.0	−69.7	−66.0

TABLE 2

Additional example assumptions

ID	Parameter	Notation	Value	Unit
1	Frequency assignment	f	13	GHz
2	Reference bandwidth of pfd mask	BW_{Ref}	1.0 or 14.0, depending on the altitude under examination	MHz
3	A-ESIM antenna peak gain	G_{max}	36	dBi
4	A-ESIM antenna gain pattern	-	As per Rec. ITU-R S.580 (see C.10.d.5.a)	

TABLE 3

Additional assumptions defined in the methodology

ID	Parameter	Notation	Value	Unit
1	A-ESIM minimum elevation angle towards GSO satellite	ε	Appendix **4**, C.10.d.10	degrees
2	Atmospheric attenuation	L_{atm}	Computed with Rec. ITU-R P.676 (see NOTE below)	dB
3	Angle of arrival of the incident wave on the Earth's surface	δ	Specified in the pre-established sets of pfd limits, variable from 0° to 90°	degrees
4	Minimum examination altitude	H_{min}	0.01	km
5	Maximum examination altitude	H_{max}	15.0	km
6	Examination altitude spacing[1]	H_{step}	1.0	km
7	Fuselage attenuation	L_f	Use Table 4 if no ITU-R Recommendation provided in Appendix **4**, C.10.d.11	dB

[1] The fourth altitude value (H_4) computed in accordance with this H_{step} is adjusted to 2.99 km to facilitate the examination of compliance with the two sets of predefined pfd values indicated in Table 5A and Table 5B.

NOTE: The atmospheric attenuation is computed using the most recent version of Recommendation ITU-R P.676, with the mean annual global reference atmosphere as defined in the most recent version of Recommendation ITU-R P.835.

FIGURE 1

Geometry for examination of compliance for two different A-ESIM altitudes

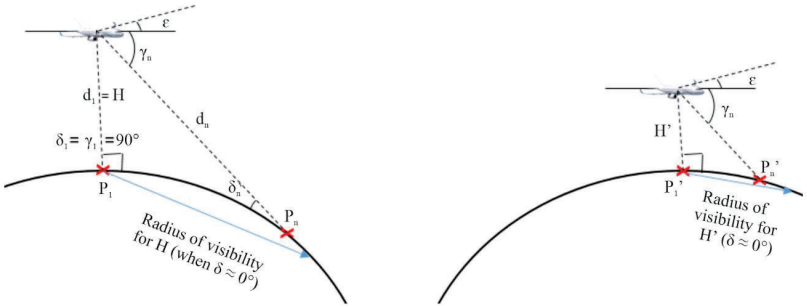


TABLE 4

Fuselage attenuation model based on Report ITU-R M.2221-0

$L_{fuse}(\gamma) = 3.5 + 0.25 \cdot \gamma$	dB	for	$0° \leq \gamma \leq 10°$
$L_{fuse}(\gamma) = -2 + 0.79 \cdot \gamma$	dB	for	$10° < \gamma \leq 34°$
$L_{fuse}(\gamma) = 3.75 + 0.625 \cdot \gamma$	dB	for	$34° < \gamma \leq 50°$
$L_{fuse}(\gamma) = 35$	dB	for	$50° < \gamma \leq 90°$

Notes:

– This fuselage attenuation model is based on measurements made at 14.2 GHz (see Fig. 3.6-14 in Report ITU-R M.2221-0).

– Table 5A and Table 5B are taken from Part II of Annex 2 to this Resolution. The reference bandwidth for the sets of pfd limits included in Table 5A and Table 5B are 1 MHz and 14 MHz, respectively.

TABLE 5A

Required conformance pfd mask for altitudes up to 3 km

$pfd(\theta) = -123.5$	$dB(W/(m^2 \cdot MHz))$	for	$\theta \leq 5°$
$pfd(\theta) = -128.5 + \theta$	$dB(W/(m^2 \cdot MHz))$	for	$5° < \theta \leq 40°$
$pfd(\theta) = -88.5$	$dB(W/(m^2 \cdot MHz))$	for	$40° < \theta \leq 90°$

TABLE 5B

Required conformance pfd mask for altitudes above 3 km

$pfd(\theta) = -112$	$dB(W/(m^2 \cdot 14\ MHz))$	for	$\theta \leq 5°$
$pfd(\theta) = -117 + \theta$	$dB(W/(m^2 \cdot 14\ MHz))$	for	$5° < \theta \leq 40°$
$pfd(\theta) = -77$	$dB(W/(m^2 \cdot 14\ MHz)$	for	$40° < \theta \leq 90°$

3.3 Calculation algorithm

This section includes a step-by-step description of how the examination methodology would be implemented.

START

i) For each A-ESIM altitude, it is necessary to generate as many δ_n angles (angle of arrival of the incident wave) as required in order to test full compliance with the applicable set of pfd limits. The N angles δ_n must be between 0° and 90° and have a resolution compatible with the granularity of the pre-established pfd limits. Each of the N angles δ_n will correspond to as many N points on the ground.

ii) For each altitude $H_j = H_{min}$, $H_{min} + H_{step}$, …, H_{max}:

a) set the altitude of the *A-ESIM* to H_j

b) compute the angles below the horizon $\gamma_{j,n}$ as seen from the A-ESIM for each of the N angles δ_n generated in i) using the following equation:

$$\gamma_{j,n} = \arccos\left(\frac{R_e \cdot \cos(\delta_n)}{(R_e + H_j)}\right) \tag{1}$$

where R_e is the mean earth radius.

c) Compute the distance $D_{j,n}$, in km, for $n = 1, \ldots, N$ between the A-ESIM and the tested point on the ground:

$$D_{j,n} = \sqrt{R_e^2 + (R_e + H_j)^2 - 2R_e(R_e + H_j)\cos(\gamma_n - \delta_n)} \tag{2}$$

d) Compute the fuselage attenuation $L_{f\,j,n}$ (dB) with $n = 1, \ldots, N$ applicable to each of the angles $\gamma_{j,n}$ computed in *b)* above.

e) Compute the gaseous absorption $L_{atm\,j,n}$ (dB) with $n = 1, \ldots, N$ applicable to each of the distances $D_{j,n}$, computed in *c)* above, using the applicable sections of the most recent version of Recommendation ITU-R P.676.

iii) *a)* For each altitude $H_j = H_{min}$, $H_{min} + H_{step}$, …, H_{max}, and each angle below the horizon $\gamma_{j,n}$, compute the maximum emission power in the reference bandwidth $P_{j,n}(\delta_n, \gamma_{j,n})$ for which the pfd limits are met using the following algorithm:

$$P_{j,n}(\delta_n, \gamma_{j,n}) = pdf(\delta_n) + 10\log_{10}\left(4\pi\left(D_{j,n} \cdot 1000\right)^2\right) + L_{f\,j,n} + L_{atm\,j,n} - Gtx(\gamma_{j,n} + \varepsilon)$$

with $Gtx(\gamma_{j,n} + \varepsilon)$ being the transmit antenna gain with the off-axis angle from the boresight, consisting of the summation of both angles $\gamma_{j,n}$ and minimum elevation angle ε as defined in Table 3.

b) Compute the minimum Pj across all values calculated at the previous step:

$$P_j = \mathrm{Min}\left(P_{j,n}(\delta_n, \gamma_{j,n})\right)$$

The output of this step is the maximum power in the reference bandwidth that can be used by the A-ESIM to ensure it complies with the pfd limits indicated in Table 5A or Table 5B, as applicable, with respect to all angles δ_n at the altitude H_j, and the elevation indicated in Table 3. There will be one P_j for each of the H_j altitudes considered.

The output of step *b)* is summarized in Table 6 below:

TABLE 6

Computed P_j values

H_j (Altitude) (km)	P_j (Maximum power in the reference bandwidth that can be used at minimum elevation) dB(W/BW)
0.01	*TBD*
1.0	*TBD*
2.0	*TBD*
2.99	*TBD*
4.0	*TBD*
5.0	*TBD*
6.0	*TBD*
7.0	*TBD*
8.0	*TBD*
9.0	*TBD*
10.0	*TBD*
11.0	*TBD*
12.0	*TBD*
13.0	*TBD*
14.0	*TBD*
15.0	*TBD*

c) For each altitude $H_j = H_{min}, H_{min} + H_{step}, \ldots, H_{max}$, and each emission in each group of emissions under examination, compute the minimum and the maximum powers of the emission in the reference bandwidth:

$$P_{\min_emission,j} = minimum\ power\ density\left(emission, dBW/Hz\right) + 10 * \log_{10}\left(BW\right)$$

$$P_{\max_emission,j} = maximum\ power\ density\left(emission, dBW/Hz\right) + 10 * \log_{10}\left(BW\right)$$

BW in Hz is:

BW_{Ref} if BW_{Ref} =1 MHz

BW_{Ref} if BW_{Ref} =14 MHz and $BW_{emission} \geq BW_{Ref}$

$BW_{emission}$ if BW_{Ref} =14 MHz and $BW_{emission} < BW_{Ref}$

The methodology assumes that only one emission within the reference bandwidth of 14 MHz is transmitted by A-ESIM.

d) For each emission in each group of emissions under examination, check if there is at least one altitude H_j for which:

$$P_{\max_emission,j} > P_j > P_{\min_emission,j}$$

The results of this check are illustrated in Table 7 below.

TABLE 7

Example comparison between P_j and ($P_{\min_emission,j}$; $P_{\max_emission,j}$)

Emission No.	C.7.a Designation of emission	$BW_{emission}$ MHz	C.8.a.3 Minimum power density dB(W/Hz)	C.8.a.2 Maximum power density dB(W/Hz)	Lowest altitude H_j(km) for which $P_{\max_emission,j} > P_j > P_{\min_emission,j}$
1	6M00G7W--	6.0	−69.7	−66.0	TBD

e) Based on the test detailed in iii) *d)* above applied to all emissions in the group under examination, the results of the Bureau's examination for that group is favourable, after removing emissions that have failed the examination; otherwise, it is unfavourable (i.e. all emissions have failed).

iv) The output of this methodology should, at a minimum, include:

– the resulting parameters as contained in Table 6;

– the examination results for each group;

– for those cases when some emissions successfully pass and some do not, the examination results for the resulting new group that includes only the emission(s) which successfully passed the examination.

END

ANNEX 5 TO RESOLUTION 121 (WRC-23)

Required capabilities of earth stations in motion communicating with geostationary-satellite networks (in accordance with *resolves* 10.1 of this Resolution)

This Annex provides the minimum requirements for earth stations in motion (ESIMs) communicating with geostationary-satellite (GSO) networks subject to this Resolution, as shown in Table 8 below.

TABLE 8

GSO ESIM minimum requirements

Requirement	Associated provision(s)
Ability to monitor and control pointing of main beam in direction of satellite with which ESIM communicates	*Resolves* 10.2
Geolocation capability	*Resolves* 10.4
Ability of ESIM to receive information and execute commands from network control and monitoring centre (NCMC)	*Resolves* 10.3 *Resolves* 10.4
Ability to send information to NCMC	*Resolves* 10.4
Ability to monitor and control transmission power and frequency	*Resolves* 10.4
Ability to enable/disable ESIM transmission	*Resolves* 10.3

RESOLUTION 122 (REV.WRC-19)

Use of the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz by high-altitude platform stations in the fixed service

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that the frequency band 47.2-50.2 GHz is allocated to the fixed service, the mobile service and the fixed-satellite service (FSS) on a co-primary basis;

b) that WRC-97 made provision for the operation of high-altitude platform stations (HAPS), also known as stratospheric repeaters, within the fixed service in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz;

c) that establishing a stable technical and regulatory environment will promote the use of all co-primary services in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz;

d) that Recommendation ITU-R F.1500 contains the characteristics of systems in the fixed service using HAPS in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz;

e) that, while the decision to deploy HAPS can be taken on a national basis, such deployment may affect the territory of other administrations and operators of co-primary services;

f) that the ITU Radiocommunication Sector (ITU-R) has completed studies dealing with sharing between systems using HAPS in the fixed service and other types of systems in the fixed service in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz;

g) that ITU-R has conducted studies dealing with compatibility between systems using HAPS and existing services in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz, leading to Report ITU-R F.2476;

h) that No. **5.552** urges administrations to take all practicable steps to reserve FSS use of the frequency band 47.2-49.2 GHz for feeder links for the broadcasting-satellite service (BSS) operating in the frequency band 40.5-42.5 GHz, and that ITU-R studies indicate that HAPS in the fixed service may share with such feeder links;

i) that the technical characteristics of expected BSS feeder links and FSS gateway-type stations are similar;

j) that ITU-R has updated studies on sharing between HAPS ground stations in the fixed service and the FSS, noting the negligible contribution to interference from HAPS stations to FSS space receivers,

recognizing

a) that Recommendation ITU-R SF.1843 provides information on the feasibility of HAPS systems in the fixed service sharing with the FSS;

b) that ITU-R studies have established specific power flux-density (pfd) values to be met at international borders to facilitate sharing conditions for HAPS with other types of fixed-service systems in a neighbouring country;

c) that FSS networks and systems with earth station antenna diameters of 2.5 metres or larger operating as a gateway-type station are capable of sharing with HAPS ground stations;

d) that, during periods of rain, the equivalent isotropically radiated power (e.i.r.p.) of the beam of the HAPS system suffering rain fade may be increased by a level commensurate with the level of rain fade, by up to 20 dB above the e.i.r.p. under clear-sky conditions indicated in Appendix **4**,

resolves

1 that to facilitate sharing with the FSS (Earth-to-space), the maximum transmit e.i.r.p. density of a HAPS ground station shall not exceed the following levels under clear-sky conditions:

6.4	dB(W/MHz)	for	$30° < \theta \leq 90°$
22.57	dB(W/MHz)	for	$15° < \theta \leq 30°$
28	dB(W/MHz)	for	$5° < \theta \leq 15°$

where θ is the HAPS ground station elevation angle in degrees (angle of arrival above the horizontal plane);

2 that the ground station antenna patterns of HAPS operating in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz shall meet the following antenna beam patterns:

$$G(\varphi) = G_{max} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda} \varphi \right)^2 \quad \text{for} \quad 0° < \varphi < \varphi_m$$

$$G(\varphi) = 39 - 5 \log (D/\lambda) - 25 \log \varphi \quad \text{for} \quad \varphi_m \leq \varphi < 48°$$

$$G(\varphi) = -3 - 5 \log (D/\lambda) \quad \text{for} \quad 48° \leq \varphi \leq 180°$$

where:

G_{max}: maximum antenna gain (dBi)

$G(\varphi)$: gain (dBi) relative to an isotropic antenna

φ : off-axis angle (degrees)

D: antenna diameter
λ: wavelength
} expressed in the same units

$$\varphi_m = \frac{20\,\lambda}{D} \sqrt{G_{\max} - G_1} \text{ degrees}$$

G_1: gain of the first side lobe

$= 2 + 15 \log (D/\lambda)$ (dBi);

3 that, for the purpose of protecting fixed-service systems in the territory of other administrations in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz, the pfd level per HAPS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limits, developed for clear-sky conditions, unless the explicit agreement of the affected administration is provided at the time of notification of HAPS:

−141	dB(W/(m^2 · MHz))	for	$0° \leq \theta < 3°$
−141 + 2(θ − 3)	dB(W/(m^2 · MHz))	for	$3° \leq \theta \leq 13°$
−121	dB(W/(m^2 · MHz))	for	$13° < \theta \leq 90°$

where θ is the angle of the arrival of the incident wave above the horizontal plane, in degrees;

4 that, for the purpose of protecting mobile-service systems in the territory of other administrations in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz, the pfd level per HAPS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limits, developed for clear-sky conditions, unless the explicit agreement of the affected administration is provided at the time of notification of HAPS:

−106	dB(W/(m^2 · MHz))	for	$0° \leq \theta \leq 4°$
−106 + 1.2 (θ – 4)	dB(W/(m^2 · MHz))	for	$4° < \theta \leq 11.5°$
−97	dB(W/(m^2 · MHz))	for	$11.5° < \theta \leq 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees.

The limits above take into account the 3 dB aggregate loss due to polarization mismatch, and body loss was not taken into account;

5 that, to protect radio astronomy stations operating in the frequency band 48.94-49.04 GHz from unwanted emissions of HAPS operating in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz, the separation distance between the radio astronomy station and the nadir of a HAPS platform shall exceed 50 km;

6 that administrations planning to implement a HAPS system in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz shall notify the frequency assignments by submitting all mandatory elements of Appendix **4** to the Radiocommunication Bureau for the examination of compliance with respect to this Resolution with a view to their registration in the Master International Frequency Register,

instructs the Director of the Radiocommunication Bureau

to take all necessary measures to implement this Resolution.

RESOLUTION 123 (WRC-23)

Use of the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz and 19.7-20.2 GHz (space-to-Earth) and 27.5-29.1 GHz and 29.5-30 GHz (Earth-to-space) by aeronautical and maritime earth stations in motion communicating with non-geostationary space stations in the fixed-satellite service

The World Radiocommunication Conference (Dubai, 2023),

recalling

the Preamble to the ITU Constitution,

considering

a) that there is some interest in global broadband satellite communications, and that some of this need could be met by allowing aeronautical and maritime earth stations in motion (A-ESIMs and M-ESIMs, respectively) to communicate with non-geostationary-satellite (non-GSO) fixed-satellite service (FSS) systems operating in the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz and 19.7-20.2 GHz (space-to-Earth), and 27.5-29.1 GHz and 29.5-30 GHz (Earth-to-space);

b) that the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz and 19.7-20.2 GHz (space-to-Earth) and 27.5-29.1 GHz and 29.5-30 GHz (Earth-to-space) are allocated to space services, and that the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz, and 27.5-29.1 GHz are allocated to terrestrial services on a primary basis worldwide;

c) that, in the countries identified in No. **5.524**, the frequency band 19.7-20.2 GHz is allocated to the fixed and mobile services on a primary basis; and that, in the countries identified in No. **5.542**, the frequency band 29.5-30 GHz is allocated to the fixed and mobile services on a secondary basis;

d) that the frequency bands in *considering a)* above are used by a variety of different systems and that these existing services and their future development need to be protected without being adversely affected by the operation of non- GSO earth stations in motion (ESIMs)[1];

e) that the frequency band 18.6-18.8 GHz is allocated to the Earth exploration-satellite service (EESS) (passive) and space research service (SRS) (passive) and that these services need to be protected from the operation of those systems with which non-GSO ESIMs communicate;

f) that there is no regulatory procedure in the Radio Regulations for the coordination of non-GSO ESIMs relating to terrestrial assignments pertaining to a station of these services;

[1] Throughout this Resolution, aeronautical and maritime non-GSO ESIMs are referred to as non-GSO A-ESIMs and non-GSO M-ESIMs, respectively.

g) that regulatory procedures and interference management mechanisms, including necessary mitigation measures, are required for the operation of non-GSO ESIMs to protect other space and terrestrial services to which the frequency bands referred to in *considering a)* are allocated,

considering further

a) that there is no publicly available information on the conditions stipulated in coordination agreements reached among administrations with respect to non-GSO FSS satellite systems;

b) that, in order to enable sharing between transmitting non-GSO ESIMs and its terrestrial services, an administration intending to authorize the operation of non-GSO ESIMs on the territory under its jurisdiction, including territorial waters and national airspace, may consider adopting interference management procedures and/or mitigation measures different from those contained in this Resolution, as long as the provisions of this Resolution apply with respect to any other administration;

c) that the service area of the non-GSO FSS systems with which non-GSO ESIMs communicate may cover territories under the jurisdiction of multiple administrations;

d) that this Resolution in no way establishes or addresses any technical or regulatory provisions for the operation and use of land non-GSO ESIMs communicating with non-GSO FSS systems, and that any authorization of land non-GSO ESIMs is outside the scope of this Resolution (see *recalling* above),

recognizing

a) that an administration authorizing non-GSO ESIMs on the territory under its jurisdiction, including territorial waters and national airspace, has the right to require that the non-GSO ESIMs referred to above use only those assignments associated with non-GSO FSS systems that have been successfully coordinated, notified, brought into use and recorded in the Master International Frequency Register (MIFR) with a favourable finding under Articles **9** and **11**, including No. **11.31**, **11.32** or **11.32A**, where applicable, with the exception of No. **11.41**;

b) that, where assignments to non-GSO FSS systems recorded under No. **11.41** will be used for the operation of non-GSO ESIMs in the frequency bands 17.8-18.6 GHz and 19.7-20.2 GHz (space-to-Earth) and 27.5-28.6 GHz and 29.5-30 GHz (Earth-to-space), such assignments may be used for non-GSO FSS ESIMs only in accordance with No. **11.42**;

c) that for cases of incomplete coordination under No. **9.7B** of the non-GSO FSS system with which non-GSO ESIMs communicate, the operation of non-GSO ESIMs in the frequency bands 17.8-18.6 GHz and 19.7-20.2 GHz (space-to-Earth) needs to be in accordance with the provisions of No. **11.42** with respect to any recorded frequency assignment which was the basis of an unfavourable finding under No. **11.38**;

d) that the provisions of No. **22.2** apply to non-GSO FSS systems with which non-GSO ESIMs operate in the frequency band 17.7-17.8 GHz (space-to-Earth) with respect to geostationary-satellite (GSO) FSS and GSO broadcasting-satellite service (BSS) networks;

e) that, under the provisions of No. **22.2**, in the frequency bands 27.5-28.6 GHz and 29.5-30 GHz (Earth-to-space) non-GSO ESIMs shall not cause unacceptable interference to GSO FSS and BSS networks operating in accordance with the Radio Regulations, and shall not claim protection from them in the frequency bands 17.8-18.6 GHz and 19.7-20.2 GHz (space-to-Earth), and No. **5.43A** does not apply in this case;

f) that a non-GSO FSS system operating in the frequency bands 17.8-18.6 GHz and 19.7-20.2 GHz (space-to-Earth) and 27.5-28.6 GHz and 29.5-30 GHz (Earth-to-space) in compliance with the provisions and equivalent power flux-density (epfd) limits set out in Nos. **22.5C**, **22.5D** and **22.5F** is considered as having fulfilled its obligations under No. **22.2** with respect to not causing unacceptable interference to any GSO network, provided that the operational limits given in Table **22-4B** are also met by the non-GSO FSS system;

g) that the use of the frequency bands 18.8-19.3 GHz (space-to-Earth) and 28.6-29.1 GHz (Earth-to-space) by non-GSO FSS systems is subject to No**. 9.11A** (i.e. the provisions of Nos. **9.12** to **9.16** apply), and No. **22.2** does not apply in this case;

h) that, for the use of the frequency bands 17.8-18.6 GHz and 19.7-20.2 GHz (space-to-Earth) and 27.5-29.1 GHz and 29.5-30 GHz (Earth-to-space) by non-GSO systems, No. **9.12** applies;

i) that, with respect to GSO FSS networks, in the frequency bands 18.8-19.3 GHz (space-to-Earth) and 28.6-29.1 GHz (Earth-to-space) Nos. **9.12A** and **9.13** apply, and No. **22.2** does not apply;

j) that there is no obligation for any administration to authorize any non-GSO ESIMs to operate within the territory under its jurisdiction, including territorial waters and national airspace,

recognizing further

a) that frequency assignments to non-GSO ESIMs need to be notified to the Radiocommunication Bureau;

b) that the notification by different administrations of frequency assignments to be used by the same non-GSO satellite system could create difficulties to identify the responsible administration in case of unacceptable interference;

c) that an administration authorizing the operation of non-GSO ESIMs within the territory under its jurisdiction may modify or withdraw that authorization at any time,

resolves

1 that, before using non-GSO A-ESIMs and non-GSO M-ESIMs in the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz and 19.7-20.2 GHz (space-to-Earth) and 27.5-29.1 GHz and 29.5-30 GHz (Earth-to-space), the notifying administration for the non-GSO FSS system in which the non-GSO ESIM is to be used shall send the Bureau the relevant Appendix **4** notification information relating to the characteristics of the non-GSO ESIM intended to communicate with the non-GSO FSS system, together with a commitment to operate the non-GSO ESIM in conformity with the Radio Regulations, including this Resolution;

1.1 that, upon receipt of the notification information and commitment referred to in *resolves* 1 above, the Bureau shall examine them to check conformity with Article **11**, taking into account *recognizing a)* and *b)*, and with the provisions of this Resolution, and publish the results of its examination in its International Frequency Information Circular (BR IFIC);

2 that the characteristics of non-GSO ESIMs shall remain within the envelope characteristics, including any applicable coordination agreement, of typical earth stations associated with the non-GSO FSS system with which the ESIMs communicate;

3 that, with respect to space services in the frequency bands referred to in *resolves* 1 above, or portions thereof, non-GSO ESIMs shall comply with the following conditions:

3.1 non-GSO ESIMs communicating with space stations of a non-GSO FSS system shall not cause more interference or claim more protection than what is applicable to typical earth stations of that same non-GSO FSS system;

3.2 the notifying administration for the non-GSO FSS system with which a non-GSO ESIM communicates, together with the administration authorizing the use of that non-GSO ESIM within the territory under its jurisdiction, including territorial waters and national airspace, shall ensure that the operation of that ESIM complies with *resolves* 3.1 above and with the coordination agreements for the frequency assignments of the typical earth station of that non-GSO FSS system obtained under the provisions of Article **9**, taking into account *recognizing a)* above;

3.3 taking into account *recognizing f)* above, the notifying administration for the non-GSO FSS system with which ESIMs communicate shall ensure that non-GSO ESIMs comply with the provisions and epfd limits set out in Nos. **22.5C**, **22.5D** and **22.5F**, as well as the operational limits given in Table **22-4B**;

3.4 non-GSO ESIMs shall not claim protection from BSS feeder-link earth stations operating in accordance with the Radio Regulations in the frequency band 17.7-18.4 GHz;

3.5 with respect to the protection of EESS (passive) operating in the frequency band 18.6-18.8 GHz, any non-GSO FSS system with an orbital apogee of less than 20 000 km operating in the frequency bands 18.3-18.6 GHz and 18.8-19.1 GHz with which non-GSO A-ESIMs and/or non-GSO M-ESIMs communicate and for which the complete notification information has been received by the Bureau after 1 January 2025 shall comply with the provisions indicated in Annex 3 to this Resolution;

3.6 for the implementation of *resolves* 3.5 above, the notifying administration for the non-GSO FSS system with which non-GSO ESIMs communicate shall send the Bureau the relevant Appendix **4** notification information, including a commitment that operation shall be in conformity with *resolves* 3.5 above and *further resolves* 1, 2, 3 and 4 below;

3.7 where the operation of the ESIM referred to in *resolves* 1 uses assignments to non-GSO FSS systems recorded under No. **11.41**, such assignments may be used for non-GSO ESIMs only in accordance with No. **11.42**;

3.7.1 for the implementation of *resolves* 3.7 above, the notifying administration for the non-GSO FSS system with which non-GSO ESIMs communicate shall send the Bureau a commitment that operation shall be in conformity with *resolves* 3.7 above and *further resolves* 1, 2, 3 and 4 below;

4 that, with respect to terrestrial services that operate in accordance with the Radio Regulations in the frequency bands referred to in *resolves* 1 above, or portions thereof, non-GSO ESIMs shall comply with the following conditions:

4.1 receiving non-GSO ESIMs in the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz and 19.7-20.2 GHz (see No. **5.524**) shall not claim protection from assignments in the terrestrial services to which those frequency bands are allocated;

4.2 transmitting non-GSO ESIMs in the frequency band 27.5-29.1 GHz shall not cause unacceptable interference to terrestrial services to which the frequency band is allocated, and Annex 1 to this Resolution shall apply;

4.3 transmitting non-GSO ESIMs in the frequency band 29.5-30 GHz shall not adversely affect the operations of terrestrial services to which that frequency band is allocated on a secondary basis, and the limits in Annex 1 to this Resolution shall apply with respect to those administrations mentioned in No. **5.542**;

4.4 the provisions in this Resolution, including Annex 1, set conditions for the purpose of protecting terrestrial services from unacceptable interference from non-GSO A-ESIMs and non-GSO M-ESIMs, in accordance with the provisions included in *resolves* 4.2 and 4.3 above; however, the requirement not to cause unacceptable interference to, or claim protection from, terrestrial services to which the frequency bands are allocated and that are operating in accordance with the Radio Regulations remains valid;

4.5 should an administration authorizing non-GSO A-ESIMs and/or non-GSO M-ESIMs agree to limits less stringent than those contained in Annex 1 to this Resolution within the territory under its jurisdiction, including territorial waters and national airspace, such agreement shall not adversely affect other countries that are not party to that agreement;

5 that the Bureau shall examine, in accordance with the provisions included in *resolves* 4.2 and 4.3 above and with the methodology included in Annex 2 to this Resolution, the characteristics of non-GSO A-ESIMs with respect to conformity with the power flux-density (pfd) limits at the Earth's surface specified in Part 2 of Annex 1 to this Resolution and publish the results of such examination in the BR IFIC;

5.1 should the results of the examination by the Bureau with respect to this Resolution, including *resolves* 5 above, be satisfactory, the assignments in question shall be published in the appropriate special section of the BR IFIC and recorded in the MIFR with a favourable finding; otherwise, the assignments in question shall be returned to the notifying administration with the reasons therefor;

6 that, in the event that unacceptable interference caused by non-GSO A-ESIMs and/or non-GSO M-ESIMs is reported:

6.1 the notifying administration for the non-GSO FSS system with which ESIMs communicate is responsible for eliminating the case of unacceptable interference; consequently, no other administration shall be held responsible for eliminating cases of unacceptable interference (see also *resolves* 6.3 below);

6.1.1 for the implementation of *resolves* 6.1 above, the system shall employ the minimum requirements specified in Annex 4 to this Resolution;

6.2 in the event that there is more than one administration involved in the notification of frequency assignments to the same operating non-GSO satellite system with which ESIMs communicate, those administrations shall nominate one administration as the notifying administration responsible to act on their behalf to eliminate any unacceptable interference cases, and inform the Bureau accordingly;

6.3 any authorizing administration, subject to its explicit agreement and to the extent of its ability, provide any available information that may help eliminate the case of unacceptable interference;

6.4 the administration responsible for the aircraft or vessel on which the ESIM operates shall, when requested, provide the affected administration with a point of contact to assist in identifying the notifying administration for the satellite with which the ESIM communicates, which is responsible for eliminating the case of unacceptable interference (see *resolves* 6.1 and 6.2 above);

7 that the notifying administration for the non-GSO FSS system with which non-GSO ESIMs communicate shall ensure that:

7.1 for the operation of non-GSO ESIMs, techniques are employed to maintain adequate antenna-pointing accuracy towards the associated non-GSO FSS satellite to avoid inadvertently tracking non-GSO satellites other than the associated non-GSO satellite;

7.2 measures are taken so that non-GSO ESIMs are subject to permanent monitoring and control by a network control and monitoring centre (NCMC) in order to comply with the provisions in this Resolution, including the minimum requirements specified in Annex 4;

7.3 measures are taken so that non-GSO A-ESIMs and non-GSO M-ESIMs do not transmit from territory, including territorial waters and national airspace, under the jurisdiction of an administration situated inside the service area of the non-GSO FSS system with which those non-GSO A-ESIMs and non-GSO M-ESIMs communicate that has not authorized their use within its territory;

7.4 non-GSO ESIMs operate only in the territory, including territorial waters and national airspace, under the jurisdiction of administrations from which an authorization has been obtained, taking into account *recognizing further c)*;

7.5 a point of contact is designated and provided in the Appendix **4** submission by the notifying administration for the non-GSO FSS systems with which the non-GSO ESIMs communicate for the purpose of tracing any cases of unacceptable interference from non-GSO ESIMs and to respond immediately to requests from the focal point of the affected administration;

8 that non-GSO ESIMs shall not be used or relied upon for safety-of-life applications;

9 that the application of this Resolution does not provide regulatory status to non-GSO ESIMs different from that derived from the non-GSO FSS system with which they communicate, taking into account the provisions referred to in this Resolution (see *recognizing a)* and *b)*);

10 that any course of action taken under this Resolution has no impact on the original date of receipt of the frequency assignments to space and earth stations of the non-GSO FSS system with which non-GSO ESIMs communicate or on the coordination requirements of that system;

11 that compliance with this Resolution by non-GSO ESIMs does not, in any way whatsoever, release the notifying administration(s) from its/their obligation not to cause unacceptable interference to, or claim protection from, the incumbent services, as referred to in this Resolution;

12 that the operation of non-GSO A-ESIMs and M-ESIMs, including operation of the NCMC, the interference management system, and the mechanism and functioning of switching facilities, is subject to the availability of the ITU-R Recommendation referred to in *invites the ITU Radiocommunication Sector* below; in the meantime, *further resolves* 1, 2 and 3 shall strictly apply;

13 that the operation of non-GSO A-ESIMs and M-ESIMs using frequency assignments recorded under No. **11.41**, including operation of the NCMC, the interference management system, and the mechanism and functioning of switching facilities, is subject to the availability of the ITU-R Recommendation referred to in *invites the ITU Radiocommunication Sector* below, with the understanding that, in the meantime, *further resolves* 1, 2 and 3 strictly apply,

further resolves

1 that the notifying administration for the non-GSO system with which ESIMs communicate, when submitting Appendix **4** information, shall send a firm, objective, actionable, measurable and enforceable commitment that, in the event of unacceptable interference being reported, it undertakes to immediately eliminate the interference or reduce it to an acceptable level;

2 that, in the case of no action being taken with regard to the obligation referred to in *further resolves* 1 above, the Bureau shall send a reminder and request the notifying administration for the non-GSO system with which ESIMs communicate to comply with the requirements referred to in the commitment;

3 that, should the interference persist 30 days after the dispatch date of the above-mentioned reminder, the Bureau shall submit the case to the subsequent meeting of the Radio Regulations Board (RRB) for review and the necessary actions (including suppression of the frequency assignment in question), as appropriate;

4 that, for the implementation of *further resolves* 1 above, the notifying administration responsible for the operation of non-GSO A-ESIMs and non-GSO M-ESIMs shall also be responsible for observing and complying with all relevant regulatory and administrative provisions applicable to the operation of the ESIMs included in this Resolution or contained in the Radio Regulations;

5 that, in accordance with *instructs the Director of the Radiocommunication Bureau* 4 below, any notifying administration for a non-GSO system operating non-GSO A-ESIMs and non-GSO M-ESIMs, upon request by the Bureau regarding cases of unacceptable interference reported by an affected administration, shall provide the Bureau with a list of the administrations that have authorized non-GSO ESIM operations to communicate with that non-GSO FSS system and that are potentially related to a reported case of unacceptable interference,

instructs the Director of the Radiocommunication Bureau

1 to take all necessary actions to facilitate the implementation of this Resolution;

2 to report to future world radiocommunication conferences on any difficulties or inconsistencies encountered in the implementation of this Resolution, in particular with respect to the verification of compliance with the epfd limits specified in Article **22**;

3 not to examine, under No. **11.31**, the conformity of non-GSO FSS systems with the provisions of *resolves* 3.5 of this Resolution with respect to the EESS (passive);

4 in the case of unacceptable interference:

4.1 based on information provided by the affected administration, to request the notifying administrations for non-GSO FSS systems with which non-GSO ESIMs communicate that could potentially be causing unacceptable interference to provide the affected administration promptly with the relevant list of administrations that have authorized non-GSO ESIM operations;

4.2 to provide the affected administration with a list of non-GSO FSS systems potentially related to the reported case of unacceptable interference;

4.3 if a notifying administration fails to provide the information required under *instructs the Director of the Radiocommunication Bureau* 4.1 above within 45 days from the date of dispatch of the Bureau's request as referred to in *instructs the Director of the Radiocommunication Bureau* 4.1, to send the notifying administration a reminder to provide the required list within 15 days from the date of that reminder;

4.4 if a notifying administration fails to provide the required information following the reminder under *instructs the Director of the Radiocommunication Bureau* 4.3 above, and if the affected administration has not confirmed to the Bureau that the case of unacceptable interference has been resolved, to submit the case to the subsequent meeting of the RRB for review and the necessary actions, as appropriate,

invites the ITU Radiocommunication Sector

to study, as a matter of urgency, with the objective of preparing a Recommendation to be adopted and approved in accordance with Resolution ITU-R 1, the functionalities and implementation of NCMCs for ESIMs,

instructs the Secretary-General

1 to bring this Resolution to the attention of the International Maritime Organization and the International Civil Aviation Organization;

2 to bring this Resolution to the attention of the ITU Council with a view to its considering whether cost recovery should be applied to non-GSO A-ESIMs and non-GSO M-ESIMs.

ANNEX 1 TO RESOLUTION 123 (WRC-23)

Provisions for maritime and aeronautical earth stations in motion communicating with non-geostationary-satellite systems to protect terrestrial services operating in the frequency band 27.5-29.1 GHz and for the frequency band 29.5-30 GHz with respect to administrations mentioned in No. 5.542

1 The parts below contain provisions to ensure that maritime and aeronautical earth stations in motion (ESIMs) communicating with non-geostationary-satellite (non-GSO) systems in the fixed-satellite service (FSS) do not cause unacceptable interference at any time in neighbouring countries to terrestrial service operations when such non-GSO ESIMs are operating in frequencies overlapping with those used by terrestrial services to which the frequency band 27.5-29.1 GHz is allocated and operating in accordance with the Radio Regulations. The provisions specified below also apply in the frequency band 29.5-30 GHz with respect to administrations mentioned in No. **5.542** (see *resolves* 4.2 and 4.3).

Part 1: Non-GSO maritime ESIMs

2 The notifying administration for the non-GSO FSS system with which maritime ESIMs (M-ESIMs) communicate shall ensure compliance of the non-GSO M-ESIM operating within the frequency bands, or parts thereof, indicated in § 1 above with the following conditions for the protection of terrestrial services to which the frequency bands are allocated within a coastal State:

2.1 The minimum distance from the low-water mark as officially recognized by the coastal State beyond which non-GSO M-ESIMs can operate without the prior agreement of any administration is 70 km within the frequency bands 27.5-29.1 GHz and 29.5-30 GHz. Any transmissions from non-GSO M-ESIMs within the minimum distance shall be subject to the prior agreement of the coastal State(s) concerned.

2.2 The maximum non-GSO M-ESIM equivalent isotropically radiated power (e.i.r.p.) spectral density towards the territory of any coastal State will be limited to 24.44 dBW in a reference bandwidth of 14 MHz. Transmissions from non-GSO M-ESIMs with higher e.i.r.p. spectral density levels towards the territory of any coastal state shall be subject to the prior agreement of the coastal State(s) concerned.

Part 2: Non-GSO aeronautical ESIMs

3 The notifying administration for the non-GSO FSS system with which a non-GSO aeronautical ESIM (A-ESIM) communicates shall ensure compliance of the non-GSO A-ESIM operating within the frequency bands, or parts thereof, indicated in § 1 above with all of the following conditions for the protection of terrestrial services to which the frequency band is allocated:

3.1 When within line-of-sight of the territory of an administration, and above an altitude of 3 km, the maximum power flux-density (pfd) produced at the surface of the Earth on the territory of an administration by emissions from a single non-GSO A-ESIM shall not exceed:

$pfd(\theta) = -124.7$	$dB(W/(m^2 \cdot 14\,MHz))$	for $0° \leq \theta \leq 0.01°$
$pfd(\theta) = -120.9 + 1.9 \cdot \log\theta$	$dB(W/(m^2 \cdot 14\,MHz))$	for $0.01° < \theta \leq 0.3°$
$pfd(\theta) = -116.2 + 11 \cdot \log\theta$	$dB(W/(m^2 \cdot 14\,MHz))$	for $0.3° < \theta \leq 1°$
$pfd(\theta) = -116.2 + 18 \cdot \log\theta$	$dB(W/(m^2 \cdot 14\,MHz))$	for $1° < \theta \leq 2°$
$pfd(\theta) = -117.9 + 23.7 \cdot \log\theta$	$dB(W/(m^2 \cdot 14\,MHz))$	for $2° < \theta \leq 8°$
$pfd(\theta) = -96.5$	$dB(W/(m^2 \cdot 14\,MHz))$	for $8° < \theta \leq 90.0°$

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizon).

3.2 When within line-of-sight of the territory of an administration, and up to an altitude of 3 km, the maximum pfd produced at the surface of the Earth on the territory of an administration by emissions from a single non-GSO A-ESIM shall not exceed:

$pfd(\theta) = -136.2$	$dB(W/(m^2 \cdot 1\,MHz))$	for $0° \leq \theta \leq 0.01°$
$pfd(\theta) = -132.4 + 1.9 \cdot \log\theta$	$dB(W/(m^2 \cdot 1\,MHz))$	for $0.01° < \theta \leq 0.3°$
$pfd(\theta) = -127.7 + 11 \cdot \log\theta$	$dB(W/(m^2 \cdot 1\,MHz))$	for $0.3° < \theta \leq 1°$
$pfd(\theta) = -127.7 + 18 \cdot \log\theta$	$dB(W/(m^2 \cdot 1\,MHz))$	for $1° < \theta \leq 12.4°$
$pfd(\theta) = -108$	$dB(W/(m^2 \cdot 1\,MHz))$	for $12.4° < \theta \leq 90.0°$

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizon).

3.3 A non-GSO A-ESIM operating within the frequency bands, or parts thereof, indicated in § 1 above within the territory of an administration that has authorized fixed-service and/or mobile-service operation in the same frequency bands shall not transmit in these frequency bands without the prior agreement of that administration (see also *resolves* 4.5).

3.4 The maximum power in the out-of-band domain should be attenuated below the maximum output power of the A-ESIM transmitter as described in the most recent version of Recommendation ITU-R SM.1541.

3.5 Higher pfd levels than those specified in §§ 3.1 and 3.2 above produced by A-ESIMs at the surface of the Earth in an area under the jurisdiction of any administration shall be subject to the prior agreement of that administration (see also *resolves* 4.5).

ANNEX 2 TO RESOLUTION 123 (WRC-23)

Methodology and procedure to examine power flux-density at the Earth's surface produced by aeronautical earth stations in motion communicating with non-geostationary satellites in the fixed-satellite service and conformity with power flux-density limits

1 Overview

The methodology below is a functional description to conduct examination of aeronautical earth stations in motion (A-ESIMs) communicating with non-geostationary satellite (non-GSO) systems and their conformity with the power flux-density (pfd) limits specified in Part 2 of Annex 1 to this Resolution (see *resolves* 5).

2 A-ESIM parameters required for examination

To conduct the relevant examination of A-ESIMs and their conformity with respect to the pfd limits established in Part 2 of Annex 1, the following parameters are required:

– satellite system name;

– A-ESIM peak antenna gain;

– A-ESIM power density and bandwidth as given in Table 1; and

– fuselage attenuation mask expressed as a function of the angle below the horizon of the A-ESIM.

3 Examination methodology

3.1 Introduction

An A-ESIM can operate at different locations defined by latitude, longitude and altitude. This methodology determines the maximum allowable power P_j for an A-ESIM transmitter communicating with a non-GSO satellite system in the fixed-satellite service (FSS) to ensure compliance with the pre-established pfd limits to protect terrestrial services, at all positions, for a defined set of altitude ranges. The methodology derives P_j, taking into account the relevant loss and attenuation in the geometry considered.

The methodology then compares the computed P_j with the range of notified power for the A-ESIM emission. The minimum and maximum power values for emissions from the A-ESIM, $P_{min_emission,j}$ and $P_{max_emission,j}$, are calculated from the data included in the Appendix **4** notification information for the non-GSO FSS system with which the A-ESIM communicates and from the A-ESIM characteristics.

A-ESIMs are evaluated over a number of predefined altitude ranges in order to establish a number of P_j levels.

An examination by the Radiocommunication Bureau should apply this methodology for the defined altitude range to determine whether an A-ESIM operating under a given non-GSO satellite system complies with the pre-established pfd limits to protect terrestrial services.

3.2 Parameters and geometry

Considering a hypothetical non-GSO FSS system, Table 1 below provides an example of emissions that are included in one group associated with the A-ESIM non-GSO FSS class of earth station transmitting in the frequency bands 27.5-29.1 GHz and 29.5-30 GHz. Tables 2 to 4 provide additional assumptions and Figure 1 illustrates the geometry involved in the examination.

TABLE 1

Example of a group of A-ESIM emissions
(with reference to relevant Appendix 4 data fields)

Emission No.	C.7.a Designation of emission	$BW_{emission}$ MHz	C.8.c.3 Minimum power density dB(W/Hz)	C.8.a.2/C.8.b.2 Maximum power density dB(W/Hz)
1	6M00G7W--	6.0	−69.7	−66.0
2	6M00G7W--	6.0	−64.7	−61.0
3	6M00G7W--	6.0	−59.7	−56.0

TABLE 2

Additional example assumptions

ID	Parameter	Notation	Value	Unit
1	Frequency assignment	f	29.1	GHz
2	Reference bandwidth of pfd mask	BW_{Ref}	1.0 or 14.0, depending on the altitude under examination	MHz
3	A-ESIM antenna peak gain	G_{max}	37.5	dBi
4	A-ESIM antenna gain pattern	-	As per Rec. ITU-R S.580 (see C.10.d.5.a)	

TABLE 3

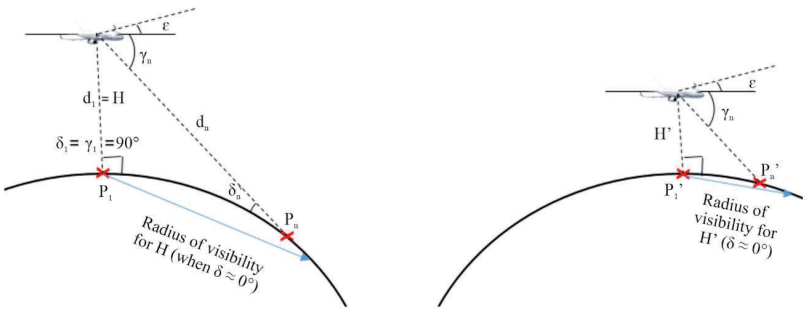
Characteristics defined in the methodology

ID	Parameter	Notation	Value	Unit
1	A-ESIM minimum elevation angle towards non-GSO FSS system	ε	Appendix **4**, data item A.36.a	degrees
2	Atmospheric attenuation	L_{atm}	Computed with Rec. ITU-R P.676 (see NOTE below)	dB
3	Angle of arrival of the incident wave on the Earth's surface	δ	Specified in the pre-established sets of pfd limits in Part 2 of Annex 1, variable from 0° to 90°	degrees
4	Minimum examination altitude	H_{min}	0.01	km
5	Maximum examination altitude	H_{max}	15.0	km
6	Examination altitude spacing[2]	H_{step}	1.0	km
7	Fuselage attenuation	L_f	Use Table 4 if no ITU-R Recommendation provided in Appendix **4** (see data item A.36.b)	dB

NOTE: The atmospheric attenuation is computed using the most recent version of Recommendation ITU-R P.676, with the mean annual global reference atmosphere as defined in the most recent version of Recommendation ITU-R P.835.

FIGURE 1

Geometry for examination of compliance for two different A-ESIM altitudes



[2] The fourth altitude value (H_4) computed in accordance with this H_{step} is adjusted to 2.99 km to facilitate the examination of compliance with the two sets of pfd values indicated in Part 2 of Annex 1 to this Resolution.

TABLE 4

Fuselage attenuation model based on Report ITU-R M.2221-0

$L_{fuse}(\gamma) = 3.5 + 0.25 \cdot \gamma$	dB	for	$0° \leq \gamma \leq 10°$
$L_{fuse}(\gamma) = -2 + 0.79 \cdot \gamma$	dB	for	$10° < \gamma \leq 34°$
$L_{fuse}(\gamma) = 3.75 + 0.625 \cdot \gamma$	dB	for	$34° < \gamma \leq 50°$
$L_{fuse}(\gamma) = 35$	dB	for	$50° < \gamma \leq 90°$

NOTE: This fuselage attenuation model is based on measurements made at 14.2 GHz (see Figure 3.6-14 in Report ITU-R M.2221-0).

3.3 Calculation algorithm

This section includes a step-by-step description of how the examination methodology would be implemented.

START

i) For each A-ESIM altitude, it is necessary to generate as many δ_n angles (angle of arrival of the incident wave) as required in order to test full compliance with the applicable set of pfd limits. The N angles δ_n must be between 0° and 90° and have a resolution compatible with the granularity of the pre-established pfd limits. Each of the N angles δ_n will correspond to as many N points on the ground.

ii) For each altitude $H_j = H_{min}, H_{min} + H_{step}, \ldots, H_{max}$:

a) Set the altitude of the A-ESIM to H_j

b) Compute the angle below the horizon $\gamma_{j,n}$ as seen from the A-ESIM for each of the N angles δ_n generated in i) using the following equation:

$$\gamma_{j,n} = \arccos\left(\frac{R_e \cdot \cos(\delta_n)}{(R_e + H_j)}\right) \tag{1}$$

where R_e is the mean Earth radius.

c) Compute the distance $D_{j,n}$, in km, for $n = 1, \ldots, N$ between the A-ESIM and the tested point on the ground:

$$D_{j,n} = \sqrt{R_e^2 + (R_e + H_j)^2 - 2R_e(R_e + H_j)\cos(\gamma_n - \delta_n)} \tag{2}$$

d) Compute the fuselage attenuation $L_{f\,j,n}$ (dB) with $n = 1, \ldots, N$ applicable to each of the angles $\gamma_{j,n}$ computed in b) above.

e) Compute the gaseous absorption $L_{atm_j,n}$ (dB) with $n = 1, \ldots, N$ applicable to each of the distances $D_{j,n}$ computed in c) above, using the applicable sections of the most recent version of Recommendation ITU-R P.676.

iii)

a) For each altitude $H_j = H_{min}, H_{min} + H_{step}, \ldots, H_{max}$, and each angle below the horizon $\gamma_{j,n}$, compute the maximum emission power in the reference bandwidth $P_{j,n}(\delta_n, \gamma_{j,n})$ for which the pfd limits are met using the following algorithm:

$$P_{j,n}(\delta_n, \gamma_{j,n}) = pfd(\delta_n) + 10\log_{10}\left(4\pi\left(D_{j,n} \cdot 1000\right)^2\right) + L_{f\,j,n} + L_{atm_j,n} - Gtx(\gamma_{j,n} + \varepsilon)$$

With $Gtx(\gamma_{j,n} + \varepsilon)$ being the transmit antenna gain with the off-axis angle from the boresight, consisting of the summation of both angles $\gamma_{j,n}$ and minimum elevation angle ε as defined in Table 3.

b) Compute the minimum P_j across all values calculated at the previous step:

$$P_j = \mathrm{Min}\left(P_{j,n}\left(\delta_n, \gamma_{j,n}\right)\right)$$

The output of this step is the maximum power in the reference bandwidth that can be used by the A-ESIM to ensure it complies with the pfd limits in Part 2 of Annex 1, with respect to all angles δ_n at the altitude H_j, and the elevation indicated in Table 3. There will be one P_j for each of the H_j altitudes considered.

The output of step *b)* is summarized in Table 5 below:

TABLE 5

Computed P_j values

H_j (Altitude) **(km)**	**P_j (Maximum power in the reference bandwidth that can be used at minimum elevation)** **dB(W/BW)**
0.01	*TBD*
1.0	*TBD*
2.0	*TBD*
2.99	*TBD*
4.0	*TBD*
5.0	*TBD*
6.0	*TBD*
7.0	*TBD*
8.0	*TBD*
9.0	*TBD*
10.0	*TBD*
11.0	*TBD*
12.0	*TBD*
13.0	*TBD*
14.0	*TBD*
15.0	*TBD*

c) For each altitude $H_j = H_{min}, H_{min} + H_{step}, \ldots, H_{max}$, and each emission in each group of emissions under examination, compute the minimum and the maximum powers of the emission in the reference bandwidth:

$$P_{\min_emission,j} = minimum\ power\ density(emission, dBW/Hz) + 10 * \log_{10}(BW)$$

$$P_{\max_emission,j} = maximum\ power\ density(emission, dBW/Hz) + 10 * \log_{10}(BW)$$

BW in Hz is:

BW_{Ref} if BW_{Ref} = 1 MHz

BW_{Ref} if BW_{Ref} = 14 MHz and $BW_{emission} \geq BW_{Ref}$

$BW_{emission}$ if BW_{Ref} = 14 MHz and $BW_{emission} < BW_{Ref}$

d) For each emission in each group of emissions under examination check if there is at least one altitude H_j for which:

$$P_{\max_emission,j} > P_j > P_{\min_emission,j}$$

The results of this check are illustrated in Table 6 below:

TABLE 6

Example comparison between P_j and ($P_{\min_emission,j}$; $P_{\max_emission,j}$)

Emission No.	**C.7.a Designation of emission**	**$BW_{emission}$ MHz**	**C.8.c.3 Minimum power density dB(W/Hz)**	**C.8.a.2/C.8.b.2 Maximum power density dB(W/Hz)**	**Lowest altitude H_j (km) for which $P_{\max_emission,j} > P_j > P_{\min_emission,j}$**
1	6M00G7W--	6.0	−69.7	−66.0	*TBD*
2	6M00G7W--	6.0	−64.7	−61.0	*TBD*
3	6M00G7W--	6.0	−59.7	−56.0	*TBD*

e) Based on the test detailed in iii) *d)* above applied to all emissions in the group under examination, the results of the Bureau's examination for that group is favourable, after removing emissions that have failed the examination; otherwise, it is unfavourable (i.e. all emissions have failed).

iv) The output of this methodology should, at a minimum, include:

– the resulting parameters as contained in Table 5;

– the examination results for each group;

– for those cases when some emissions successfully pass and some do not, the examination results for the resulting new group that includes only the emission(s) which successfully passed the examination.

END

ANNEX 3 TO RESOLUTION 123 (WRC-23)

Provisions for non-geostationary-satellite fixed-satellite service systems[3] transmitting to aeronautical and/or maritime earth stations in motion operating in or over an ocean in the frequency bands 18.3-18.6 GHz and 18.8-19.1 GHz with respect to the Earth exploration-satellite service (passive) operating in the frequency band 18.6-18.8 GHz (in accordance with *resolves* 3.5 of this Resolution)

Non-geostationary-satellite (non-GSO) space stations operating with an orbit apogee of more than 2 000 km and less than 20 000 km in the frequency bands 18.3-18.6 GHz and 18.8-19.1 GHz, when communicating with an aeronautical or maritime earth station in motion (A-ESIM and M-ESIM, respectively), shall not exceed a power flux-density (pfd) of −118 dB(W/(m² · 200 MHz)) produced at the surface of the oceans across the 200 MHz of the frequency band 18.6-18.8 GHz.

Non-GSO space stations operating with an orbit apogee less than or equal to 2 000 km in the frequency bands 18.3-18.6 GHz and 18.8-19.1 GHz, when communicating with an A-ESIM or M-ESIM, shall not exceed a pfd of −110 dB(W/(m² · 200 MHz)) produced at the surface of the oceans across the 200 MHz of the frequency band 18.6-18.8 GHz.

ANNEX 4 TO RESOLUTION 123 (WRC-23)

Required capabilities of earth stations in motion communicating with non-geostationary-satellite systems (in accordance with *resolves* 6.1.1 of this Resolution)

This Annex provides the minimum requirements for earth stations in motion (ESIMs) communicating with non-geostationary-satellite (non-GSO) systems subject to this Resolution, as shown in Table A4-1 below.

[3] These provisions do not apply to non-GSO systems using orbits with an apogee less than 2 000 km that employ a frequency reuse factor of at least 3.

TABLE A4-1

Non-GSO ESIM minimum requirements

Requirement	Associated provision(s)
Ability to monitor and control pointing of main beam in direction of satellite with which ESIM communicates	*Resolves* 7.1
Geolocation capability	*Resolves* 7.3 *Resolves* 7.4
Ability of ESIM to receive information and execute commands from network control and monitoring centre (NCMC)	*Resolves* 7.2 *Resolves* 7.3 *Resolves* 7.4
Ability to send information to NCMC	*Resolves* 7.3
Ability to monitor and control transmission power and frequency	*Resolves* 7.3
Ability to enable/disable ESIM transmission	*Resolves* 7.3 *Resolves* 7.4

RESOLUTION 125 (REV.WRC-12)

Frequency sharing in the bands 1 610.6-1 613.8 MHz and 1 660-1 660.5 MHz between the mobile-satellite service and the radio astronomy service

The World Radiocommunication Conference (Geneva, 2012),

with a view

to enabling the mobile-satellite service (MSS) and the radio astronomy service to make the most efficient use of frequency bands allocated to them, having due regard to the other services to which those bands are also allocated,

considering

a) that the bands 1 610.6-1 613.8 MHz and 1 660-1 660.5 MHz are allocated to the radio astronomy service and the MSS (Earth-to-space) on a co-primary basis;

b) that No. **5.372** states that "Harmful interference shall not be caused to stations of the radio astronomy service using the band 1 610.6-1 613.8 MHz by stations of the radiodetermination-satellite and mobile-satellite services (No. **29.13** applies)"; and that Article **29** also points out that emissions from space or airborne stations can be particularly serious sources of interference to the radio astronomy service;

c) that the nature of objects studied by the radio astronomy service in the bands 1 610.6-1 613.8 MHz and 1 660-1 660.5 MHz demands maximum flexibility in the planning of observation frequencies;

d) that, in the bands 1 610.6-1 613.8 MHz and 1 660-1 660.5 MHz, which are shared between the radio astronomy service and the MSS, operational constraints are necessary for MSS mobile earth stations;

e) that a former ITU-R Recommendation relating to sharing between the MSS and the radio astronomy service in the band 1 660-1 660.5 MHz noted that further studies were required, particularly in the areas of propagation models and assumptions used for the determination of separation distances;

f) that Recommendation ITU-R M.1316 may be used in order to facilitate coordination between mobile earth stations and radio astronomy stations in the bands 1 610.6-1 613.8 MHz and 1 660-1 660.5 MHz;

g) that no experience has been gained up to now with the use of the Recommendation mentioned in *considering f)*;

h) that the threshold levels of interference detrimental to the radio astronomy service are given in Recommendation ITU-R RA.769,

resolves

that a future competent conference should evaluate frequency sharing in the bands 1 610.6-1 613.8 MHz and 1 660-1 660.5 MHz between the MSS and the radio astronomy service, based upon the experience gained with the use of ITU-R M.1316 and other relevant ITU-R Recommendations,

invites ITU-R

to continue studies to evaluate the effectiveness of Recommendations aiming to facilitate sharing between the MSS and the radio astronomy service,

instructs the Director of the Radiocommunication Bureau

to provide the results of the studies in the Report of the Director to a future competent conference,

urges administrations

to participate actively in this evaluation.

RESOLUTION 126 (WRC-23)

Temporary regulatory measures in Appendix 30B to improve the reference situation of severely impacted national allotments

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that some national allotments, especially those of developing countries, have low overall aggregate carrier-to-interference values in Appendix **30B**;

b) that implementation of a national allotment with a low overall aggregate carrier-to-interference value could be difficult,

recognizing

a) that the special procedure outlined in this Resolution may be difficult to implement when the territory of the administration responsible for an affected national allotment, deemed to have implicitly agreed to the assignment in the List, is neighbouring the territories included in the service area of that assignment (see § 6.15 of Appendix **30B** of the 2020 version of the Radio Regulations);

b) that Article 44 of the ITU Constitution stipulates that: "In using frequency bands for radio services, Member States shall bear in mind that radio frequencies and any associated orbits, including the geostationary-satellite orbit, are limited natural resources and that they must be used rationally, efficiently and economically, in conformity with the provisions of the Radio Regulations, so that countries or groups of countries may have equitable access to those orbits and frequencies, taking into account the special needs of developing countries and the geographical situation of particular countries";

c) that the administration of an assignment in the List which applied § 6.15 of Appendix **30B** with regard to a national allotment can sign an agreement under § 6.15*quat* of Appendix **30B** (WRC-23),

resolves

1 that the special procedure outlined in this Resolution shall only be applied by administrations of assignments in the List and administrations of national allotments for which § 6.15 of Appendix **30B** of the 2020 version of the Radio Regulations was applied;

2 that, when agreements under § 6.15*quat* of Appendix **30B** are received by the Radiocommunication Bureau in accordance with *recognizing c)*, the Bureau shall immediately apply § 6.15*quin* and § 6.27*bis* of Appendix **30B** (WRC-23) and update the reference situation without reviewing the previous examinations;

3 to request the notifying administrations of assignments for which the procedures of Article 6 of Appendix **30B** have not yet been completed and which have been examined by the Bureau before its application of *resolves* 2 to make their utmost efforts to take into account the new reference situations of national allotments with respect to which the special procedure of this Resolution has been applied when submitting their notice under § 6.17 or § 6.25 of Appendix **30B**,

instructs the Director of the Radiocommunication Bureau

1 to take the necessary actions to implement this Resolution, including drawing the attention of notifying administrations to *resolves* 3 and providing necessary assistance to notifying administrations for the implementation of *resolves* 3;

2 to report to the relevant meetings of the Radio Regulations Board on the efforts undertaken by the notifying administrations in implementing *resolves* 3 for further consideration;

3 to report to a future world radiocommunication conference on the implementation of this Resolution.

RESOLUTION 129 (WRC-23)

Studies on possible revisions of sharing conditions in the frequency band 13.75-14 GHz to allow the use of uplink fixed-satellite service earth stations with smaller antenna sizes

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that WARC-92 added an allocation to the fixed-satellite service (FSS) (Earth-to-space) in the frequency band 13.75-14 GHz;

b) that WRC-03 introduced changes to Nos. **5.502** and **5.503** that made it possible to use earth station antennas in the range of 1.2 to 4.5 metres for the geostationary fixed-satellite service (FSS) networks with limits on power flux-density (pfd) and equivalent isotropically radiated power (e.i.r.p.) density;

c) that WRC-03 did not introduce any changes in Nos. **5.502** and **5.503** in regard to earth stations for non-geostationary-satellite orbit (non-GSO) systems;

d) that there is congestion in the geostationary orbit (GSO);

e) that many new satellite systems are being introduced into non-GSO;

f) that it is necessary to guarantee that orbit and spectrum resources are used efficiently and rationally to facilitate the introduction of new satellite networks;

g) that there is a requirement for more uplink spectrum in the frequency range 13-15 GHz, which could be used worldwide by smaller earth station antennas, to complement the downlink capacity in the frequency range 10-13 GHz;

h) that the frequency band 13.75-14 GHz is allocated worldwide on a primary basis to the radiolocation service (RLS);

i) that the frequency band 13.75-14 GHz is shared with the RLS on the basis of the conditions set forth in No. **5.502**;

j) that the sharing conditions in No. **5.502** impose technical limitations on both the RLS and FSS to balance the operational needs of the two services;

k) that WRC-03 decided that a reduction in the FSS earth station's antenna size required the application of a pfd limit applied at the low-water mark and at national land borders to ensure continued protection of the RLS;

l) that the enhancement of operating conditions of the earth stations in the frequency band 13.75-14 GHz would help to meet the evolving needs of FSS applications and facilitate an efficient and rational use of the Earth-to-space and space-to-Earth frequency bands corresponding to the frequency ranges 13-15 GHz and 10-13 GHz;

m) that space research service (SRS) systems continue to operate in the frequency band 13.75-14 GHz, including on a primary basis under No. **5.503**,

noting

a) that the SRS is allocated to this band on a secondary basis;

b) that the geostationary space stations of the SRS for which the Bureau has received information for advance publication before 31 January 1992 shall be operating on an equal footing with the stations in the FSS; after that date, the new geostationary space stations of the SRS shall operate on a secondary basis;

c) that, until the geostationary space stations of the SRS for which the Bureau has received information for advance publication before 31 January 1992 stop operating in that frequency band, the frequency band 13.77-13.78 GHz shall be shared with the SRS under the conditions set forth in No. **5.503**;

d) that, in the Master International Frequency Register, there is currently only a very limited number of earth stations and satellite networks of the SRS in the frequency band 13.77-13.78 GHz for which advance publication information was received before 31 January 1992;

e) that the usage of the FSS and other services that share this band may have evolved;

f) that the service objectives, geographical areas of operations, and protection requirements of the RLS are described in Recommendation ITU-R M.1644;

g) that, in some countries, the band is also allocated to the fixed service and the mobile service (Nos. **5.499** and **5.500**) and to the radionavigation service (RNS) (No. **5.501**),

recognizing

a) that the possible use of the frequency band 13.75-14 GHz by uplink FSS earth stations with smaller antenna sizes requires studies to support possible regulatory changes while continuing to ensure the protection of the RLS and SRS, as addressed in Nos. **5.502** and **5.503**;

b) that it is necessary to study possible revised coexistence conditions between the primary services that share this band with their current characteristics and applications and uplink FSS earth stations with smaller antenna sizes, in particular noting Nos. **5.502** and **5.503**;

c) that these studies need to take into account that current SRS systems have been developed and operate in the current sharing environment in accordance with Nos. **5.502** and **5.503**, and changes to these regulations may change this sharing environment;

d) that there is a need to ensure the continued operations of the RLS in the frequency band 13.75-14 GHz;

e) that the pfd limits at the low-water mark and at the border of national territories in No. **5.502** are critical to ensure the protection of the RLS;

f) that the power limitations applicable to stations in the RLS and RNS stated in No. **5.502** shall remain unchanged;

g) that frequency assignments to ship and mobile stations of the RLS cannot be notified under No. **11.14**, and as such the coordination procedure as stipulated in Section II of Article **9** cannot apply as a method for resolving interference issues between FSS earth stations and mobile stations of the RLS;

h) that the protection of the RLS in the frequency band 13.75-14 GHz and SRS in the frequency band 13.77-13.78 GHz relies on the application of a combination of FSS antenna size limitation and of pfd limits at the low-water mark and at the border of national territories,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

1 studies on the technical and operational limitations regarding the minimum antenna size and associated power limitations of GSO and non-GSO FSS earth stations in the frequency band 13.75-14 GHz (Earth-to-space), while ensuring the protection of the services stipulated in Nos. **5.502** and **5.503**;

2 studies on possible changes to Nos. **5.502** and **5.503** and possible associated regulatory measures,

invites administrations

to participate actively in the studies and provide the information required for the studies listed under *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* by submitting contributions to the ITU Radiocommunication Sector,

invites the 2027 world radiocommunication conference

to consider, based on the results of the above studies, the minimum antenna size and associated power limitations of GSO and non-GSO FSS earth stations in the frequency band 13.75-14 GHz (Earth-to-space), possible changes to Nos. **5.502** and **5.503**, and consequential regulatory measures.

RESOLUTION 130 (WRC-23)

Studies relating to the use of the frequency band 51.4-52.4 GHz to enable its use by gateway earth stations transmitting to non-geostationary-satellite orbit systems in the fixed-satellite service (Earth-to-space)

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that satellite systems are increasingly being used to deliver broadband services and can help enable universal broadband access;

b) that next-generation fixed-satellite service (FSS) technologies for broadband will increase speeds, with faster rates expected in the near future;

c) that technological developments such as advances in spot-beam technologies and frequency reuse are used by the FSS in frequency bands above 30 GHz to increase the efficient use of spectrum;

d) that fixed-satellite applications in frequency bands above 30 GHz, such as feeder links, may be easier to share with other radiocommunication services than high-density FSS (HDFSS) applications;

e) that the current frequency allocations to the FSS in the frequency band 51.4-52.4 GHz do not enable its use by non-geostationary-satellite orbit (non-GSO) gateway operations, and as such do not meet the expected needs of such systems;

f) that the protection of the Earth exploration-satellite service (EESS) (passive) in the adjacent frequency bands 50.2-50.4 GHz and 52.6-54.25 GHz is vital to weather prediction and disaster management,

recognizing

a) the need to protect existing services when considering frequency bands for possible additional allocations to any service;

b) that the conditions in No. **5.555C** with respect to geostationary-satellite orbit (GSO) networks should not be changed;

c) that the frequency band 51.4-52.4 GHz is allocated to the fixed and mobile services, which will need to be protected, and is available for high-density applications in the fixed service, as indicated in No. **5.547**;

d) that No. **5.340** applies to the frequency bands 50.2-50.4 GHz and 52.6-54.25 GHz;

e) that in the frequency band 51.4-54.25 GHz, radio astronomy observations are carried out under national arrangements, as indicated in No. **5.556**, and that appropriate measures may have to be defined to protect the radio astronomy service;

f) that Report ITU-R S.2461 identifies the spectrum needs in the frequency band 51.4-52.4 GHz for additional FSS spectrum (Earth-to-space) for both GSO networks and non-GSO systems;

g) that the use of the frequency band 51.4-52.4 GHz by the FSS (Earth-to-space) is limited only to GSO networks and associated gateway earth stations with a minimum antenna diameter of 2.4 metres, in accordance with No. **5.555C**, as a result of WRC-19 studies;

h) that, in the frequency band 51.4-52.4 GHz, Resolution **750 (Rev.WRC-19)** applies as indicated in No. **5.338A**;

i) that the frequency band 50.2-50.4 GHz is also allocated to the EESS (passive) with the applicable non-GSO FSS unwanted emission limits provided in Resolution **750 (Rev.WRC-19)**;

j) that the frequency band 52.6-54.25 GHz is allocated to the EESS (passive), which needs to be protected, as indicated in No. **5.340**, through revision of Resolution **750 (Rev.WRC-19)**, with a view to including the non-GSO FSS unwanted emission limit for the frequency band 52.6-54.25 GHz together with possible modification of the GSO FSS unwanted emission limit for the frequency band 52.6-54.25 GHz, subject to the result of the studies, taking into account the aggregation of interference into EESS (passive);

k) that the existing limits for GSO FSS networks to protect EESS (passive) operating in the frequency band 52.6-54.25 GHz established in Resolution **750 (Rev.WRC-19)** continue to apply for those GSO FSS networks that were notified/brought into use before a date to be defined at WRC-27;

l) that Report ITU-R S.2462 contains studies on sharing and compatibility between GSO FSS networks and non-GSO FSS systems in the frequency bands 37.5-42.5 GHz, 47.2-50.2 GHz and 50.4-51.4 GHz;

m) that, although the studies prior to WRC-19 were conducted only for GSO FSS earth stations, as noted in Report ITU-R S.2463, spectrum needs for both GSO and non-GSO FSS earth stations in the frequency band 51.4-52.4 GHz were ultimately identified, as indicated in *recognizing f)*;

n) that the need for additional uplink spectrum in the 50 GHz frequency range for non-GSO FSS gateway earth station use continues,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

1 sharing and compatibility studies with existing services, including in adjacent bands, including protection of the fixed and mobile services, and studies relating to the suitability of revising conditions associated with the primary allocation to the FSS in the frequency band 51.4-52.4 GHz (Earth-to-space) to enable its use by gateway earth stations of non-GSO FSS systems (Earth-to-space), and the relevant regulatory studies;

2 compatibility studies between non-GSO FSS gateway operation in the frequency band 51.4-52.4 GHz and the existing primary passive services operating in the frequency band 52.6-54.25 GHz in order to review and revise Resolution **750 (Rev.WRC-19)** to protect the EESS (passive), considering the aggregated interference from GSO gateway earth stations and non-GSO FSS gateway earth stations and taking into account that the existing limits for GSO FSS networks to protect the EESS (passive) operating in the frequency band 52.6-54.25 GHz established in Resolution **750 (Rev.WRC-19)** continue to apply for those GSO FSS networks that were notified/brought into use before a date to be defined at WRC-27;

3 studies on sharing and compatibility between non-GSO FSS gateway operation in the frequency band 51.4-52.4 GHz and the radio astronomy observations carried out in the frequency band 51.4-54.25 GHz in conformity with No. **5.556**, in order to determine the conditions to ensure the protection of these observations;

4 studies regarding the protection of GSO FSS space stations from the emissions of non-GSO FSS gateway earth stations, including possible associated regulatory actions and possible inclusion of the frequency band 51.4-52.4 GHz in the scope of Resolutions **769 (WRC-19)** and **770 (Rev.WRC-23)**,

invites administrations

to participate actively in the studies and provide the information required for the studies listed under *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* by submitting contributions to the ITU Radiocommunication Sector (ITU-R),

invites the 2027 world radiocommunication conference

to consider, based on the results of the ITU-R studies, the possible revision of the conditions related to allocations to the FSS in the frequency band 51.4-52.4 GHz to enable its use by non-GSO FSS gateway earth stations on a primary basis and any other related regulatory provisions.

RESOLUTION 131 (WRC-23)

Consideration of technical and regulatory measures for fixed-satellite service satellite networks/systems in the frequency bands 37.5-42.5 GHz (space-to-Earth), 42.5-43.5 GHz (Earth-to-space), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space) for equitable access to these frequency bands

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that, in the frequency ranges at 4/6/10/11/12/13/14/17/20/30/40/50 GHz, there are allocations to the fixed-satellite service (FSS) and/or broadcasting-satellite service (BSS) on a primary basis;

b) that a portion of radio-frequency spectrum in the frequency ranges at 4/6/10/11/12/13/14/17 GHz has been used to develop planned space services as contained in Appendices **30**, **30A** and **30B**;

c) the additional regulatory measures for the enhancement of equitable access are included in Resolution **553 (Rev.WRC-23)** in the BSS in the frequency band 21.4-22 GHz in Regions 1 and 3;

d) that all countries have equal rights with respect to the use of both the radio frequencies allocated to various space radiocommunication services and geostationary-satellite orbits (GSO) and non-geostationary-satellite orbits (non-GSO) for these services in accordance with the Radio Regulations;

e) that, accordingly, a country or a group of countries having satellite filings in the FSS in the frequency ranges at 30/40/50 GHz can take practical measures to facilitate the use of new space systems by other countries or groups of countries;

f) that the Plenipotentiary Conference 2022 adopted Resolution 219 (Bucharest, 2022), on sustainability of the radio-frequency spectrum and associated satellite-orbit resources used by space services;

g) that No. **5.550B**, which identifies the 37-43.5 GHz band for IMT, notes that potential deployment of FSS earth stations within the frequency range 37.5-42.5 GHz and high-density applications in the FSS in the frequency bands 39.5-40 GHz in Region 1, 40-40.5 GHz in all Regions and 40.5-42 GHz in Region 2 (see No. **5.516B**); administrations should further take into account potential constraints to IMT in these frequency bands, as appropriate,

considering further

that planning for FSS networks, as was done in the Appendices **30**, **30A** and **30B** in the C- and Ku-bands, resulted in undesired consequences such as a lack of flexibility to adapt to new technologies, and that lessons learned should be taken into account in the consideration of the frequency bands 37.5-42.5 GHz (space-to-Earth), 42.5-43.5 GHz (Earth-to-space), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space) for equitable access,

recognizing

a) that Articles 12 and 44 of the ITU Constitution lay down the basic principles for the use of the radio-frequency spectrum and the GSO and non-GSO systems, taking into account the needs of developing countries;

b) that the "first-come, first-served" concept in Articles **9** and **11** can result in difficulties for future access to limited spectrum and orbits resources for later filed systems;

c) the relative disadvantage for developing countries in coordination negotiations due to reasons such as a lack of resources and expertise;

d) that Resolution **2** **(Rev.WRC-03)** resolves that "the registration with the Radiocommunication Bureau of frequency assignments for space radiocommunication services and their use do not provide any permanent priority for any individual country or groups of countries and do not create an obstacle to the establishment of space systems by other countries";

e) that Resolution ITU-R 74 resolves to continue activities in the scope of the ITU Radiocommunication Sector (ITU-R) with a focus on equitable, efficient and economical use of the radio-frequency spectrum taking into account the special needs of developing countries,

recognizing further

a) that there is a need to have additional technical and regulatory measures to ensure equitable access to the frequency ranges at 30/40/50 GHz in the FSS;

b) that there are many GSO FSS submissions in the frequency ranges at 30/40/50 GHz, which can prevent access to these frequency bands by developing countries,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

to study the technical and regulatory measures for FSS satellite networks/systems in the frequency bands 37.5-42.5 GHz (space-to-Earth), 42.5-43.5 GHz (Earth-to-space), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space), or portions thereof, for equitable access, while ensuring the protection of existing primary services to which the band is allocated in the same and adjacent bands, taking into account the specific needs of developing countries:

– without adversely affecting those services, specifically the operation of the satellite networks and systems in the bands;

– without changing measures to protect terrestrial services from unacceptable interference,

invites the 2027 world radiocommunication conference

to review the results of the studies in accordance with *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* above and take appropriate action on the usage of the frequency bands 37.5-42.5 GHz (space-to-Earth), 42.5-43.5 GHz (Earth-to-space), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space) for equitable access to these frequency bands by FSS satellite networks/systems,

invites administrations

to participate actively in the studies by submitting contributions to ITU-R.

RESOLUTION 133 (WRC-23)

Study of the possible use of the frequency band 12.75-13.25 GHz by aeronautical and maritime earth stations in motion communicating with non-geostationary space stations in the fixed-satellite service (Earth-to-space)

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the frequency band 12.75-13.25 GHz is currently allocated, on a primary basis, to fixed service, mobile service and fixed-satellite service (FSS) (Earth-to-space) and, on a secondary basis, to the deep-space research service (space-to-Earth) worldwide;

b) that the frequency band 12.75-13.25 GHz is used in the FSS by geostationary-satellite networks (GSO) in conformity with the provisions of Appendix **30B** (No. **5.441**) and that there are GSO satellite networks in the FSS that are operating in this frequency band;

c) that the frequency band 12.75-13.25 GHz is used in the FSS by non-geostationary-satellite (non-GSO) systems in conformity with No. **5.441**;

d) that the demand for aeronautical and maritime connectivity could be partially met by allowing aeronautical earth stations in motion (A-ESIMs) and maritime earth stations in motion (M-ESIMs) to communicate with non-GSO space stations in the FSS in the frequency band 12.75-13.25 GHz (Earth-to-space);

e) that advances in technology, including the use of antenna tracking techniques, allow A-ESIMs and M-ESIMs to operate within the characteristics of fixed earth stations in the FSS;

f) that the use of the frequency band 12.75-13.25 GHz for A-ESIMs and M-ESIMs operating with non-GSO FSS could contribute, as an additional use of the spectrum, to improving broadband communications for passengers;

g) that A-ESIMs and M-ESIMs referred to in the present Resolution are not to be used for safety-of-life applications;

h) that the frequency band 10.6-10.7 GHz is used for the Earth exploration-satellite service (EESS) (passive) in line with Recommendation ITU-R RS.1861;

i) that all emissions are prohibited in the frequency band 10.68-10.7 GHz according to No. **5.340**,

noting

a) that Resolution **156 (Rev.WRC-23)** addresses the use of earth stations in motion (ESIMs) communicating with GSO space stations in the FSS in the frequency bands 19.7-20.2 GHz and 29.5-30.0 GHz;

b) that Resolution **169 (Rev.WRC-23)** addresses the use of ESIMs communicating with GSO space stations in the FSS in the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz;

c) that this conference has adopted Resolution **123 (WRC-23)** which contains the technical operational and regulatory provisions for ESIMs communicating with non-GSO space stations in the FSS in the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz and 19.7-20.2 GHz (space-to-Earth), and the frequency bands 27.5-29.1 GHz and 29.5-30.0 GHz (Earth-to-space);

d) that this conference has adopted Resolution **121 (WRC-23)**, which contains the technical operational and regulatory provisions for the use of A-ESIMs and M-ESIMs communicating with GSO space stations in the FSS in the frequency band 12.75-13.25 GHz;

e) that the use of non-GSO space stations in the FSS may introduce more complicated sharing scenarios,

recognizing

a) that, in conformity with No. **5.441**, non-GSO systems shall not claim protection from GSO networks operating in conformity with the Radio Regulations and shall operate in such a way that any unacceptable interference that might occur due to their operation is immediately eliminated;

b) that, in conformity with No. **5.441**, the use of the frequency band 12.75-13.25 GHz (Earth-to-space) by a non-GSO satellite system in the FSS is subject to the application of the provisions of No. **9.12** for coordination with other non-GSO satellite systems in the FSS;

c) that Article **21** contains the power flux-density limits at the Earth's surface produced by emissions from non-GSO FSS systems in the space-to-Earth direction to protect fixed and mobile services;

d) that Article **22** contains the equivalent power flux-density limits for non-GSO FSS systems in the frequency band 12.75-13.25 GHz (Earth-to-space) that guarantee the protection of GSO networks;

e) that non-GSO FSS systems that operate in the frequency band 12.75-13.25 GHz (Earth-to-space) may also operate in the frequency band 10.7-10.95 GHz (space-to-Earth) in accordance with No. **5.441**;

f) that the potential interference impact from unwanted emissions produced by non-GSO FSS systems communicating with A-ESIMs and M-ESIMs in the frequency band 10.7-10.95 GHz (space-to-Earth) in accordance with No. **5.441**, into passive sensors of the EESS operating in the adjacent frequency band 10.6-10.7 GHz, should be studied to ensure protection of existing and future use of the frequency band by the EESS (passive);

g) that the current use and future development of existing services in the frequency band should be protected from unacceptable interference caused by operation of A-ESIMs and M-ESIMs communicating with non-GSO space stations in the frequency band;

h) that interference management mechanisms, including necessary mitigation measures, are required for the operation of non-GSO ESIMs to protect other space and terrestrial services to which the frequency band referred to in *considering a)* are allocated,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference

1 studies on the technical and operational characteristics of A-ESIMs and M-ESIMs planning to communicate with the non-GSO space stations in the FSS in the frequency band 12.75-13.25 GHz (Earth-to-space);

2 studies on sharing and compatibility between A-ESIMs and M-ESIMs communicating with non-GSO space stations in the FSS and the current and planned stations of existing services with allocations in the frequency band 12.75-13.25 GHz, ensuring that ESIMs will not call for further protection or cause more interference than existing typical earth stations;

3 the development of the technical conditions and regulatory provisions for the operation of A-ESIMs and M-ESIMs communicating with non-GSO space stations in the FSS that operate in the frequency band 12.75-13.25 GHz (Earth-to-space), taking into account the results of the studies outlined in *resolves to invite the ITU Radiocommunication Sector* t*o complete in time for the 2031 world radiocommunication conference* 1 and 2, while ensuring the protection of incumbent services;

4 sharing and compatibility studies for communications between non-GSO space stations in the FSS and ESIMs with respect to the EESS (passive) allocated in the adjacent frequency band referred to in *recognizing f)*;

5 studies on the development of a new Recommendation for the network control and monitoring centre functionality for ESIM operation;

6 studies on the responsibility of the entities involved in the operation of the A-ESIMs and M-ESIMs addressed by this Resolution,

invites administrations

to participate actively in the studies by sending their contributions to the ITU Radiocommunication Sector,

invites the 2031 world radiocommunication conference

to consider the results of the above-mentioned studies and to adopt the necessary measures accordingly.

RESOLUTION 140 (REV.WRC-23)

Measures and studies associated with the equivalent power flux-density (epfd) limits in the frequency band 19.7-20.2 GHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that, after several years of study, WRC-2000 adopted epfd limits in a number of frequency bands to give practical effect to No. **22.2**, in order to facilitate non-geostationary-orbit (non-GSO) systems in the fixed-satellite service (FSS) to operate while still ensuring protection of GSO FSS networks from unacceptable interference;

b) that in Resolution **76 (WRC-2000)**[*], WRC-2000 also adopted aggregate epfd↓ limits in the same frequency bands for the protection of GSO FSS systems;

c) that a small number of systems based on constellations of satellites in highly elliptical orbits (HEOs), in certain FSS bands, have been operating for many years;

d) that since the late 1990s, especially after WRC-2000, there has been a growing interest in HEOs in a number of frequency bands and for several space services, predominantly in the FSS allocations below 30 GHz;

e) that ITU-R studies reported to WRC-03 considered HEO systems to be a sub-category of non-GSO systems and characterized their operational features;

f) that in the period between WRC-2000 and WRC-03, ITU-R developed Recommendations concerning frequency sharing between HEO FSS systems and other systems, including GSO, low Earth orbit (LEO), medium Earth orbit (MEO) and HEO systems;

g) that certain types of HEO system would have difficulty in meeting the long-term portion of epfd↓ limits in force in the frequency band 19.7-20.2 GHz,

noting

a) that, in the long-term portion, the epfd↓ limits in the frequency band 19.7-20.2 GHz are considerably more stringent than those in the 17.8-18.6 GHz frequency band;

b) that Nos. **9.7A** and **9.7B** apply in this frequency band;

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[*] *Note by the Secretariat:* This Resolution was revised by WRC-15 and WRC-23.

c) that the frequency band 19.7-20.2 GHz is one of the few bands identified by WRC-03 on a global basis for high-density applications in the fixed-satellite service;

d) that Recommendation ITU-R S.1715 provides guidelines to protect GSO FSS networks in the frequency band 19.7-20.2 GHz,

resolves to invite administrations

to consider using the relevant ITU-R Recommendations regarding the protection of GSO FSS satellite networks from interference by non-GSO FSS systems as a guideline for consultation between administrations, to fulfil their obligations under No. **22.2** in the frequency band 19.7-20.2 GHz, and in the case where an administration responsible for a non-GSO FSS system requests the application of No. **22.5CA**,

instructs the Radiocommunication Bureau

in cases where an administration responsible for a non-GSO FSS system indicates in its coordination request its wish to apply No. **22.5CA** with respect to the epfd↓ limits in Table **22-1C** in the frequency band 19.7-20.2 GHz but has not yet reached the necessary agreements, to make a qualified favourable finding with respect to this provision. This provisional finding regarding compliance with epfd↓ limits shall be changed to a definitive favourable finding at the notification stage, only if all explicit agreements from administrations for which epfd limits are exceeded are obtained and an indication thereof is provided to the Bureau within two years from the date of receipt of the coordination request. Otherwise, this provisional finding shall be changed to a definitive unfavourable finding.

RESOLUTION 143 (REV.WRC-19)

Guidelines for the implementation of high-density applications in the fixed-satellite service in frequency bands identified for these applications

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that demand has been increasing steadily for global broadband communication services throughout the world, such as those provided by high-density applications in the fixed-satellite service (HDFSS);

b) that HDFSS systems are characterized by flexible, rapid and ubiquitous deployment of large numbers of cost-optimized earth stations employing small antennas and having common technical characteristics;

c) that HDFSS is an advanced broadband communication application concept that will provide access to a wide range of broadband telecommunication applications supported by fixed telecommunication networks (including the Internet), and thus will complement other telecommunication systems;

d) that, as with other fixed-satellite service (FSS) systems, HDFSS offers great potential to establish telecommunication infrastructure rapidly;

e) that HDFSS applications can be provided by satellites of any orbital type;

f) that interference mitigation techniques have been and continue to be studied in the ITU Radiocommunication Sector (ITU-R) to facilitate sharing between HDFSS earth stations and terrestrial services;

g) that, to date, studies have not concluded on the practicability of implementation of interference mitigation techniques for all HDFSS earth stations,

noting

a) that No. **5.516B** identifies frequency bands for HDFSS;

b) that, in some of these frequency bands, the FSS allocations are co-primary with fixed- and mobile-service allocations as well as other services;

c) that this identification does not preclude the use of these frequency bands by other services or by other FSS applications, and does not establish priority in these Radio Regulations among users of the frequency bands;

d) that, in the frequency band 18.6-18.8 GHz, the FSS allocation is co-primary with the Earth exploration-satellite service (EESS) (passive) with the restrictions of Nos. **5.522A** and **5.522B**;

e) that radio astronomy observations are carried out in the frequency band 48.94-49.04 GHz, and that such observations require protection at notified radio astronomy stations;

f) that co-frequency sharing between transmitting HDFSS earth stations and terrestrial services is difficult in the same geographical area;

g) that co-frequency sharing between receiving HDFSS earth stations and terrestrial stations in the same geographical area may be facilitated through the implementation of interference mitigation techniques, if practicable;

h) that many FSS systems with other types of earth stations and characteristics have already been brought into use or are planned to be brought into use in some of the frequency bands identified for HDFSS in No. **5.516B**;

i) that HDFSS stations in these frequency bands are expected to be deployed in large numbers over urban, suburban and rural areas of large geographical extent;

j) that the frequency band 50.2-50.4 GHz, adjacent to the frequency band 48.2-50.2 GHz (Earth-to-space) identified for HDFSS in Region 2, is allocated to the EESS (passive),

recognizing

a) that in cases where FSS earth stations use frequency bands that are shared on a co-primary basis with terrestrial services, the Radio Regulations stipulate that earth stations of the FSS shall be individually notified to the Radiocommunication Bureau when their coordination contours extend into the territory of another administration;

b) that, as a consequence of their general characteristics, it is expected that the coordination of HDFSS earth stations with fixed-service stations on an individual site-by-site basis between administrations will be a difficult and long process;

c) that, to minimize the burden for administrations, simplified coordination procedures and provisions can be agreed by administrations for large numbers of similar HDFSS earth stations associated with a given satellite system;

d) that harmonized worldwide frequency bands for HDFSS would facilitate the implementation of HDFSS, thereby helping to maximize global access and economies of scale,

recognizing further

that HDFSS applications implemented on FSS networks and systems are subject to all provisions of the Radio Regulations applicable to the FSS, such as coordination and notification pursuant to Articles **9** and **11**, including any requirements to coordinate with terrestrial services of other countries, and the provisions of Articles **21** and **22**,

resolves

that administrations which implement HDFSS should consider the following guidelines:

a) make some or all of the frequency bands identified in No. **5.516B** available for HDFSS applications;

b) in making frequency bands available under *resolves a)*, take into account:

– that HDFSS deployment will be simplified in frequency bands that are not shared with terrestrial services;

– in frequency bands shared with terrestrial services, the impact that the further deployment of terrestrial stations would have on the existing and future development of HDFSS, and the further deployment of HDFSS earth stations would have on the existing and future development of terrestrial services;

c) take into account the relevant technical characteristics applicable to HDFSS, as identified by ITU-R Recommendations (e.g. the most recent versions of Recommendations ITU-R S.524, ITU-R S.1594 and ITU-R S.1783);

d) take into account other existing and planned FSS systems, having different characteristics, in frequency bands where HDFSS is implemented in accordance with *resolves a)* above, and the conditions specified in No. **5.516B**,

invites administrations

1 to give due consideration to the benefits of harmonized utilization of the spectrum for HDFSS on a global basis, taking into account the use and planned use of these frequency bands by all other services to which they are allocated, as well as other types of FSS applications;

2 to consider implementing simplified procedures and provisions that facilitate the deployment of HDFSS systems in some or all of the frequency bands identified in No. **5.516B**;

3 when considering the deployment of HDFSS systems in the upper portion of the frequency band 48.2-50.2 GHz, to take into account as appropriate the potential impact such deployment may have on the satellite passive services in the adjacent frequency band 50.2-50.4 GHz, and to participate in ITU-R studies on the compatibility between these services, taking into account No. **5.340**;

4 to consider, given *invites administrations* 3 above, and where practicable, starting the deployment of HDFSS earth stations in the lower part of the frequency band 48.2-50.2 GHz.

RESOLUTION 144 (REV.WRC-15)

Special requirements of geographically small or narrow countries operating earth stations in the fixed-satellite service in the frequency band 13.75-14 GHz

The World Radiocommunication Conference (Geneva, 2015),

considering

a) that WARC-92 made an additional allocation to the fixed-satellite service (FSS) (Earth-to-space) in the frequency band 13.75-14 GHz;

b) that this frequency band is shared with the radiolocation and radionavigation services;

c) that, following a decision by WRC-2000 and the completion of ITU-R studies, WRC-03 reviewed and revised the sharing conditions for the services in this frequency band and adopted new regulations which govern sharing between the FSS, radiolocation and radionavigation services (see No. **5.502)**;

d) that these revised sharing conditions additionally permit the operation of geostationary FSS earth stations in the frequency band 13.75-14 GHz with antennas having diameters between 1.2 m and 4.5 m,

recognizing

a) that these sharing conditions of No. **5.502** will mean that countries which are geographically small or narrow will have significant difficulties deploying geostationary FSS earth stations in this frequency band with antennas having diameters between 1.2 m and 4.5 m;

b) that in order to further facilitate sharing between the FSS and the maritime radiolocation systems operating in the radiolocation service, there may be a need to develop technical and operational methods;

c) that these technical and operational methods may be used to allow a greater deployment of FSS earth stations in the frequency band 13.75-14 GHz in conformity with No. **5.502** while protecting the radiolocation service,

noting

Recommendation ITU-R S.1712 “Methodologies for determining whether an FSS earth station at a given location could transmit in the frequency band 13.75-14 GHz without exceeding the pfd limits in No. **5.502** of the Radio Regulations, and guidelines to mitigate excesses”,

resolves

that the administrations of geographically small or narrow countries may exceed the limitations on FSS earth station power flux-density at the low-water mark in No. **5.502** if such operation is in conformance with bilateral agreements with administrations deploying maritime radiolocation systems in the frequency band 13.75-14 GHz, this being in order to provide due consideration to administrations of geographically small or narrow countries,

encourages

administrations deploying maritime and land mobile radiolocation systems in the frequency band 13.75-14 GHz to rapidly reach bilateral agreements relating to the operation of FSS earth stations in this frequency band with administrations of those geographically small or narrow countries deploying these FSS earth stations, this being in order to provide due consideration to administrations of geographically small or narrow countries.

RESOLUTION 145 (REV.WRC-19)

Use of the frequency band 27.9-28.2 GHz by high-altitude platform stations in the fixed service

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that WRC-97 made provision for the operation of high-altitude platform stations (HAPS), also known as stratospheric repeaters, within a 2 × 300 MHz portion of the fixed-service allocation in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz;

b) that No. **4.23** specifies that transmissions to or from HAPS shall be limited to the frequency bands specifically identified in Article **5**;

c) that, at WRC-2000, several countries in Region 3 and one country in Region 1 expressed a need for a lower frequency band for HAPS due to the excessive rain attenuation that occurs at 47 GHz in these countries;

d) that some countries in Region 2 have also expressed an interest in using a frequency range lower than those referred to in *considering a)*;

e) that, in order to accommodate the need expressed by the countries referred to in *considering c)*, WRC-2000 adopted Nos. **5.537A** and **5.543A**, which were modified at WRC-03 and then again at WRC-07 to permit the use of HAPS in the fixed service in the frequency band 27.9-28.2 GHz and in the frequency band 31-31.3 GHz in certain Region 1 and 3 countries on a non-harmful interference, non-protection basis;

f) that the frequency band 27.9-28.2 GHz is already heavily used or planned to be used by a number of different services and a number of other types of applications in the fixed service;

g) that while the decision to deploy HAPS can be taken on a national basis, such deployment may affect neighbouring administrations, particularly in small countries;

h) that the ITU Radiocommunication Sector (ITU-R) has conducted studies dealing with sharing between systems using HAPS in the fixed service and other types of systems in the fixed service in the frequency band 27.9-28.2 GHz, leading to Recommendation ITU-R F.1609;

i) that results of some ITU-R studies indicate that, in the frequency band 27.9-28.2 GHz, sharing between fixed-service systems using HAPS and other conventional fixed-service systems in the same area will require appropriate interference mitigation techniques to be developed and implemented;

j) that ITU-R has produced Recommendation ITU-R SF.1601 containing methodologies for evaluating interference from fixed-service systems using HAPS into geostationary-satellite systems in the fixed-satellite service in the frequency band 27.9-28.2 GHz;

k) that HAPS technical issues could continue to be studied in order to determine appropriate measures for protecting the fixed service and other co-primary services in the frequency band 27.9-28.2 GHz,

resolves

1 that, notwithstanding No. **4.23**, in Region 2 the use of HAPS within the fixed-service allocations in the frequency band 27.9-28.2 GHz shall not cause harmful interference to, or claim protection from, other stations of services operating in accordance with the Table of Frequency Allocations of Article **5**, and, further, that the development of these other services shall proceed without constraints by HAPS operating pursuant to this Resolution;

2 that any use by HAPS of the fixed-service allocation at 27.9-28.2 GHz pursuant to *resolves* 1 above shall be limited to operation in the HAPS-to-ground direction;

3 that the administrations listed in No. **5.537A** which intend to implement systems using HAPS in the fixed service in the frequency band 27.9-28.2 GHz shall seek explicit agreement of concerned administrations with regard to their stations of primary services to ensure that the conditions in No. **5.537A** are met, and those administrations in Region 2 which intend to implement systems using HAPS in the fixed service in these frequency bands shall seek explicit agreement of concerned administrations with regard to their stations of services operating in accordance with the Table of Frequency Allocations of Article **5** to ensure that the conditions in *resolves* 1 are met;

4 that administrations planning to implement a HAPS system pursuant to *resolves* 1 above shall notify the frequency assignment(s) by submitting all mandatory elements of Appendix **4** to the Radiocommunication Bureau for the examination of compliance with *resolves* 3 above,

invites the ITU Radiocommunication Sector

1 to continue to carry out studies on the appropriate interference mitigation techniques for the situations referred to in *considering i)*;

2 to develop protection criteria for the mobile service having primary allocations in the frequency band 27.9-28.2 GHz from HAPS in the fixed service and include the results of these studies in existing or new ITU-R Reports/Recommendations, as appropriate.

RESOLUTION 147 (WRC-07)

Power flux-density limits for certain systems in the fixed-satellite service using highly-inclined orbits having an apogee altitude greater than 18 000 km and an orbital inclination between 35° and 145° in the band 17.7-19.7 GHz

The World Radiocommunication Conference (Geneva, 2007),

considering

a) that the band 17.7-19.7 GHz is heavily used in many countries for fixed service (FS) applications including mobile communication network infrastructure;

b) that in the band 17.7-19.7 GHz, there are planned or existing non-geostationary (non-GSO) fixed-satellite service (FSS) systems using satellites with highly-inclined orbits having an apogee altitude greater than 18 000 km and an orbital inclination between 35° and 145°;

c) that in this frequency band, ITU-R has conducted studies of the impact on FS stations of the pfd produced or to be produced by non-GSO FSS systems of the types described in *considering b)*;

d) that one of the types of systems referred to in *considering b)* under the ITU filing name USCSID-P, was notified and brought into use under the applicable power flux-density (pfd) levels for the 17.7-19.7 GHz band in Table **21-4**:

-115	dB(W/(m^2 · MHz))	for	$0° \leq \delta < 5°$
$-115 + 0.5(\delta - 5)$	dB(W/(m^2 · MHz))	for	$5° \leq \delta \leq 25°$
-105	dB(W/(m^2 · MHz))	for	$25° < \delta \leq 90°$

where δ is the angle of arrival above the horizontal plane in degrees,

recognizing

1 that studies carried out in ITU-R of the systems described in *considering b)*, demonstrated that the system described in *considering d)* did not cause harmful interference to the fixed service in the 17.7-19.7 GHz band;

2 that one FSS system of the type described in *considering d)* has been operating since 1995 at the −115/−105 dB(W/(m^2 · MHz)) levels and there has been no complaint of harmful interference to any station in the fixed service of any administration,

resolves

that in the band 17.7-19.7 GHz, FSS space stations currently operating in a system of the type described in *considering d)* and for which advance publication information was received by the Radiocommunication Bureau before 5 July 2003, as well as space stations with the same parameters in a future notice for a replacement system, shall continue to be subject to the power flux-density limits:

-115	dB(W/(m^2 · MHz))	for	$0°$	$\leq$	$\delta < 5°$
$-115 + 0.5(\delta - 5)$	dB(W/(m^2 · MHz))	for	$5°$	$\leq$	$\delta \leq 25°$
-105	dB(W/(m^2 · MHz))	for	$25°$	$<$	$\delta \leq 90°$

where δ is the angle of arrival above the horizontal plane in degrees.

RESOLUTION 148 (REV.WRC-15)

Satellite systems formerly listed in Part B of the Plan of Appendix 30B (WARC Orb-88)

The World Radiocommunication Conference (Geneva, 2015),

considering

a) that WARC Orb-88 adopted a Plan for the fixed-satellite service in the frequency bands 4 500-4 800 MHz, 6 725-7 025 MHz, 10.70-10.95 GHz, 11.20-11.45 GHz and 12.75-13.25 GHz contained in Appendix **30B (WARC Orb-88)**;

b) that, when the Plan was adopted, some satellite systems in the same frequency bands were under coordination or had been recorded in the Master International Frequency Register (MIFR), or had information relating to advance publication that was received by the Radiocommunication Bureau before 8 August 1985, and which in all cases were listed in Part B of the Plan at WARC Orb-88;

c) that in the original provisions of Appendix **30B (WARC Orb-88)**, the satellite systems mentioned in *considering b)* above were referred to as "existing systems";

d) that satellite systems identified in *considering b)* have either been included in the List of Appendix **30B** or cancelled, and thus Part B of the Plan is empty;

e) that, therefore, WRC-07 suppressed Part B of the Plan in Appendix **30B**,

recognizing

a) that § 9.2 of Appendix **30B (WARC Orb-88)** indicates that "The existing systems listed in Part B of the Plan may continue in operation for a maximum period of 20 years from the date of entry into force of this Appendix", and consequently the period of operation of satellite systems in Part B of the Plan expires after 16 March 2010;

b) that some administrations expressed their wish to continue operation of these systems after the deadline mentioned in *recognizing a)*;

c) that satellite systems referred to in *considering b)* are compatible with satellite networks in Appendix **30B**,

resolves

that an administration wishing to further extend the notified period of validity of assignments to "existing system(s)" as referred to in *considering c)* shall inform the Bureau accordingly more than three years before the expiry of the notified period of validity and, if the characteristics of that assignment remain unchanged, the Bureau shall amend, as requested, the notified period of validity and publish that information in a special section of the Bureau's International Frequency Information Circular (BR IFIC),

instructs the Radiocommunication Bureau

1 to cancel from the Master Register and the List assignments to "existing system(s)" as referred to in *considering c)* upon expiry of their notified period of validity;

2 to calculate aggregate *C*/*I* of the "existing systems" as referred to in *considering c)* without taking into account the interference between these systems;

3 to take the appropriate actions in accordance with *resolves* above.

RESOLUTION 149 (REV.WRC-12)

Submissions from new Member States of the Union relating to Appendix 30B of the Radio Regulations

The World Radiocommunication Conference (Geneva, 2012),

considering

a) that WARC Orb-88 adopted a Plan for the fixed-satellite service in the frequency bands 4 500-4 800 MHz, 6 725-7 025 MHz, 10.70-10.95 GHz, 11.20-11.45 GHz and 12.75-13.25 GHz as contained in Appendix **30B (WARC Orb-88)**;

b) that WRC-07 revised the Appendix **30B** Plan and the associated regulatory procedures;

c) that WRC-07 decided that the principle of guaranteed access to spectrum resources for all Members of the Union must be maintained and, as a consequence, the highest priority should be given to submissions from countries not having a national allotment in the Plan or an assignment in the List stemming from the conversion of an allotment;

d) that under the regulatory provisions adopted by WARC Orb-88 and revised by subsequent conferences, submissions from Member States not having a national allotment in the Plan or an assignment in the List stemming from the conversion of an allotment are processed in order of receipt together with other submissions,

recognizing

that some countries that have joined, or may join, the Union as a Member State do not have a national allotment or an assignment in the List stemming from the conversion of an allotment,

resolves

1 that an administration of a country which has joined the Union as a Member State and does not have a national allotment in the Plan or an assignment in the List stemming from the conversion of an allotment shall have the right to request the Bureau to exclude its territory from the service area of an allotment or an assignment, whereupon the Bureau shall exclude the territory accordingly without adversely affecting the rest of the service area and subsequently recalculate the new reference situation for the Appendix **30B** Plan and List;

2 to urge administrations[1] to make utmost efforts to accommodate submissions received from new Member States of ITU.

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[1] Those administrations which are the basis of unfavourable findings with respect to submissions from new Member States.

RESOLUTION 150 (WRC-12)

Use of the bands 6 440-6 520 MHz and 6 560-6 640 MHz by gateway links for high-altitude platform stations in the fixed service

The World Radiocommunication Conference (Geneva, 2012),

considering

a) that ITU has among its purposes "to promote the extension of the benefit of the new telecommunication technologies to all the world's inhabitants" (No. 6 of the Constitution);

b) that systems based on new technologies using high-altitude platform stations (HAPS) can potentially be used for various applications such as the provision of high-capacity services to urban and rural areas;

c) that provision has been made in the Radio Regulations for the deployment of HAPS in specific bands, including as base stations to serve IMT networks;

d) that at WRC-07, a need for provision for gateway links to serve HAPS operations was expressed;

e) that WRC-07 invited ITU-R to conduct sharing studies, with a view to identifying two channels of 80 MHz each for gateway links for HAPS in the range from 5 850 to 7 075 MHz, in bands already allocated to the fixed service, while ensuring the protection of existing services;

f) that for the purpose of protecting the operations of the Earth exploration-satellite service (EESS) (passive) in the band 6 425-7 075 MHz, No. **5.458** applies;

g) that for the purpose of protecting the radio astronomy service in the band 6 650-6 675.2 MHz, No. **5.149** applies;

h) that the range 5 850-7 075 MHz is already heavily used or planned to be used by a number of different services and a number of other types of applications in the fixed service;

i) that in order to accommodate the need stated in *considering d)*, WRC-12 adopted No. **5.457** to permit the use of HAPS gateway links in the fixed service in the bands 6 440-6 520 MHz and 6 560-6 640 MHz in the limited number of countries listed in the footnote;

j) that compatibility between HAPS and affected services will largely depend on the number of administrations deploying HAPS and the total number of such systems;

k) that while the deployment of HAPS gateway links in the bands 6 440-6 520 MHz and 6 560-6 640 MHz is taken on a national basis, such deployment would affect other administrations;

l) that Appendix **4** does not contain all the necessary data elements pertaining to HAPS gateway links,

recognizing

a) that ITU-R has studied technical and operational characteristics of HAPS gateway links in the fixed service in the range 5 850-7 075 MHz resulting in Recommendation ITU-R F.1891;

b) that Recommendation ITU-R F.2011 contains a methodology to evaluate interference from HAPS gateway downlinks in the fixed service to conventional fixed wireless systems in the range 5 850-7 075 MHz;

c) that Report ITU-R F.2240 contains the results of interference analyses between HAPS gateway links in the fixed service and other systems/services in the range 5 850-7 075 MHz;

d) that the World Summit on the Information Society has encouraged the development and application of emerging technologies to facilitate infrastructure and network development worldwide with special focus on under-served regions and areas,

resolves

1 that the antenna pattern for both the HAPS platform and the HAPS gateway station in the bands 6 440-6 520 MHz and 6 560-6 640 MHz shall meet the following antenna beam patterns:

$G(\psi) = G_m - 3(\psi/\psi_b)^2$	dBi	for	$0° \leq \psi \leq \psi_1$
$G(\psi) = G_m + L_N$	dBi	for	$\psi_1 < \psi \leq \psi_2$
$G(\psi) = X - 60 \log(\psi)$	dBi	for	$\psi_2 < \psi \leq \psi_3$
$G(\psi) = L_F$	dBi	for	$\psi_3 < \psi \leq 90°$

where:

$G(\psi)$: gain at the angle ψ from the main beam direction (dBi)

G_m: maximum gain in the main lobe (dBi)

ψ_b: one-half of the 3 dB beamwidth in the plane considered (3 dB below G_m) (degrees)

L_N: near side-lobe level (dB) relative to the peak gain required by the system design, and has a maximum value of −25 dB

L_F: far side-lobe level, G_m − 73 dBi.

$$\psi_1 = \psi_b \sqrt{-L_N/3} \quad \text{degrees}$$

$$\psi_2 = 3.745\ \psi_b \quad \text{degrees}$$

$$X = G_m + L_N + 60 \log(\psi_2) \quad \text{dBi}$$

$$\psi_3 = 10^{(X - L_F)/60} \quad \text{degrees}$$

$$\psi_b = \sqrt{7\ 442/(10^{0.1G_m})} \quad \text{degrees;}$$

2 that the maximum angle of deviation of the HAPS airborne antenna from the nadir for gateway links shall be limited to 60 degrees corresponding to the urban area coverage of the HAPS; and the maximum number of gateway stations operating with a single platform shall not exceed 5;

3 that the minimum antenna elevation angle of HAPS gateway stations on the ground shall be 30 degrees;

4 that for the purpose of protecting the fixed satellite service (Earth-to-space), the aggregate pfd of HAPS uplinks shall be limited to a maximum of −183.9 dBW/m^2 in 4 kHz at any point in the geostationary arc. To meet this aggregate pfd criterion, the maximum e.i.r.p. value of a single HAPS gateway link towards the geostationary arc shall not exceed −59.9 dBW/4 kHz in any direction within ±5 degrees of the geostationary arc;

5 that for the purpose of protecting the fixed wireless systems in other administrations in the band 6 440-6 520 MHz, the e.i.r.p. of the HAPS downlink shall be limited to a maximum of −0.5 dBW/10 MHz for all off-axis angles from the nadir to 60 degrees from the nadir;

6 that for the purpose of protecting EESS passive operations over oceans, HAPS gateway stations shall maintain a minimum distance of 100 kilometres for a single HAPS gateway station and 150 kilometres for several HAPS gateway stations from coast lines;

7 that administrations planning to implement HAPS gateway links in the notification to the Bureau of the frequency assignment(s) shall submit all mandatory parameters for the examination by the Bureau for compliance with respect to *resolves* 1 to 6 above, and also the explicit agreement obtained pursuant to No. **5.457**,

invites

administrations to consult with the Director of the Radiocommunication Bureau to determine the data elements of HAPS gateway stations necessary for notification and examination of frequency assignments in accordance with the provisions of Article **11** and Appendix **4**,

instructs the Director of the Radiocommunication Bureau

to implement this Resolution.

RESOLUTION 154 (REV.WRC-15)

Consideration of technical and regulatory actions in order to support existing and future operation of fixed-satellite service earth stations within the frequency band 3 400-4 200 MHz, as an aid to the safe operation of aircraft and reliable distribution of meteorological information in some countries in Region 1

The World Radiocommunication Conference (Geneva, 2015),

considering

a) that the frequency band 3 400-4 200 MHz is allocated worldwide to the fixed-satellite service (FSS) in the space-to-Earth direction and to the fixed service on a primary basis;

b) that the frequency band 3 400-3 600 MHz is allocated on a primary basis to the mobile, except aeronautical mobile, service and identified for International Mobile Telecommunications (IMT) in Region 1 countries as specified in Article **5** of the Radio Regulations;

c) that in Region 1, the allocation to the mobile, except aeronautical mobile, service in the frequency band 3 400-3 600 MHz is subject to technical and regulatory conditions aimed at ensuring compatibility with co-primary services of neighbouring countries;

d) that a number of developing countries rely, to a great extent, on FSS systems using very small aperture terminals (VSAT) in the frequency band 3 400-4 200 MHz for the provision of communications as an aid to safe operation of aircraft and reliable distribution of meteorological information;

e) that, in some cases, where an adequate terrestrial communication infrastructure is not available, VSAT networks referred to in *considering d)* above are the only viable option to augment the communication infrastructure in order to satisfy the overall communications infrastructure requirements of the International Civil Aviation Organization (ICAO) and to ensure distribution of meteorological information under the auspices of the World Meteorological Organization (WMO);

f) that the relevant ITU Radiocommunication Sector (ITU-R) studies showed a potential for interference from fixed wireless access and IMT stations into FSS receiving earth stations at distances from less than one kilometre up to hundreds of kilometres, depending on the parameters and deployment of stations of these services;

g) that WRC-12, taking into account the studies mentioned in *considering f)* above, decided to study technical and regulatory measures to support the FSS earth stations referred to in *considering e)* above,

noting

a) that, by the date of this conference, several cases of harmful interference to the FSS VSATs used for aeronautical safety communications from fixed wireless access or IMT stations were reported;

b) that these reported cases of interference indicated difficulties that some administrations have encountered in the coordination of frequencies between the fixed wireless access or IMT systems and frequency assignments for VSATs used for aeronautical and meteorological purposes;

c) that, in many countries, FSS VSAT earth stations are not subject to individual licensing and not registered as specific stations in their national frequency databases and in the ITU Master International Frequency Register (MIFR) due to the considerable administrative work involved;

d) that knowledge of the location and operational frequencies of VSAT stations used for communications as an aid to the safe operation of aircraft and/or distribution of meteorological information is critically important for ensuring compatibility with applications of other services,

recognizing

a) that ITU-R conducted comprehensive studies of compatibility between FSS on the one hand and fixed wireless access systems and IMT applications on the other hand in the frequency band 3 400-4 200 MHz, and summarized the results of the studies in Recommendation ITU-R SF.1486 as well as Reports ITU-R S.2199, ITU-R M.2109 and ITU-R S.2368;

b) that the Recommendation and Reports identified in *recognizing a)* offer a set of mitigation techniques that could be employed for international coordination and at a national level and to facilitate coexistence of FSS, fixed service and mobile service systems;

c) that Recommendation ITU-R S.1856 contains methodologies for verification of compliance with the relevant power flux-density (pfd) limit set forth in the Radio Regulations,

resolves

1 to recommend that administrations in countries where the frequency band 3 400-3 600 MHz is allocated on a primary basis to the mobile, except aeronautical mobile, service in Region 1 and identified for IMT in Region 1 ensure compliance of IMT stations with the relevant provisions set forth in the Radio Regulations and apply the relevant coordination procedures before bringing these applications into use;

2 to urge administrations in Region 1, when planning and/or licensing fixed point-to-point, fixed wireless access and IMT systems in frequency bands referred to in *considering b)* above, to take into account the protection needs of existing and planned FSS earth stations within the frequency band 3 400-4 200 MHz, as an aid to the safe operation of aircraft and reliable distribution of meteorological information in some countries in Region 1;

3 to invite administrations in Region 1, taking into account the number of earth stations involved for this particular type of usage, to consider the possibility of licensing the FSS earth stations used for communications as an aid to the safe operation of aircraft and/or distribution of meteorological information on an individual basis and registering them in the MIFR as specific earth stations;

4 to encourage administrations in Region 1 to employ the appropriate mitigation techniques described in the ITU-R publications referred to in *recognizing a)* above;

5 to invite administrations to ensure that the application of these technical and regulatory measures to FSS and the mobile service does not limit the use of the frequency band 3 400-4 200 MHz by other existing and planned systems and services in other countries,

instructs the Secretary-General

to bring this Resolution to the attention of ICAO and WMO.

RESOLUTION 155 (REV.WRC-19)

Regulatory provisions related to earth stations on board unmanned aircraft which operate with geostationary-satellite networks in the fixed-satellite service in certain frequency bands not subject to a Plan of Appendices 30, 30A and 30B for the control and non-payload communications of unmanned aircraft systems in non-segregated airspaces*

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that the operation of unmanned aircraft systems (UAS) requires reliable control and non-payload communication (CNPC) links, in particular to relay air traffic control communications and for the remote pilot to control the flight;

b) that satellite networks may be used to provide CNPC links of UAS beyond the line-of-sight, as shown in Annex 1 to this Resolution;

c) that CNPC links between space stations and stations on board unmanned aircraft (UA) are proposed to be operated under this Resolution in the primary fixed-satellite service (FSS) in frequency bands shared with other primary services, including terrestrial services, however that would not preclude the use of other available allocations to accommodate this application,

considering further

that UAS CNPC links relate to the safe operation of UAS and have to comply with certain technical, operational and regulatory requirements,

noting

a) that WRC-15 adopted Resolution **156 (WRC-15)**** on the use of earth stations in motion communicating with geostationary FSS space stations in the frequency bands 19.7-20.2 GHz and 29.5-30.0 GHz;

b) that Report ITU-R M.2171 provides information on characteristics of UAS and spectrum requirements to support their safe operation in non-segregated airspace,

recognizing

a) that the UAS CNPC links will operate in accordance with international standards and recommended practices (SARPs) and procedures established in accordance with the Convention on International Civil Aviation;

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* May also be used consistent with international standards and practices approved by the responsible civil aviation authority.

** *Note by the Secretariat:* This Resolution was revised by WRC-23.

b) that, in this Resolution, conditions are provided for operations of CNPC links without prejudging whether the International Civil Aviation Organization (ICAO) would be able to develop SARPs to ensure safe operation of UAS under these conditions,

resolves

1 that assignments to stations of GSO FSS networks operating in the frequency bands 10.95-11.2 GHz (space-to-Earth), 11.45-11.7 GHz (space-to-Earth), 11.7-12.2 GHz (space-to-Earth) in Region 2, 12.2-12.5 GHz (space-to-Earth) in Region 3, 12.5-12.75 GHz (space-to-Earth) in Regions 1 and 3 and 19.7-20.2 GHz (space-to-Earth), and in the frequency bands 14-14.47 GHz (Earth-to-space) and 29.5-30.0 GHz (Earth-to-space), may be used for UAS CNPC links in non-segregated airspace*, provided that the conditions specified in *resolves* below are met;

2 that earth stations in motion on board UA may communicate with the space station of a GSO FSS network operating in the frequency bands listed in *resolves* 1 above, provided that the class of the earth station in motion on board UA is matched with the class of the space station and that other conditions of this Resolution are met (see also *instructs the Director of the Radiocommunication Bureau* 3 below);

3 that the frequency bands specified in *resolves* 1 shall not be used for the UAS CNPC links before the adoption of the relevant international aeronautical SARPs consistent with Article 37 of the Convention on International Civil Aviation, taking into account *instructs the Director of the Radiocommunication Bureau* 4;

4 that administrations responsible for an FSS network providing UA CNPC links shall apply the relevant provisions of Articles **9** (necessary provisions need to be identified or developed) and **11** for the relevant assignments, including, as appropriate, assignments to the corresponding space station, specific and typical earth station and earth station in motion on board UA, including the request for publication in the International Frequency Information Circular (BR IFIC) of items referred to in *resolves* 2 and the course of actions identified in that *resolves* in order to obtain international rights and recognition as specified in Article **8**;

5 that earth stations of UAS CNPC links shall operate within the notified and recorded technical parameters of the associated satellite network, including specific or typical earth stations of the GSO FSS network(s) as published by the Radiocommunication Bureau (BR);

6 that earth stations of UAS CNPC links shall not cause more interference to, or claim more protection from, other satellite networks and systems than specific or typical earth stations as indicated in *resolves* 5 as published by BR;

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* May also be used consistent with international standards and practices approved by the responsible civil aviation authority.

7 that, in order to apply *resolves* 6 above, administrations responsible for the FSS network to be used for UAS CNPC links shall provide the level of interference for the reference assignments of the network used for CNPC links upon request by an administration authorizing the use of UAS CNPC links within its territory;

8 that earth stations of UAS CNPC links of a particular FSS network shall not cause more interference to, or claim more protection from, stations of terrestrial services than specific or typical earth stations of that FSS network as indicated in *resolves* 5 that have been previously coordinated and/or notified under relevant provisions of Articles **9** and **11**;

9 that the use of assignments of an FSS satellite network for UAS CNPC links shall not constrain other FSS networks during the application of the provisions of Articles **9** and **11**;

10 that the introduction of UAS CNPC links shall not result in additional coordination constraints on terrestrial services under Articles **9** and **11**;

11 that earth stations on board UA shall be designed and operated so as to be able to accept the interference caused by terrestrial services operating in conformity with the Radio Regulations in the frequency bands listed in *resolves* 1 without complaints under Article **15**;

12 that earth stations on board UA shall be designed and operated so as to be able to operate with interference caused by other satellite networks resulting from application of Articles **9** and **11**;

13 that, in order to ensure safety-of-flight operation of UAS, administrations responsible for operating UAS CNPC links shall:

– ensure that the use of UAS CNPC links be in accordance with international SARPs consistent with Article 37 of the Convention on International Civil Aviation;

– take the required measures, consistent with No. **4.10**, to ensure freedom from harmful interference to earth stations on board UA operated in accordance with this Resolution;

– act immediately when their attention is drawn to any such harmful interference, as freedom from harmful interference to UAS CNPC links is imperative to ensure their safe operation, taking into account *resolves* 11;

– use assignments associated with the FSS networks for UAS CNPC links (see Figure 1 in Annex 1), including assignments to space stations, specific or typical earth stations and earth stations on board UA (see *resolves* 2), that have been successfully coordinated under Article **9** (including provisions identified in *resolves* 4) and recorded in the Master International Frequency Register with a favourable finding under Article **11**, including Nos. **11.31**, **11.32** or **11.32A** where applicable, and except those assignments that have not successfully completed coordination procedures under No. **11.32** by applying Appendix **5** § 6.d.i;

– ensure that real-time interference monitoring, estimation and prediction of interference risks and planning solutions for potential interference scenarios are addressed by FSS operators and UAS operators with guidance from aviation authorities;

14 that, unless otherwise agreed between the administrations concerned, UA CNPC earth stations shall not cause harmful interference to terrestrial services of other administrations (see also Annex 2 to this Resolution);

15 that, in order to implement *resolves* 14 above, power flux-density (pfd) hard limits need to be developed for UAS CNPC links; possible examples of such provisional limits to protect the fixed service are provided in Annex 2; subject to agreement between the administrations concerned, that annex may be used for the implementation of this Resolution;

16 that the pfd hard limits provided in Annex 2 shall be reviewed and, if necessary, revised by WRC-23[1];

17 that, in order to protect the radio astronomy service in the frequency band 14.47-14.5 GHz, administrations operating UAS in accordance with this Resolution in the frequency band 14-14.47 GHz within line-of-sight of radio astronomy stations are urged to take all practicable steps to ensure that the emissions from the UA in the frequency band 14.47-14.5 GHz do not exceed the levels and percentage of data loss given in the most recent versions of Recommendations ITU-R RA.769 and ITU-R RA.1513;

18 to consider the progress obtained by ICAO in the process of preparation of SARPs for UAS CNPC links, to review this Resolution at WRC-23, taking into account the results of the implementation of Resolution **156 (WRC-15)***, and to take necessary actions as appropriate;

19 that the ITU Radiocommunication Sector (ITU-R) studies on technical, operational and regulatory aspects in relation to the implementation of this Resolution shall be completed, together with the adoption of relevant ITU-R Recommendations defining the technical characteristics of CNPC links and conditions of sharing with other services,

encourages administrations

1 to provide the relevant information where available in order to facilitate the application of *resolves* 6;

2 to participate actively in the studies referred to in *invites the ITU Radiocommunication Sector* by submitting contributions to ITU-R,

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[1] WRC-19 received a proposal from one regional organization regarding protection of the fixed service using a revised pfd mask as contained in Annex 2 section b). ITU-R is invited, in continuing its study on the implementation of this Resolution, to consider this mask and take necessary action as appropriate.

* *Note by the Secretariat:* This Resolution was revised by WRC-23.

invites the 2023 World Radiocommunication Conference

to consider the results of the above studies referred to in this Resolution with a view to reviewing and, if necessary, revising this Resolution, and take necessary actions, as appropriate,

invites the ITU Radiocommunication Sector

to conduct, as a matter of urgency, relevant studies of technical, operational and regulatory aspects in relation to the implementation of this Resolution[1],

instructs the Director of the Radiocommunication Bureau

1 to examine the relevant part of this Resolution requiring actions to be taken by administrations to implement this Resolution, with a view to sending it to administrations and posting it on the ITU website;

2 to present to subsequent WRCs a progress report relating to the implementation of this Resolution;

3 to define a new class of station in order to be able to process satellite network filings submitted by administrations for earth stations providing UA CNPC links, after the Resolution is implemented, in accordance with this Resolution, and publish the information as referred to in *resolves* 4;

4 not to process satellite network filing submissions by administrations with a new class of a station for earth stations providing UA CNPC links before *resolves* 1-12 and 14-19 of this Resolution are implemented;

5 to report to subsequent WRCs on the progress made by ICAO on the development of SARPs for UAS CNPC links,

instructs the Secretary-General

to bring this Resolution to the attention of the Secretary General of ICAO,

invites the International Civil Aviation Organization

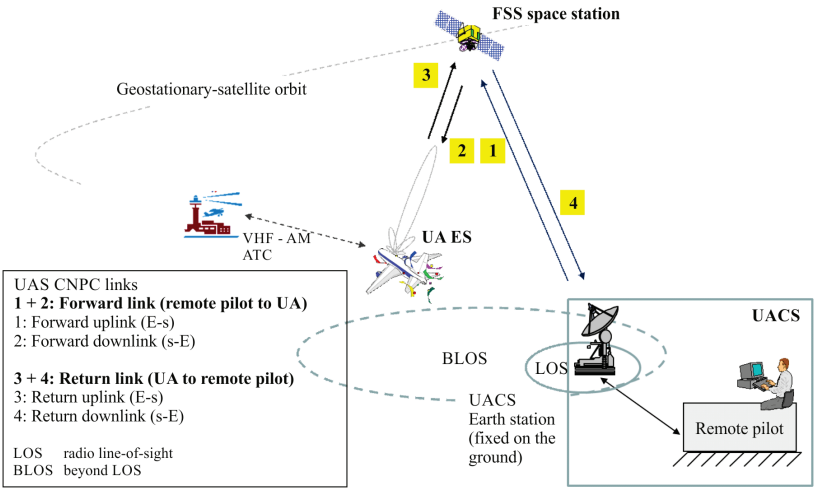
to provide to the Director of BR, in time for WRC-23, information on ICAO efforts regarding implementation of UAS CNPC links, including the information related to the development of SARPs for UAS CNPC links.

ANNEX 1 TO RESOLUTION 155 (REV.WRC-19)

UAS CNPC links

FIGURE 1

Elements of UAS architecture using the FSS



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ANNEX 2 TO RESOLUTION 155 (REV.WRC-19)

Protection of the fixed service from UAS CNPC emissions

a) Example provided to WRC-15

The fixed service is allocated by table entries and footnotes in several countries with co-primary status with FSS. Conditions of UA using CNPC shall be such that the fixed service is protected from any harmful interference as follows:

An earth station on board UA in the frequency band 14.0-14.47 GHz shall comply with provisional power flux-density (pfd) limits described below:

$$-132 + 0.5 \cdot \theta \quad \text{dB(W/(m}^2 \cdot \text{MHz))} \quad \text{for} \quad 0° \leq \theta \leq 40°$$

$$-112 \quad \text{dB(W/(m}^2 \cdot \text{MHz))} \quad \text{for} \quad 40° < \theta \leq 90°$$

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizontal).

NOTE – The aforementioned limits relate to the pfd and angles of arrival that would be obtained under free-space propagation conditions.

b) Example provided to WRC-19

An earth station on board UA in the frequency band 14.0-14.3 GHz shall comply with the pfd limits described below, on the territory of countries listed in No. **5.505**:

$$15\log(\theta+0.9)-124\ \text{dB}\left(\text{W}/\left(\text{m}^2\cdot\text{MHz}\right)\right) \quad \text{for}\ \ 0^\circ \le \theta \le 90^\circ$$

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizontal).

An earth station on board UA:

– in the frequency band 14.25-14.3 GHz on the territory of countries listed in No. **5.508**;

– in the frequency band 14.3-14.4 GHz in Regions 1 and 3;

– in the frequency band 14.4-14.47 GHz worldwide,

shall comply with the pfd limits described below:

$$15\log(\theta+0.9)-133.5\,\text{dB}\left(\text{W}/\left(\text{m}^2\cdot\text{MHz}\right)\right) \quad \text{for}\ \ 0^\circ \le \theta \le 90^\circ$$

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizontal).

NOTE – The aforementioned limits relate to the pfd and angles of arrival that would be obtained under free-space propagation conditions.

RESOLUTION 156 (REV.WRC-23)

Use of the frequency bands 19.7-20.2 GHz and 29.5-30.0 GHz by earth stations in motion communicating with geostationary space stations in the fixed-satellite service[1]

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that there is some regulatory ambiguity in the current No. **5.526** with respect to its scope of application;

b) that there is a need for global broadband mobile-satellite communications, and that some of this need could be met by allowing earth stations in motion (ESIMs) to communicate with space stations of the fixed-satellite service (FSS);

c) that the ITU Radiocommunication Sector (ITU-R) has studied certain aspects of the technical and operational use of ESIMs and that the result of these studies is contained in Reports ITU-R S.2223 and ITU-R S.2357;

d) that appropriate technical, regulatory and operational procedures are required for ESIMs;

e) that current regulatory provisions and their associated Rules of Procedure provide the possibility that an earth station operate within the envelope of coordination agreements established for the corresponding satellite network;

f) that there may be a need to clarify that ESIMs as referred to in this Resolution are not intended to be used or to be relied upon for the provision of safety-of-life applications,

recognizing

a) that the frequency bands 19.7-20.2 GHz and 29.5-30.0 GHz are globally allocated on a primary basis to the FSS and are used by geostationary-satellite orbit (GSO) FSS networks;

b) that, in the frequency band 29.5-30.0 GHz, there is an allocation to the fixed and mobile services on a secondary basis in a number of countries (see No. **5.542**) and, in the frequency band 19.7-20.2 GHz, there is an allocation to the fixed and mobile services on a primary basis in a number of countries (see No. **5.524**);

c) that there is a need to take actions to eliminate harmful interference which may be caused to terrestrial services of those administrations listed in No. **5.542**;

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[1] As referred to in the Table of Frequency Allocations.

d) that, currently, there is no specific regulatory procedure for the coordination of ESIMs with regard to terrestrial services;

e) that WRC-15 adopted No. **5.527A** to clarify that ESIMs can communicate with GSO FSS space stations in the frequency bands 19.7-20.2 GHz and 29.5-30.0 GHz under certain conditions specified in *resolves* 1-4 below;

f) that a class of station is defined in the Preface to the International Frequency Information Circular of the Radiocommunication Bureau (BR IFIC) for ESIMs communicating with GSO FSS space stations for the application of the provisions of No. **5.527A** for satellite network filings under Articles **9** and **11**;

g) that successful coordination does not in any way imply licensing authorization to provide a service within the territory of a Member State (see also *recognizing b)* of Resolution **25 (Rev.WRC-23)**),

resolves

1 that ESIMs communicating with the GSO FSS shall operate under the following conditions:

1.1 with respect to satellite networks of other administrations, the earth station shall remain within the envelope of the coordination agreements of the satellite networks with which this earth station is associated or, in the absence of such agreements, comply with the off-axis equivalent isotropically radiated power (e.i.r.p.) density levels given in the Annex;

1.2 with respect to terrestrial services of other administrations mentioned in No. **5.524**, the ESIM shall not claim protection from, or impose constraints on the development of, these services operating in the frequency band 19.7-20.1 GHz in Regions 1 and 3;

1.3 with respect to any terrestrial systems operating in the frequency band 29.5-29.9 GHz in Regions 1 and 3 in the countries listed in No. **5.542**, the notifying administrations operating maritime ESIMs operating in international waters and aeronautical ESIMs operating in international airspace shall ensure that such operations do not cause unacceptable interference;

1.4 in the case of interference, the administration responsible for the satellite network shall, upon receipt of a report of harmful interference with respect to any terrestrial systems operating in the countries listed in No. **5.542**, immediately cease the interference or reduce it to an acceptable level;

1.5 to this effect, that administration shall submit to the Bureau a commitment for implementation of *resolves* 1.4 above;

1.6 that these earth stations are to be subject to permanent monitoring and control by a network control and monitoring centre (NCMC) or equivalent facility and capable of receiving and acting upon at least “enable transmission” and “disable transmission” commands from the NCMC;

1.7 that these earth stations are not to be used or relied upon for safety-of-life applications;

2 that the administration responsible for the satellite network shall ensure that the ESIMs employ techniques to track the associated GSO FSS satellite and that they are resistant to capturing and tracking adjacent GSO satellites;

3 that the notifying administration for the satellite network within which the ESIMs operate by means of fixed, mobile or transportable terminals shall ensure that they have the capability to limit operations of such earth stations to the territory or territories of administrations having authorized those earth stations and to comply with Article **18**;

4 that administrations authorizing ESIMs shall require the operators to provide a point of contact for the purpose of tracing any suspected cases of interference from ESIMs.

ANNEX TO RESOLUTION 156 (REV.WRC-23)

Off axis e.i.r.p. density levels for earth stations in motion communicating with geostationary space stations of the fixed-satellite service in the frequency band 29.5-30.0 GHz[2]

This annex provides a set of off-axis e.i.r.p. levels for earth stations in motion (ESIMs) operating in the frequency band 29.5-30.0 GHz.

ESIMs operating and communicating with geostationary space stations in the fixed-satellite service transmitting in the frequency band 29.5-30.0 GHz shall be designed in such a manner that at any angle, θ, which is 2° or more from the vector from the earth station antenna to the associated satellite (see Figure 1 below for the reference geometry of an ESIMs compared to an earth station at a fixed location), the e.i.r.p. density in any direction within 3° of the GSO, shall not exceed the following values:

Angle θ	**Maximum e.i.r.p. per 40 kHz***
$2 \leq \theta \leq 7°$	(19 − 25 log θ) dB(W/40 kHz)
$7 < \theta \leq 9.2°$	−2 dB(W/40 kHz)
$9.2 < \theta \leq 48°$	(22 − 25 log θ) dB(W/40 kHz)
$48 < \theta \leq 180°$	−10 dB(W/40 kHz)

* Other levels may be coordinated and mutually agreed between affected administrations (see also *resolves* 1.1).

NOTE 1 – The values above are maximal values under clear-sky conditions. In the case of networks employing uplink power control, these levels should include any additional margins above the minimum clear-sky level necessary for the implementation of uplink power control. When attenuation by rain occurs and uplink power control is used, the levels stated above may be exceeded to compensate for that attenuation. When uplink power control is not used and the e.i.r.p. density levels given above are not met, different values could be used in compliance with the values agreed to through bilateral coordination of GSO FSS satellite networks.

2 See also Report ITU-R S.2357 for ease of reference.

NOTE 2 – The e.i.r.p. density levels for angles of θ less than 2° may be determined from GSO FSS coordination agreements taking into account the specific parameters of the two GSO FSS satellite networks.

NOTE 3 – For geostationary space stations in the fixed-satellite service employing code division multiple access (CDMA) with which the ESIMs are expected to transmit simultaneously in the same 40 kHz band, the maximum e.i.r.p. density values should be decreased by 10 log(*N*) dB, where *N* is the number of ESIMs that are in the receive satellite beam of the associated satellite and that are expected to transmit simultaneously on the same frequency. Alternative methods may be used if agreed between affected administrations.

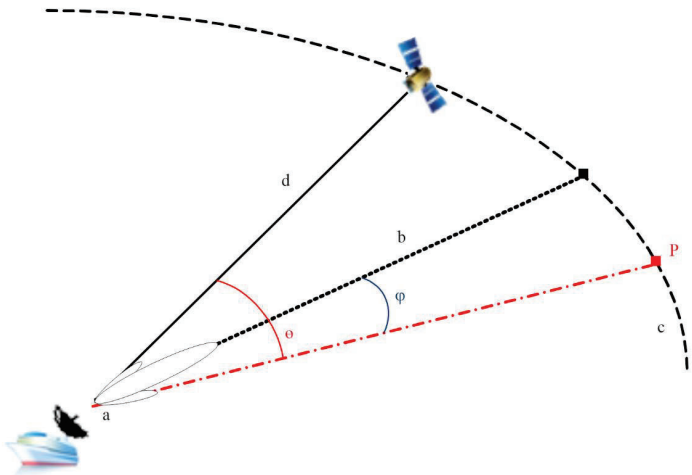
NOTE 4 – Potential aggregate interference from ESIMs operating within the fixed-satellite service using multi-spot frequency reuse technologies should be taken into account in coordination with respect to other GSO satellite networks.

NOTE 5 – ESIMs operating in the frequency band 29.5-30.0 GHz with low elevation angles to the GSO will require higher e.i.r.p. levels relative to the same terminals at high elevation angles to achieve the same power flux-densities (pfd) at the GSO due to the combined effect of increased distance and atmospheric absorption. Earth stations with low elevation angles may exceed the above levels by the following amount:

Elevation angle to GSO (ε)	**Increase in e.i.r.p. spectral density (dB)**
$\varepsilon \leq 5°$	2.5
$5° < \varepsilon \leq 30°$	$3 - 0.1\ \varepsilon$

Figure 1 below illustrates the definition of angle θ[3].

FIGURE 1



[3] In Figure 1 proportions are illustrative and not to scale.

where:

a represents the ESIM;

b represents the boresight of the earth station antenna;

c represents the geostationary-satellite orbit (GSO);

d represents the vector from the ESIM to the associated GSO FSS satellite;

φ represents the angle between the boresight of the earth station antenna and a point P on the GSO arc;

θ represents the angle between the vector d and point P on the GSO arc;

P represents a generic point on the GSO arc which angles θ and φ are referred to.

RESOLUTION 163 (WRC-15)

Deployment of earth stations in some Regions 1 and 2 countries in the frequency band 14.5-14.75 GHz in the fixed-satellite service (Earth-to-space) not for feeder links for the broadcasting-satellite service

The World Radiocommunication Conference (Geneva, 2015),

considering

a) that there is a demand for satellite communication services, particularly for the Earth-to-space direction in the frequency range 13-17 GHz;

b) that some of this demand may be met by earth stations operating in the frequency band 14.5-14.8 GHz without requiring this use to be subject to the Appendix **30A** Plan or List;

c) that certain conditions would be required in order to ensure the protection and future use of assignments subject to the Appendix **30A** Plan and List;

d) that, in order to ensure the protection of current and future use of other services to which this frequency band is allocated, earth stations would need to operate under certain technical and operational limitations (see Nos. **5.509B**, **5.509C**, **5.509D**, **5.509E** and **5.509F**);

e) that some administrations may not be in a position to ascertain the potential future use of this frequency band in their territory,

resolves

that earth stations in Regions 1 and 2 in the frequency band 14.5-14.75 GHz in the fixed-satellite service (Earth-to-space) not for feeder links for the broadcasting-satellite service shall be operated only in the following countries: Algeria, Saudi Arabia, Argentina, Armenia, Azerbaijan, Bahrain, Belarus, Brazil, Bulgaria, Cuba, Egypt, El Salvador, the Russian Federation, Iraq, Jordan, Kazakhstan, Kuwait, Mauritania, Mexico, Morocco, Nicaragua, Norway, Oman, Uzbekistan, Qatar, Türkiye, Kyrgyzstan, Sudan, Uruguay and Venezuela; such operation is subject to the technical and operational limitations contained in Nos. **5.509B**, **5.509C**, **5.509D**, **5.509E** and **5.509F**.

RESOLUTION 164 (WRC-15)

Deployment of earth stations in some Region 3 countries in the frequency band 14.5-14.8 GHz in the fixed-satellite service (Earth-to-space) not for feeder links for the broadcasting-satellite service

The World Radiocommunication Conference (Geneva, 2015),

considering

a) that there is a demand for satellite communication services, particularly for the Earth-to-space direction in the frequency range 13-17 GHz;

b) that some of this demand may be met by earth stations operating in the frequency band 14.5-14.8 GHz without requiring this use to be subject to the Appendix **30A** Plan or List;

c) that certain conditions would be required in order to ensure the protection and future use of assignments subject to the Appendix **30A** Plan and List;

d) that, in order to ensure the protection of current and future use of other services to which this frequency band is allocated, earth stations would need to operate under certain technical and operational limitations (see Nos. **5.509B**, **5.509C**, **5.509D**, **5.509E** and **5.509F**);

e) that some administrations may not be in a position to ascertain the potential future use of this frequency band in their territory,

resolves

that earth stations in Region 3 in the frequency band 14.5-14.8 GHz in the fixed-satellite service (Earth-to-space) not for feeder links for the broadcasting-satellite service shall be operated only in the following countries: Australia, Cambodia, China, Japan, Lao P.D.R., Pakistan, Papua New Guinea, Thailand and Viet Nam; such operation is subject to the technical and operational limitations contained in Nos. **5.509B**, **5.509C**, **5.509D**, **5.509E** and **5.509F**.

RESOLUTION 165 (REV.WRC-23)

Use of the frequency band 21.4-22 GHz by high-altitude platform stations in the fixed service in Region 2

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that there is a need for greater broadband connectivity in underserved communities and in rural and remote areas;

b) that WRC-15 invited the ITU Radiocommunication Sector (ITU-R) to study additional spectrum needs for fixed high-altitude platform station (HAPS) links to provide broadband connectivity and to facilitate the use of HAPS links on a global or regional basis, recognizing that the existing HAPS identifications were established without reference to today's broadband capabilities;

c) that HAPS can provide broadband connectivity with minimal ground network infrastructure;

d) that ITU-R has conducted studies dealing with compatibility between systems using HAPS and existing services in the frequency band 21.4-22 GHz in Region 2, leading to Report ITU-R F.2471,

considering further

that current technologies can be used to deliver broadband applications by HAPS, which can provide broadband connectivity and disaster-recovery communications with minimal ground network infrastructure,

recognizing

a) that a HAPS is defined in No. **1.66A** as a station located on an object at an altitude of 20 to 50 km and at a specified, nominal, fixed point relative to the Earth, and is subject to No. **4.23**;

b) that the aeronautical mobile service (AMS) within the mobile service operates in the frequency range 21.2-21.5 GHz on a primary basis within Region 2,

noting

a) that limits to be met at the border by HAPS transmitters may not be appropriate for frameworks for the introduction of HAPS nationally;

b) that Reports ITU-R F.2438 and ITU-R F.2439 provide information relevant to the development of a framework for the introduction of HAPS by administrations,

resolves

1 that, for the purpose of protecting fixed-service systems in the territory of other administrations in the frequency band 21.4-22 GHz, the power flux-density (pfd) level per HAPS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limits, developed for clear-sky conditions, unless the explicit agreement of the affected administration is provided at the time of notification of HAPS:

$0.7\,\theta - 135$	dB(W/(m² · MHz))	for	$0° \leq \theta < 10°$
$2.4\,\theta - 152$	dB(W/(m² · MHz))	for	$10° \leq \theta < 20°$
$0.45\,\theta - 113$	dB(W/(m² · MHz))	for	$20° \leq \theta < 60°$
-86	dB(W/(m² · MHz))	for	$60° \leq \theta \leq 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

during periods of rain, the equivalent isotropically radiated power (e.i.r.p.) of the beam suffering rain fade may be increased by a level commensurate with the level of rain fade, by up to 20 dB above the e.i.r.p. associated with the above pfd mask at the surface of the Earth;

2 that, for the purpose of protecting the Earth exploration-satellite service (passive) in the frequency bands 21.2-21.4 GHz and 22.21-22.5 GHz, the e.i.r.p. density in the frequency bands 21.2-21.4 GHz and 22.21-22.5 GHz per HAPS operating in the frequency band 21.4-22 GHz shall not exceed:

$-0.76\,\theta - 9.5$	dB(W/100 MHz)	for	$-4.53° \leq \theta < 35.5°$
-36.5	dB(W/100 MHz)	for	$35.5° \leq \theta \leq 90°$

where θ is the elevation angle in degrees at the platform height;

3 that, in order to ensure the protection of the radio astronomy service (RAS), the pfd level produced by unwanted emissions from HAPS downlink transmissions in the frequency band 21.4-22 GHz shall not exceed −176 dB(W/(m^2 · 290 MHz)) for continuum observations and −192 dB(W/(m^2 · 250 kHz)) for spectral line observations in the frequency band 22.21-22.5 GHz at an RAS station location at a height of 50 m; this limit relates to the pfd which would be obtained using a time percentage of 2% in the relevant propagation model;

to verify compliance, the following formula shall be used:

$$pfd = e.i.r.p._{nominal\ clear\ sky}(Az, \theta) + Att_{618_{p=2\%}} - 10\log\left(4\pi d^2\right) - GasAtt(\theta)$$

where:

$e.i.r.p._{nominal\ clear\ sky}$: nominal unwanted emission e.i.r.p. density towards the RAS station at which the HAPS operates under clear-sky conditions in dB(W/290 MHz) for continuum observations and in dB(W/250 kHz) for spectral line observations in the frequency band 22.21-22.5 GHz

Az: azimuth in degrees from the HAPS towards the RAS station

θ: elevation angle in degrees at the HAPS towards the RAS station

$Att_{618p=2\%}$: attenuation in dB from the most recent version of Recommendation ITU R P.618 corresponding to $p = 2\%$ of the time at the radio astronomy location

d: separation distance in metres between the HAPS and the RAS station

GasAtt(θ): gaseous attenuation for an elevation angle of θ (see the most recent version of Recommendation ITU-R SF.1395);

4 that *resolves* 3 applies at any radio astronomy station that was in operation prior to 22 November 2019 and has been notified to the Radiocommunication Bureau in the frequency band 22.21-22.5 GHz before 22 May 2020, or at any radio astronomy station that was notified before the date of receipt of the complete Appendix **4** information for notification, for the HAPS system to which *resolves* 3 applies; radio astronomy stations notified after this date may seek an agreement with administrations that have authorized HAPS;

5 that, for the purpose of protecting the AMS operating in the frequency band 21.2-21.5 GHz, the e.i.r.p. per HAPS shall not exceed 17.5 dB(W/100 MHz) in the frequency range 21.4-21.5 GHz;

6 that administrations planning to implement a HAPS system in the frequency band 21.4-22 GHz shall notify the frequency assignments by submitting all mandatory elements of Appendix **4** to the Bureau for the examination of compliance with respect to this Resolution with a view to their registration in the Master International Frequency Register,

instructs the Director of the Radiocommunication Bureau

to take all necessary measures to implement this Resolution.

RESOLUTION 166 (REV.WRC-23)

Use of the frequency band 24.25-27.5 GHz by high-altitude platform stations in the fixed service in Region 2

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that there is a need for greater broadband connectivity in underserved communities and in rural and remote areas;

b) that WRC-15 invited the ITU Radiocommunication Sector (ITU-R) to study additional spectrum needs for fixed high-altitude platform station (HAPS) links to provide broadband connectivity and to facilitate the use of HAPS links on a global or regional basis, recognizing that the existing HAPS identifications were established without reference to today's broadband capabilities;

c) that HAPS can provide broadband connectivity with minimal ground network infrastructure;

d) that ITU-R has conducted studies dealing with compatibility between HAPS systems and systems in existing services in the frequency band 24.25-27.5 GHz and in the adjacent band in Region 2, leading to Report ITU-R F.2472-0,

considering further

that current technologies can be used to deliver broadband applications by HAPS, which can provide broadband connectivity and disaster-recovery communications with minimal ground network infrastructure,

recognizing

that, in the frequency bands 24.75-25.25 GHz and 27.0-27.5 GHz, with respect to earth stations in the fixed-satellite service (FSS) (Earth-to-space) and HAPS ground station receivers which operate in the fixed service, No. **9.17** applies,

resolves

1 that, for the purpose of protecting fixed-service systems in the territory of other administrations in the frequency band 27-27.5 GHz, the power flux-density (pfd) level per HAPS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limits, developed for clear-sky conditions, unless the explicit agreement of the affected administration is provided at the time of notification of HAPS:

$0.39\,\theta - 132.12$	dB(W/(m^2 · MHz))	for	$0° \le \theta < 13°$
$2.715\,\theta - 162.3$	dB(W/(m^2 · MHz))	for	$13° \le \theta < 20°$
$0.45\,\theta - 117$	dB(W/(m^2 · MHz))	for	$20° \le \theta < 60°$
-90	dB(W/(m^2 · MHz))	for	$60° \le \theta \le 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

during periods of rain, the equivalent isotropically radiated power (e.i.r.p.) of the beam suffering rain fade may be increased by a level commensurate with the level of rain fade, by up to 20 dB above the e.i.r.p. associated with the above pfd mask at the surface of the Earth;

2 that, for the purpose of protecting mobile-service systems in the territory of other administrations in the frequency band 24.25-25.25 GHz, the pfd level per HAPS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limits, developed for clear-sky conditions, unless the explicit agreement of the affected administration is provided at the time of notification of HAPS:

-110.3	dB(W/(m^2 · MHz))	for	$0° \leq \theta \leq 4°$
$-110.3 + 1.2\,(\theta - 4)$	dB(W/(m^2 · MHz))	for	$4° < \theta \leq 9°$
-104.3	dB(W/(m^2 · MHz))	for	$9° < \theta \leq 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

the limits above take into account the 3 dB aggregate loss due to polarization mismatch, and body loss was not taken into account;

during periods of rain, the e.i.r.p. of the beam suffering rain fade may be increased by a level commensurate with the level of rain fade, by up to 20 dB above the e.i.r.p. associated with the above pfd mask at the surface of the Earth;

3 that, for the purpose of protecting mobile-service systems in the territory of other administrations in the frequency band 27-27.5 GHz, the pfd level per HAPS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limits, developed for clear-sky conditions, unless the explicit agreement of the affected administration is provided at the time of notification of HAPS:

$0.95\,\theta - 114$	dB(W/(m^2 · MHz))	for	$0° \leq \theta < 5.7°$
$0.6\,\theta - 112$	dB(W/(m^2 · MHz))	for	$5.7° \leq \theta < 20°$
-100	dB(W/(m^2 · MHz))	for	$20° \leq \theta \leq 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

the limits above take into account the 3 dB aggregate loss due to polarization mismatch, and body loss was not taken into account;

during periods of rain, the e.i.r.p. of the beam suffering rain fade may be increased by a level commensurate with the level of rain fade, by up to 20 dB above the e.i.r.p. associated with the above pfd mask at the surface of the Earth;

4 that, for the purpose of protecting mobile-service systems operating in the frequency band 25.25-27 GHz in the territory of neighbouring administrations, coordination of a transmitting HAPS ground station is required when the pfd in dB(W/(m^2 · MHz)) at the border of a neighbouring administration exceeds a pfd limit of −110.3 dB(W/(m^2 · MHz)), and the pfd values shall be verified considering a percentage of time of 1% using the most recent version of Recommendation ITU-R P.452 and a mobile-station antenna height of 20 m;

5 that, for the purpose of protecting the inter-satellite service (ISS) and the FSS, the e.i.r.p. density per HAPS in the frequency band 27-27.5 GHz shall not exceed −10.7 dB(W/MHz) for off-nadir angles higher than 85.5°;

6 that, for the purpose of protecting the ISS, the e.i.r.p. density per HAPS in the frequency band 24.45-24.75 GHz shall not exceed −19.9 dB(W/MHz) for off-nadir angles higher than 85.5°;

7 that, for the purpose of protecting non-geostationary space stations of the ISS, the e.i.r.p. density per HAPS ground station in the frequency band 25.25-27 GHz shall not exceed 12.3 dB(W/MHz) under clear-sky conditions;

in addition, for the purpose of protecting geostationary space stations of the ISS, the maximum e.i.r.p. density in the frequency band 25.25-27 GHz of HAPS ground stations shall not exceed 0.5 dB(W/MHz) in the direction of the geostationary arc under clear-sky conditions; it is also necessary to take into account a possible orbit inclination of GSO space stations of between −5° and 5°;

automatic power control may be used to increase the e.i.r.p. density only to the level to compensate rain fade, by up to 20 dB;

8 that, for the purpose of protecting the FSS, the e.i.r.p. density per HAPS in the frequency band 24.75-25.25 GHz shall not exceed −9.1 dB(W/MHz) for off-nadir angles higher than 85.5°;

9 that, for the purpose of protecting the Earth exploration-satellite service (EESS) (passive) in the frequency band 23.6-24 GHz, the e.i.r.p. density in the frequency band 23.6-24 GHz per HAPS operating in the frequency band 24.25-25.25 GHz shall not exceed:

$-0.7714\,\theta - 16.5$	dB(W/200 MHz)	for	$-4.53° \leq \theta < 35°$
-43.5	dB(W/200 MHz)	for	$35° \leq \theta \leq 90°$

where θ is the elevation angle in degrees at the platform height;

10 that, in order to ensure the protection of in-band space research service (SRS)/EESS in the territory of other administrations from the HAPS gateway in the frequency band 25.5-27.0 GHz, the pfd shall not exceed the threshold values given below at the SRS/EESS earth stations at a height of 20 m above ground level; if the pfd threshold values below are exceeded, then HAPS shall coordinate in accordance with No. **9.18**, taking into account the parameters of the relevant systems; these limits relate to the pfd which would be obtained under assumed propagation conditions predicted by the most recent version of Recommendation ITU-R P.452 using the following time percentages: 0.001% for SRS, 0.005% for EESS non-GSO and 20% for EESS GSO:

SRS: pfd = −121 dB(W/(m^2 · MHz))

EESS non-GSO: pfd = −97 dB(W/(m^2 · MHz))

EESS GSO: pfd = −129 dB(W/(m^2 · MHz));

11 that, in order to ensure the protection of the radio astronomy service (RAS), the pfd level produced by unwanted emissions from HAPS downlink transmissions in the frequency band 24.25-25.25 GHz shall not exceed −177 dB(W/(m² · 400 MHz)) for continuum observations and −191 dB(W/(m² · 250 kHz)) for spectral line observations in the frequency band 23.6-24 GHz at an RAS station location at a height of 50 m; this limit relates to the pfd which would be obtained using a time percentage of 2% in the relevant propagation model;

to verify compliance, the following formula shall be used:

$$pfd = e.i.r.p._{nominal\ clear\ sky}(Az, \theta) + Att_{618_{p=2\%}} - 10\log(4\pi d^2) - GasAtt(\theta)$$

where:

$e.i.r.p._{nominal\ clear\ sky}$: nominal unwanted emission e.i.r.p. density towards the RAS station at which the HAPS operates under clear-sky conditions in dB(W/400 MHz) for continuum observations and in dB(W/250 kHz) for spectral line observations in the frequency band 23.6-24 GHz

Az: azimuth in degrees from the HAPS towards the RAS station

θ: elevation angle in degrees at the HAPS towards the RAS station

$Att_{618p=2\%}$: attenuation in dB from the most recent version of Recommendation ITU-R P.618 corresponding to $p = 2\%$ of the time at the radio astronomy location

d: separation distance in metres between the HAPS and the RAS station

pfd: pfd at the Earth's surface per HAPS in dB(W/(m^2 · 400 MHz)) for continuum observations and in dB(W/(m^2 · 250 kHz)) for spectral line observations in the frequency band 23.6-24 GHz

$GasAtt(\theta)$: gaseous attenuation for an elevation angle of θ (see the most recent version of Recommendation ITU-R SF.1395);

12 that *resolves* 11 applies at any radio astronomy station that was in operation prior to 22 November 2019 and has been notified to the Radiocommunication Bureau in the frequency band 23.6-24 GHz before 22 May 2020, or at any radio astronomy station that was notified before the date of receipt of the complete Appendix **4** information for notification, for the HAPS system to which *resolves* 11 applies; radio astronomy stations notified after this date may seek an agreement with administrations that have authorized HAPS;

13 that administrations planning to implement a HAPS system in the frequency band 24.25-27.5 GHz shall notify the frequency assignments by submitting all mandatory elements of Appendix **4** to the Bureau for the examination of compliance with respect to this Resolution with a view to their registration in the Master International Frequency Register,

instructs the Director of the Radiocommunication Bureau

to take all necessary measures to implement this Resolution.

RESOLUTION 167 (REV.WRC-23)

Use of the frequency band 31-31.3 GHz by high-altitude platform stations in the fixed service

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that there is a need for greater broadband connectivity in underserved communities and in rural and remote areas;

b) that WRC-15 invited the ITU Radiocommunication Sector (ITU-R) to study additional spectrum needs for fixed high-altitude platform station (HAPS) links to provide broadband connectivity and to facilitate the use of HAPS links on a global or regional basis, recognizing that the existing HAPS identifications were established without reference to today's broadband capabilities;

c) that ITU-R has conducted studies dealing with compatibility between systems using HAPS and passive services in the frequency band 31.3-31.8 GHz, leading to Report ITU-R F.2473;

d) that Report ITU-R F.2439 provides deployment and technical characteristics of broadband HAPS systems;

e) that Report ITU-R F.2438 contains worldwide spectrum needs of HAPS systems;

f) that ITU-R has conducted studies dealing with sharing between systems using HAPS in the fixed service and other types of systems in the fixed service in the frequency band 31-31.3 GHz, leading to Report ITU-R F.2473,

considering further

that current technologies, such as HAPS, can be used to deliver broadband applications for broadband connectivity and disaster-recovery communications with minimal ground network infrastructure,

recognizing

that, during periods of rain, the equivalent isotropically radiated power (e.i.r.p.) of the HAPS beam suffering rain fade may be increased by a level commensurate with the level of rain fade, by up to 20 dB above the e.i.r.p. under clear-sky conditions indicated in Appendix **4**,

noting

a) that WRC-2000 adopted No. **5.543A**, which was modified at WRC-03 and then again at WRC-07, to permit the use of HAPS in the fixed service in the frequency band 31-31.3 GHz in certain Region 1 and 3 countries on a non-harmful interference, non-protection basis;

b) that the frequency band 31-31.3 GHz is widely used or planned to be used by a number of different services and a number of other types of applications in the fixed service;

c) that, while the decision to deploy HAPS can be taken on a national basis, such deployment may affect neighbouring administrations, particularly in small countries;

d) that results of some ITU-R studies indicate that, in the frequency band 31-31.3 GHz, sharing between fixed-service systems using HAPS and other conventional fixed-service systems in the same area is subject to appropriate interference mitigation techniques to be developed and implemented,

resolves

1 that, for the purpose of protecting fixed-service systems in the territory of other administrations in the frequency band 31-31.3 GHz, the power flux-density (pfd) level per HAPS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limits, developed for clear-sky conditions, unless the explicit agreement of the affected administration is provided at the time of notification of HAPS:

$0.875\,\theta - 143$	dB(W/(m² · MHz))	for	$0° \le \theta < 8°$
$2.58\,\theta - 156.6$	dB(W/(m² · MHz))	for	$8° \le \theta < 20°$
$0.375\,\theta - 112.5$	dB(W/(m² · MHz))	for	$20° \le \theta < 60°$
-90	dB(W/(m² · MHz))	for	$60° \le \theta \le 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

2 that, with regard to the protection of fixed-service stations with pointing elevation beyond 5°, an administration believing that unacceptable interference may still be caused shall, within four months of the date of publication of the relevant International Frequency Information Circular of the Radiocommunication Bureau (BR IFIC), provide its comments with the relevant justification to the notifying administration;

3 that, in order to ensure the protection of the Earth-exploration satellite service (EESS) (passive), the level of unwanted power density in the frequency band 31.3-31.8 GHz into the antenna of a HAPS ground station operating in the frequency band 31-31.3 GHz shall be limited to −83 dB(W/200 MHz) under clear-sky conditions, and may be increased under rainy conditions to mitigate fading due to rain, provided that the effective impact on the passive satellite does not exceed the impact under clear-sky conditions;

4 that, in order to ensure the protection of the EESS (passive), the level of unwanted emission e.i.r.p. density per HAPS transmitter operating in the frequency band 31-31.3 GHz into the frequency band 31.3-31.8 GHz shall be limited to:

$-\theta - 13.1$	dB(W/200 MHz)	for	$-4.53° \le \theta < 22°$
-35.1	dB(W/200 MHz)	for	$22° \le \theta < 90°$

where θ is the elevation angle in degrees at the platform height;

5 that, in order to ensure the protection of the radio astronomy service (RAS), the pfd level produced by any HAPS ground station operating in the frequency band 31-31.3 GHz at RAS station locations at a height of 50 m shall not exceed −141 dB(W/(m^2 · 500 MHz)) in the frequency band 31.3-31.8 GHz; this limit relates to the pfd which would be obtained under assumed propagation conditions predicted by the most recent version of Recommendation ITU-R P.452 using a time percentage of 2%;

6 that, in order to ensure the protection of the RAS, the pfd level produced by unwanted emissions from HAPS downlink transmissions in the frequency band 31-31.3 GHz shall not exceed −171 dB(W/(m² · 500 MHz)) for continuum observations in the frequency band 31.3-31.8 GHz at an RAS station location at a height of 50 m; this limit relates to the pfd which would be obtained using a time percentage of 2% in the relevant propagation model;

to verify compliance, the following formula shall be used:

$$pfd(\theta) = e.i.r.p._{nominal\ clear\ sky}(Az, \theta) + Att_{618\,p=2\%} - 10\log\left(4\pi d^2\right) - GassAtt(\theta)$$

where:

$e.i.r.p._{nominal\ clear\ sky}$: nominal unwanted emission e.i.r.p. density towards the RAS station at which the HAPS operates under clear-sky conditions in dB(W/500 MHz) in the RAS frequency band

Az: azimuth in degrees from the HAPS towards the RAS station

θ: elevation angle in degrees at the HAPS towards the RAS station

$Att_{618p=2\%}$: attenuation in dB from the most recent version of Recommendation ITU-R P.618 corresponding to $p = 2\%$ of the time at the radio astronomy location

d: separation distance in metres between the HAPS and the RAS station

$pfd(\theta)$: pfd at the Earth's surface per HAPS station in dB(W/(m² · 500 MHz))

$GasAtt(\theta)$: gaseous attenuation for an elevation angle of θ (see the most recent version of Recommendation ITU-R SF.1395);

7 that *resolves* 5 and 6 apply at any radio astronomy station that was in operation prior to 22 November 2019 and has been notified to the Bureau in the frequency band 31.3-31.8 GHz before 22 May 2020, or at any radio astronomy station that was notified before the date of receipt of the complete Appendix **4** information for notification, for the HAPS system to which *resolves* 5 and 6 apply; radio astronomy stations notified after this date may seek an agreement with administrations that have authorized HAPS;

8 that administrations planning to implement a HAPS system in the frequency band 31-31.3 GHz shall notify the frequency assignments by submitting all mandatory elements under Appendix **4** to the Bureau for the examination of compliance with respect to this Resolution with a view to their registration in the Master International Frequency Register,

instructs the Director of the Radiocommunication Bureau

to take all necessary measures to implement this Resolution.

RESOLUTION 168 (REV.WRC-23)

Use of the frequency band 38-39.5 GHz by high-altitude platform stations in the fixed service

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that there is a need for greater broadband connectivity in underserved communities and in rural and remote areas;

b) that WRC-15 invited the ITU Radiocommunication Sector (ITU-R) to study additional spectrum needs for fixed high-altitude platform station (HAPS) links to provide broadband connectivity and to facilitate the use of HAPS links on a global or regional basis, recognizing that the existing HAPS identifications were established without reference to today's broadband capabilities;

c) that Report ITU-R F.2439 provides updated deployment and technical characteristics of broadband HAPS systems;

d) that Report ITU-R F.2438 contains worldwide spectrum needs of HAPS systems;

e) that ITU-R has conducted studies dealing with compatibility between systems using HAPS and existing services in the frequency band 38-39.5 GHz, leading to Report ITU-R F.2475,

considering further

that current technologies, such as HAPS, can be used to deliver broadband applications for broadband connectivity and disaster-recovery communications with minimal ground network infrastructure,

recognizing

a) that, during periods of rain, the equivalent isotropically radiated power (e.i.r.p.) of the HAPS beam suffering rain fade may be increased by a level commensurate with the level of rain fade, by up to 20 dB above the e.i.r.p. under clear-sky conditions indicated in Appendix **4**;

b) that existing services shall be protected from HAPS operations, and no undue constraints shall be imposed on the future development of existing services by HAPS,

resolves

1 that, for the purpose of protecting fixed-service systems in the territory of other administrations in the frequency band 38-39.5 GHz, the power flux-density (pfd) level per HAPS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limits, developed for clear-sky conditions, unless the explicit agreement of the affected administration is provided at the time of notification of HAPS:

-137	dB(W/(m² · MHz))	for	$0° \leq \theta \leq 13°$
$-137 + 3.125\ (\theta - 13)$	dB(W/(m² · MHz))	for	$13° < \theta \leq 25°$
$-99.5 + 0.5\ (\theta - 25)$	dB(W/(m² · MHz))	for	$25° < \theta \leq 50°$
-87	dB(W/(m² · MHz))	for	$50° < \theta \leq 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

2 that, with regard to the protection of fixed-service stations with pointing elevation beyond 15°, an administration believing that unacceptable interference may still be caused shall, within four months of the date of publication of the relevant International Frequency Information Circular of the Radiocommunication Bureau (BR IFIC), provide its comments with relevant justification to the notifying administration;

3 that, for the purpose of protecting mobile-service systems in the territory of other administrations in the frequency band 38-39.5 GHz, the power flux-density (pfd) level per HAPS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limits, developed for clear-sky conditions, unless the explicit agreement of the affected administration is provided at the time of notification of HAPS:

-107.8	dB(W/(m² · MHz))	for	$0° \leq \theta \leq 4°$
$-107.8 + 1.5\ (\theta - 4)$	dB(W/(m² · MHz))	for	$4° < \theta \leq 10°$
-98.8	dB(W/(m² · MHz))	for	$10° < \theta \leq 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

the limits above take into account the 3 dB aggregate loss due to polarization mismatch, and body loss was not taken into account;

4 that, for the purpose of protecting mobile-service systems operating in the frequency band 38-39.5 GHz in the territory of neighbouring administrations, coordination of a transmitting HAPS ground station is required when the pfd in dB(W/(m² · MHz)) at the border of a neighbouring administration exceeds a pfd limit of −110.8 dB(W/(m² · MHz)), and the pfd values shall be verified considering a percentage of time of 1% in the relevant propagation model of the most recent version of Recommendation ITU-R P.452 and a mobile-station antenna height of 20 m;

5 that, for the purpose of protecting earth stations in the geostationary-satellite (GSO) fixed-satellite service (FSS) (space-to-Earth) in the territory of other administrations, the pfd in the territory of other neighbouring administrations shall not exceed the following values, unless the explicit agreement of the affected administration is provided at the time of notification of HAPS:

$-169.9 + 1954\ \alpha^2$	dB(W/(m² · MHz))	for	0°	$\leq \alpha < 0.136°$
-133.9	dB(W/(m² · MHz))	for	0.136°	$\leq \alpha < 1°$
$-133.9 + 25 \log \alpha$	dB(W/(m² · MHz))	for	1°	$\leq \alpha < 47.9°$
-91.9	dB(W/(m² · MHz))	for	47.9°	$\leq \alpha \leq 180°$

where α is the minimum angle between the line to the HAPS (taking into account the HAPS location tolerance) and the lines to the GSO arc, in degrees, at any point on the territory of other administrations;

to calculate the pfd produced by a HAPS platform, the following equation shall be used:

$$pfd = e.i.r.p. - 10\log\left(4\pi d^2\right) - Att_{gaz}$$

where:

d: distance in metres between the HAPS and the GSO FSS earth station

Att_{gaz}: attenuation in dB due to atmospheric gases on the HAPS-to-GSO FSS earth station path (see the most recent version of Recommendation ITU-R P.676)

e.i.r.p.: maximum HAPS e.i.r.p. spectral density in the direction of the GSO FSS earth station in dB(W/MHz);

6 that, for the purpose of protecting non-geostationary-satellite (non-GSO) systems in the FSS (space-to-Earth) in the territory of other administrations from HAPS interference, administrations implementing HAPS shall seek explicit agreement with any other administration when the distance between the HAPS nadir point and any point on such other administration's border is less than the distance calculated by the following formula, where the minimum earth station elevation angle is 10 degrees; this does not preclude lower elevation angles being used for the operation of earth stations; and this distance can be decreased by explicit agreement of affected administrations on a case-by-case basis:

$$d = \frac{\pi R}{180}\left(90 - \theta - \operatorname{asin}\left(\frac{R}{R+h}\cos\theta\right)\right)$$

where:

R: Earth's radius (6 371 km)

θ: minimum elevation angle at the non-GSO FSS earth station (10°)

h: HAPS altitude (km);

7 that, in making assignments to HAPS systems (HAPS ground stations and HAPS) in the fixed service in the frequency band 38-39.5 GHz, administrations shall protect the space research service (SRS) (space-to-Earth) in the frequency band 37-38 GHz from harmful interference by unwanted emissions, taking into account the SRS (space-to-Earth) protection level of −217 dB(W/Hz) at the input of the SRS receiver with 0.001% exceedance due to atmospheric and precipitation effects, as referred to in the relevant ITU-R Recommendations;

8 that, for the purpose of protecting earth stations in the GSO and non-GSO FSS (space to-Earth) in the territory of neighbouring administrations, coordination of a transmitting HAPS ground station is required when the pfd in dB(W/(m² · MHz)) at the border of a neighbouring administration exceeds a pfd limit of −111.3 dB(W/(m² · MHz)) for non-GSO operations and −108.9 dB(W/(m² · MHz)) for GSO operations, and the pfd values shall be verified considering a percentage of time of 20% in the relevant propagation model of the most recent version of Recommendation ITU-R P.452 and an FSS earth station antenna height of 10 m;

9 that the notifying administration for the HAPS system shall send to the Bureau a commitment that the HAPS operation shall be in conformity with the Radio Regulations, including this Resolution;

10 that administrations planning to implement a HAPS system in the frequency band 38-39.5 GHz shall notify the frequency assignments by submitting all mandatory elements of Appendix **4** to the Bureau for the examination of compliance with respect to this Resolution with a view to their registration in the Master International Frequency Register;

11 that the notifying administration for the HAPS system shall send to the Bureau a commitment that, upon receiving an unacceptable interference report with relevant justification on exceedance of the limits set in this Resolution, the notifying administration for the HAPS system shall take the required action to eliminate interference or reduce it to an acceptable level,

further resolves

that, should an administration operating HAPS agree, with its neighbouring administrations, to levels higher than the limits contained in this Resolution, such agreement shall not affect other administrations that are not party to that agreement,

instructs the Director of the Radiocommunication Bureau

to take all necessary measures to implement this Resolution,

invites the ITU Radiocommunication Sector

to develop a Recommendation to provide technical guidance to facilitate the implementation of HAPS operations while ensuring the protection of non-GSO FSS earth stations.

RESOLUTION 169 (REV.WRC-23)

Use of the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz by earth stations in motion communicating with geostationary space stations in the fixed-satellite service

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that there is a need for global broadband mobile-satellite communications, and that some of this need could be met by allowing earth stations in motion (ESIMs) to communicate with space stations of the geostationary-satellite orbit (GSO) fixed-satellite service (FSS) operating in the frequency bands 17.7-19.7 GHz (space-to-Earth) and 27.5-29.5 GHz (Earth-to-space);

b) that appropriate regulatory and interference-management mechanisms are necessary for the operation of ESIMs;

c) that the frequency bands 17.7-19.7 GHz (space-to-Earth) and 27.5-29.5 GHz (Earth-to-space) are also allocated to terrestrial and space services used by a variety of different systems, and these existing services and their future development need to be protected, without the imposition of undue constraints, from the operation of ESIMs;

d) that the ITU Radiocommunication Sector has studied whether aeronautical ESIMs are capable of protecting non-geostationary (non-GSO) mobile-satellite service (MSS) feeder-link satellite receivers in the frequency band 29.1-29.5 GHz,

recognizing

a) that the administration authorizing ESIMs on territory under its jurisdiction has the right to require that the ESIMs referred to above only use those assignments associated with GSO FSS networks which have been successfully coordinated, notified, brought into use and recorded in the Master International Frequency Register with a favourable finding under Article **11**, including Nos. **11.31**, **11.32** or **11.32A**, where applicable;

b) that, for cases of incomplete coordination under No. **9.7** of the GSO FSS network with assignments to be used by ESIMs, the operation of ESIMs on those assignments in the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz needs to be in accordance with the provisions of No. **11.42** with respect to any recorded frequency assignment which was the basis of the unfavourable finding under No. **11.38**;

c) that any course of action taken under this Resolution has no impact on the original date of receipt of the frequency assignments of the GSO FSS satellite network with which ESIMs communicate or on the coordination requirements of that satellite network;

d) that successful compliance with this Resolution does not oblige any administration to authorize/license any ESIM to operate within the territory under its jurisdiction,

resolves

1 that, for any ESIM communicating with a GSO FSS space station within the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz, or parts thereof, the following conditions shall apply:

1.1 with respect to space services in the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz, ESIMs shall comply with the following conditions:

1.1.1 with respect to satellite networks or systems of other administrations, ESIM characteristics shall remain within the envelope characteristics of typical earth stations associated with the satellite network with which the ESIMs communicate;

1.1.2 the use of ESIMs shall not cause more interference and shall not claim more protection than for typical earth stations in this GSO FSS network;

1.1.3 the notifying administration of the GSO FSS network with which the ESIMs communicate shall ensure that the operation of ESIMs complies with the coordination agreements for the frequency assignments of the typical earth station of this GSO FSS network obtained under the relevant provisions of the Radio Regulations, taking into account *recognizing b)* above;

1.1.4 for the implementation of *resolves* 1.1.1 above, the notifying administration for the GSO FSS network with which the ESIMs communicate shall, in accordance with this Resolution, send to the Radiocommunication Bureau (BR) the relevant Appendix **4** notification information related to the characteristics of the ESIMs intended to communicate with that GSO FSS network, together with the commitment that the ESIM operation shall be in conformity with the Radio Regulations, including this Resolution;

1.1.5 upon receipt of the notification information referred to in *resolves* 1.1.4 above, BR shall examine it with respect to the provisions referred to in *resolves* 1.1.1 above and publish the result of such examination in its International Frequency Information Circular (BR IFIC);

1.1.6 for the protection of non-GSO FSS systems operating in the frequency band 27.5-28.6 GHz, ESIMs communicating with GSO FSS networks shall comply with the provisions contained in Annex 1 to this Resolution;

1.1.7 for the protection of non-GSO MSS feeder links of non-GSO systems for which complete coordination information was received before, and for which feeder-link earth stations were in service as of, 28 October 2019 in the frequency band 29.1-29.5 GHz, ESIMs communicating with GSO FSS networks should consider Annex 2 to this Resolution;

1.1.8 ESIMs shall not claim protection from non-GSO FSS systems operating in the frequency band 17.8-18.6 GHz in accordance with the Radio Regulations, including No. **22.5C**;

1.1.9 ESIMs shall not claim protection from broadcasting-satellite service feeder-link earth stations operating in the frequency band 17.7-18.4 GHz in accordance with the Radio Regulations;

1.2 with respect to the protection of terrestrial services to which the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz are allocated and which are operating in accordance with the Radio Regulations, ESIMs shall comply with the following conditions:

1.2.1 receiving ESIMs in the frequency band 17.7-19.7 GHz shall not claim protection from terrestrial services to which the frequency band is allocated and which are operating in accordance with the Radio Regulations;

1.2.2 transmitting aeronautical and maritime ESIMs in the frequency band 27.5-29.5 GHz shall not cause unacceptable interference to terrestrial services to which the frequency band is allocated and which are operating in accordance with the Radio Regulations, and Annex 3 to this Resolution shall apply;

1.2.3 transmitting land ESIMs in the frequency band 27.5-29.5 GHz shall not cause unacceptable interference to terrestrial services in neighbouring countries to which the frequency band is allocated and which are operating in accordance with the Radio Regulations (see *resolves* 3);

1.2.4 the provisions in this Resolution, including Annex 3, set the conditions for the purpose of protecting terrestrial services from unacceptable interference from aeronautical and maritime ESIMs in neighbouring countries in the frequency band 27.5-29.5 GHz; however, the requirement not to cause unacceptable interference to, or claim protection from, terrestrial services to which the frequency band is allocated and which are operating in accordance with the Radio Regulations remains valid (see *resolves* 4);

1.2.5 for the application of Part II of Annex 3 as referred to in *resolves* 1.2.2 and 1.2.4 above, BR shall examine the characteristics of aeronautical ESIMs with respect to the conformity with the power flux-density (pfd) limits on the Earth's surface specified in Part II of Annex 3 and publish the results of such examination in the BR IFIC;

1.2.6 the notifying administration for the GSO FSS network with which the ESIMs communicate shall send to BR a commitment that, upon receiving a report of unacceptable interference, the notifying administration for the GSO FSS network with which the ESIMs communicate shall follow the procedures in *resolves* 4;

2 that ESIMs shall not be used or relied upon for safety-of-life applications;

3 that the operation of ESIMs within the territory, including territorial waters and territorial airspace, of an administration shall be carried out only if authorized by that administration;

4 that, in the case of unacceptable interference caused by any type of ESIM:

4.1 the administration of the country in which the ESIM is authorized shall cooperate with an investigation on the matter and provide, to the extent of its ability, any required information on the operation of the ESIM and a point of contact to provide such information;

4.2 the administration of the country in which the ESIM is authorized and the notifying administration of the GSO FSS network with which the ESIM communicates shall, jointly or individually, as the case may be, upon receipt of a report of unacceptable interference, take required action to eliminate the interference or reduce it to an acceptable level;

5 that the administration responsible for the GSO FSS satellite network with which ESIMs communicate shall ensure that:

5.1 for the operation of ESIMs, techniques to maintain pointing accuracy with the associated GSO FSS satellite, without inadvertently tracking adjacent GSO satellites, are employed;

5.2 all necessary measures are taken so that ESIMs are subject to permanent monitoring and control by a network control and monitoring centre (NCMC) or equivalent facility in order to comply with the provisions in this Resolution, and are capable of receiving and acting upon at least "enable transmission" and "disable transmission" commands from the NCMC or equivalent facility;

5.3 measures, when required, are taken to limit the operation of ESIMs in the territory, including territorial waters and territorial airspace, under the jurisdiction of the administrations authorizing ESIMs;

5.4 a permanent point of contact is provided for the purpose of tracing any suspected cases of unacceptable interference from ESIMs and to immediately respond to requests from the focal point of the authorizing administration;

6 that the application of this Resolution does not provide regulatory status to ESIMs different from that derived from the GSO FSS network with which they communicate, taking into account the provisions referred to in this Resolution (see *recognizing b)* above);

7 that, if BR is unable to examine, in accordance with *resolves* 1.2.5 above, aeronautical ESIMs with respect to conformity with the pfd limits on the Earth's surface specified in Part II of Annex 3, the notifying administration shall send to BR a commitment that the aeronautical ESIMs comply with those limits;

8 that BR shall formulate a qualified favourable finding under No. **11.31** with respect to the limits contained in Part II of Annex 3, if *resolves* 7 is applied successfully, otherwise it shall formulate an unfavourable finding,

further resolves

that, should an administration authorizing ESIMs agree to pfd levels higher than the limits contained in Part II of Annex 3 within the territory under its jurisdiction, such agreement shall not affect other countries that are not party to that agreement,

instructs the Director of the Radiocommunication Bureau

1 to take all necessary actions to facilitate the implementation of this Resolution, together with providing any assistance for the resolution of interference, when required;

2 to report to future world radiocommunication conferences any difficulties or inconsistencies encountered in the implementation of this Resolution, including whether or not the responsibilities relating to the operation of ESIMs have been properly addressed;

3 to review, if necessary, once the methodology to examine the characteristics of aeronautical ESIMs with respect to conformity with the pfd limits on the Earth's surface specified in Part II of Annex 3 is available, its findings made in accordance with No. **11.31**,

invites administrations

to collaborate for the implementation of this Resolution, in particular for resolving interference, if any,

invites the ITU Radiocommunication Sector

to conduct, as a matter of urgency, relevant studies to determine a methodology with respect to the examination referred to in *resolves* 1.2.5 above,

instructs the Secretary-General

to bring this Resolution to the attention of the Secretary-General of the International Maritime Organization and of the Secretary General of the International Civil Aviation Organization.

ANNEX 1 TO RESOLUTION 169 (REV.WRC-23)

Provisions for earth stations in motion to protect non-geostationary fixed-satellite service systems in the frequency band 27.5-28.6 GHz

1 In order to protect the non-geostationary (non-GSO) fixed-satellite service (FSS) systems referred to in *resolves* 1.1.6 of this Resolution in the frequency band 27.5-28.6 GHz, earth stations in motion (ESIMs) shall comply with the following provisions:

a) the level of equivalent isotropically radiated power (e.i.r.p.) density emitted by an ESIM in a geostationary (GSO) network in the frequency band 27.5-28.6 GHz shall not exceed the following values for any off-axis angle φ which is 3° or more off the main-lobe axis of an ESIM antenna and outside 3° of the GSO arc:

Off-axis angle	*Maximum e.i.r.p. density*
$3° \leq \varphi \leq 7°$	$28 - 25 \log\varphi$ dB(W/40 kHz)
$7° < \varphi \leq 9.2°$	7 dB(W/40 kHz)
$9.2° < \varphi \leq 48°$	$31 - 25 \log\varphi$ dB(W/40 kHz)
$48° < \varphi \leq 180°$	−1 dB(W/40 kHz)

b) for any ESIM operating in the frequency band 27.5-28.6 GHz that does not meet condition *a)* above, outside of 3° of the GSO arc, the maximum ESIM on-axis e.i.r.p. shall not exceed 55 dBW for emission bandwidths up to and including 100 MHz. For emission bandwidths larger than 100 MHz, the maximum ESIM on-axis e.i.r.p. may be increased proportionately.

ANNEX 2 TO RESOLUTION 169 (REV.WRC-23)

Protection of non-geostationary mobile-satellite service feeder links in the frequency band 29.1-29.5 GHz from earth stations in motion

With regard to the non-geostationary (non-GSO) mobile-satellite service (MSS) feeder links referred to in *resolves* 1.1.7 of this Resolution, administrations should consider the provisions in Part A, Part B or Part C below, as appropriate:

A. If an earth station in motion (ESIM) communicating with a geostationary (GSO) fixed-satellite service (FSS) network complies with each of the parameters or operating conditions listed in Table 1 below, coordination may be used to ensure compatibility between the affected non-GSO MSS feeder-link systems in the frequency band 29.1-29.5 GHz and the GSO FSS network with which the ESIM is associated.

TABLE 1

ESIM operational characteristics and parameters

E.i.r.p. density per carrier (single per ESIM)	≤ 35.5 dBW/MHz
Off-axis e.i.r.p. density	as per No. **22.32**
Average carrier burst duty cycle	≤ 10% (averaged over 30 seconds)
Number of transmitting ESIMs in a single satellite beam in a 15 MHz channel	≤ 6

B. If an ESIM communicating with a GSO FSS network does not comply with each of the parameters or operating conditions listed in Table 1 above, but complies with each of the parameters or operating conditions listed in Table 2 below, coordination may be used to ensure compatibility between the affected non-GSO MSS feeder-link systems in the frequency band 29.1-29.5 GHz and the GSO FSS network with which the ESIM is associated. However, depending on the values of these parameters and characteristics in combination, there may need to be an exclusion zone or other constraint(s) on ESIMs developed by the parties and included in the agreement. Until such time as an agreement on coordination is reached, it may be appropriate for administrations to restrict ESIMs from operating within 500 km of a non-GSO MSS feeder-link earth station in any portion of the frequency band 29.1-29.5 GHz used by non-GSO MSS feeder-link earth stations, and to require that ESIMs operate subject to the condition that they do not cause harmful interference.

TABLE 2

ESIM operational characteristics and parameters

E.i.r.p. density per carrier (single per ESIM)	≤ 50 dBW/MHz
Off-axis e.i.r.p. density	as per No. **22.32**
Average carrier burst duty cycle	100% (averaged over 4 hours)
Number of transmitting ESIMs in a single satellite beam in a 15 MHz channel	≤ 12

C. If an ESIM communicating with a GSO FSS network does not comply with each of the parameters or operating conditions listed in Table 1 or Table 2 above, it may be appropriate for administrations to restrict ESIMs from operating within 725 km of the non-GSO MSS feeder-link earth station in any portion of the frequency band 29.1-29.5 GHz used by non-GSO MSS feeder-link earth stations, and to require that any ESIM operations within between 725 and 1 450 km of a non-GSO MSS feeder-link earth station in any portion of the frequency band 29.1-29.5 GHz used by non-GSO MSS feeder-link earth stations be subject to the condition that the ESIMs do not cause harmful interference.

ANNEX 3 TO RESOLUTION 169 (REV.WRC-23)

Provisions for maritime and aeronautical earth stations in motion to protect terrestrial services in the frequency band 27.5-29.5 GHz

1 The parts below contain provisions to ensure that maritime and aeronautical earth stations in motion (ESIMs) do not cause unacceptable interference in neighbouring countries to terrestrial service operations when ESIMs operate in frequencies overlapping with those used by terrestrial services at any time to which the frequency band 27.5-29.5 GHz is allocated and operating in accordance with the Radio Regulations (see also *resolves* 3 of this Resolution).

Part I: Maritime ESIMs

2 The notifying administration of the geostationary (GSO) fixed-satellite service (FSS) network with which a maritime ESIM communicates shall ensure compliance of the maritime ESIM operating within the frequency band 27.5-29.5 GHz, or parts thereof, with both of the following conditions for the protection of terrestrial services to which the frequency band is allocated within a coastal State:

2.1 The minimum distance from the low-water mark as officially recognized by the coastal State beyond which maritime ESIMs can operate without the prior agreement of any administration is 70 km in the frequency band 27.5-29.5 GHz. Any transmissions from maritime ESIMs within the minimum distance shall be subject to the prior agreement of the coastal State concerned.

2.2 The maximum maritime ESIM equivalent isotropically radiated power (e.i.r.p.) spectral density towards the horizon shall be limited to 24.44 dB(W/14 MHz). Transmissions from maritime ESIMs with higher e.i.r.p. spectral density levels towards the territory of any coastal State shall be subject to the prior agreement of the coastal State concerned.

Part II: Aeronautical ESIMs

3 The notifying administration of the GSO FSS satellite network with which an aeronautical ESIM communicates shall ensure compliance of the aeronautical ESIM operating within the frequency band 27.5-29.5 GHz, or parts thereof, with all of the following conditions for the protection of terrestrial services to which the frequency band is allocated:

3.1 When within line-of-sight of the territory of an administration, and above an altitude of 3 km, the maximum power flux-density (pfd) produced at the surface of the Earth on the territory of an administration by emissions from a single aeronautical ESIM shall not exceed:

$$\text{pfd}(\theta) = -124.7 \quad (\text{dB}(\text{W}/(\text{m}^2 \cdot 14\ \text{MHz}))) \quad \text{for} \quad 0° \le \theta \le 0.01°$$

$$\text{pfd}(\theta) = -120.9 + 1.9 \cdot \log\theta \quad (\text{dB}(\text{W}/(\text{m}^2 \cdot 14\ \text{MHz}))) \quad \text{for} \quad 0.01° < \theta \le 0.3°$$

$$\text{pfd}(\theta) = -116.2 + 11 \cdot \log\theta \quad (\text{dB}(\text{W}/(\text{m}^2 \cdot 14\ \text{MHz}))) \quad \text{for} \quad 0.3° < \theta \le 1°$$

$$\text{pfd}(\theta) = -116.2 + 18 \cdot \log\theta \quad (\text{dB}(\text{W}/(\text{m}^2 \cdot 14\ \text{MHz}))) \quad \text{for} \quad 1° < \theta \le 2°$$

$$\text{pfd}(\theta) = -117.9 + 23.7 \cdot \log\theta \quad (\text{dB}(\text{W}/(\text{m}^2 \cdot 14\ \text{MHz}))) \quad \text{for} \quad 2° < \theta \le 8°$$

$$\text{pfd}(\theta) = -96.5 \quad (\text{dB}(\text{W}/(\text{m}^2 \cdot 14\ \text{MHz}))) \quad \text{for} \quad 8° < \theta \le 90.0°$$

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizon).

3.2 When within line-of-sight of the territory of an administration, and up to an altitude of 3 km, the maximum pfd produced at the surface of the Earth on the territory of an administration by emissions from a single aeronautical ESIM shall not exceed:

$$\text{pfd}(\theta) = -136.2 \quad (\text{dB}(\text{W}/(\text{m}^2 \cdot 1\ \text{MHz}))) \quad \text{for} \quad 0° \le \theta \le 0.01°$$

$$\text{pfd}(\theta) = -132.4 + 1.9 \cdot \log\theta \quad (\text{dB}(\text{W}/(\text{m}^2 \cdot 1\ \text{MHz}))) \quad \text{for} \quad 0.01° < \theta \le 0.3°$$

$$\text{pfd}(\theta) = -127.7 + 11 \cdot \log\theta \quad (\text{dB}(\text{W}/(\text{m}^2 \cdot 1\ \text{MHz}))) \quad \text{for} \quad 0.3° < \theta \le 1°$$

$$\text{pfd}(\theta) = -127.7 + 18 \cdot \log\theta \quad (\text{dB}(\text{W}/(\text{m}^2 \cdot 1\ \text{MHz}))) \quad \text{for} \quad 1° < \theta \le 12.4°$$

$$\text{pfd}(\theta) = -108 \quad (\text{dB}(\text{W}/(\text{m}^2 \cdot 1\ \text{MHz}))) \quad \text{for} \quad 12.4° < \theta \le 90°$$

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizon).

3.3 An aeronautical ESIM operating within the territory of an administration that has authorized fixed-service and/or mobile-service operation in the same frequency bands shall not transmit in these frequency bands without prior agreement of that administration (see also *resolves* 3 of this Resolution).

4 The maximum power in the out-of-band domain should be attenuated below the maximum output power of the aeronautical ESIM transmitter as described in the most recent version of Recommendation ITU-R SM.1541.

5 Higher pfd levels than those provided in 3.1 and 3.2 above produced by aeronautical ESIMs on the surface of the Earth within an administration shall be subject to the prior agreement of that administration (see also *further resolves* of this Resolution).

RESOLUTION 170 (REV.WRC-23)

Additional measures for satellite networks in the fixed-satellite service in frequency bands subject to Appendix 30B for the enhancement of equitable access to these frequency bands

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that WARC Orb-88 created an allotment Plan for the use of the frequency bands 4 500-4 800 MHz, 6 725-7 025 MHz, 10.70-10.95 GHz, 11.20-11.45 GHz and 12.75-13.25 GHz;

b) that WRC-07 revised the regulatory regime governing the use of the frequency bands mentioned in *considering a)* above,

considering further

a) the additional regulatory measures for the enhancement of equitable access included in Resolution **553 (WRC-15)** *;

b) that the Rule of Procedure on No. **9.6** states that "the intent of Nos. **9.6** (**9.7** to **9.21**), **9.27** and Appendix **5** is to identify to which administrations a request for coordination is to be addressed, and not to state an order of priorities for rights to a particular orbital position",

recognizing

a) that Article 44 of the ITU Constitution lays down the basic principles for the use of the radio-frequency spectrum and the geostationary-satellite and other satellite orbits, taking into account the needs of developing countries;

b) that the "first-come first-served" concept can restrict and sometimes prevent access to and use of certain frequency bands and orbital positions;

c) the relative disadvantage for developing countries in coordination negotiations for various reasons such as a lack of resources and expertise;

d) that Resolution **2 (Rev.WRC-03)** resolves that "the registration with the Radiocommunication Bureau of frequency assignments for space radiocommunication services and their use do not provide any permanent priority for any individual country or groups of countries and do not create an obstacle to the establishment of space systems by other countries",

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* *Note by the Secretariat:* This Resolution was revised by WRC-23.

recognizing further

a) that information provided by the Radiocommunication Bureau (BR) in ITU Radiocommunication Sector studies indicates that a very significant number of Appendix **30B** submissions have been received by BR in the time period 1 January 2009 to 22 November 2019, and that the table below summarizes the data provided by BR into those studies (see also Attachment 2 to this Resolution) and shows the variations for the number of networks at the various stages;

	Request for conversion without change of initial allotment (national service area)	**Request for conversion with changes within the envelope of initial allotment (national service area)**	**Request for conversion with changes outside the envelope of initial allotment (national service area)**	**Request for conversion with changes outside the envelope of initial allotment (supra national service area)**	**Request for additional use (national service area)**	**Request for additional use (supra national service area and global coverage**)**	**Suppression**
2009 Q1 + Q2	0	0	0	1	3	11	0
2009 Q3 + Q4	0	0	0	0	0	6	15
2010 Q1 + Q2	1	0	0	0	1	14	2
2010 Q3 + Q4	0	0	0	0	1	19	1
2011 Q1 + Q2	1	0	0	0	2	18	1
2011 Q3 + Q4	1	0	0	0	2	20	23
2012 Q1 + Q2	0	0	0	0	3	20	1
2012 Q3 + Q4	1	0	2	0	2	23	4
2013 Q1 + Q2	1	0	0	0	4	27	7
2013 Q3 + Q4	1	0	0	0	0	17	12
2014 Q1 + Q2	1	0	0	0	2	30	42
2014 Q3 + Q4	0	0	0	0	7	20	0
2015 Q1 + Q2	0	0	1	0	1	30	11
2015 Q3 + Q4	0	0	0	0	0	26	7
2016 Q1 + Q2	0	1	0	0	0	23	8
2016 Q3 + Q4	0	0	0	0	1	24	4
2017 Q1 + Q2	0	0	0	0	4	34	1

	Request for conversion without change of initial allotment (national service area)	Request for conversion with changes within the envelope of initial allotment (national service area)	Request for conversion with changes outside the envelope of initial allotment (national service area)	Request for conversion with changes outside the envelope of initial allotment (supra national service area)	Request for additional use (national service area)	Request for additional use (supra national service area and global coverage**)	Suppression
2017 Q3 + Q4	0	1	0	0	0	25	7
2018 Q1 + Q2	0	0	0	0	6	20	9
2018 Q3 + Q4	0	0	0	0	0	10	15
2019 Q1 + Q2	1	1	0	0	0	4	17
2019 Q3	0	0	0	0	1	3	6

** Notices for additional use with service area and coverage beyond the national territory of the notifying administration.

b) that the number of Appendix **30B** submissions made by some administrations is large, which may not be realistic;

c) that the use of certain combinations of technical parameters in submissions (e.g. high-gain receiving space station antennas) can make systems/submissions overly sensitive to interference, in such a way that subsequent submissions for conversion from allotment into assignments with changes would cause interference to those systems,

taking into account

that the majority of submissions under § 6.1 of Appendix **30B** have a global coverage and service area, which is typically changed to limited service area with a considerably wider coverage area at the time of submission under § 6.17, notwithstanding the Note to Appendix **4** data item B.3.b.1, which states "Taking due account of applicable technical restrictions and allowing some reasonable degree of flexibility for satellite operations, administrations should, to the extent practicable, align the areas the satellite steerable beams could cover with the service area of their networks with due regard to their service objectives", and this is complicating coordination for administrations attempting to convert their national allotments into assignments or introducing an additional system for national use in a technically and economically viable manner, or for administrations acting on behalf of a group of named administrations introducing an additional system for their national use in a technically and economically viable manner,

resolves

that, as of 23 November 2019, the special procedure described in Attachment 1 to this Resolution shall be applied for the processing of submissions received by BR under Article 6 of Appendix **30B** for conversion of the allotment of an administration into an assignment with modifications outside the envelope of the initial allotment while restricted to providing service to its national territory, designated by test points as contained in the corresponding allotment, a submission by an administration of an additional system the service area of which is limited to its national territory, designated by test points as contained in the allotment, or a submission by an administration acting on behalf of a group of named administrations of an additional system the service area of which is limited to the national territories of the group of named administrations, designated by test points as contained in the allotments, in the frequency bands 4 500-4 800 MHz, 6 725-7 025 MHz, 10.70-10.95 GHz, 11.20-11.45 GHz and 12.75-13.25 GHz, if requested by an administration or one acting on behalf of a group of named administrations in respect of its submission, as specified in Attachment 1 to this Resolution; additional test points may be submitted inside the national territory of each participating administration provided that they are located on land and within the corresponding national territory, and that the total number of test points, per national territory, including those of the associated allotment, shall not exceed 20,

further resolves

that, when coordinating networks submitted under these additional measures, administrations, in particular those having satellite networks in process or included in the List with global coverage, exercise the utmost goodwill, and endeavour to overcome any difficulties encountered by the incoming network, in order to accommodate the incoming submission while respecting the underlying principles of No. **9.6** and its associated Rule of Procedure[1], which would apply by analogy to Article 6 of Appendix **30B**; in addressing, in particular, difficulties encountered in coordination due to the issue of potential Earth-to-space harmful interference caused by an incoming network which originates outside the service area of other potentially affected networks, administrations having potentially affected networks with global coverage shall implement, to the maximum extent possible, means to accommodate the incoming network, taking into account actual operating characteristics of the potentially affected networks,

instructs the Director of the Radiocommunication Bureau

to provide assistance, if requested by an administration, in the generation of a minimum ellipse as called for in § 3 c) of Attachment 1 to this Resolution.

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[1] "in the application of Article **9** no administration obtains any particular priority as a result of being the first to start either the advance publication phase (Section I of Article **9**) or the request for coordination procedure (Section II of Article **9**)."

ATTACHMENT 1 TO
RESOLUTION 170 (REV.WRC-23)

Additional measures for satellite networks in the fixed-satellite service in frequency bands subject to Appendix 30B for the enhancement of equitable access to these frequency bands

1 The special procedure described in this Attachment can only be applied once by an administration, or one acting on behalf of a group of named administrations[2], having no assignment in the List of Appendix **30B** or assignment submitted under § 6.1 of Appendix **30B**.

2 With regard to the latter case, in order to benefit from application of the special procedure, the submitting administration may either withdraw or modify its submission previously sent to the Radiocommunication Bureau (BR) under § 6.1 of Appendix **30B** or submit its submission under § 6.17 of Appendix **30B** to meet the criteria of this special procedure. Whenever an administration acts on behalf of a group of named administrations, all members of that group shall withdraw their submissions, if any, previously sent to BR under § 6.1 of Appendix **30B**.

3 Administrations, or ones acting on behalf of a group of named administrations, seeking to apply this special procedure shall submit their request to BR, with the information specified in § 6.1 of Appendix **30B**. Specifically, this information shall contain:

a) in the cover letter to BR, the information that the administration, or one acting on behalf of a group of named administrations, requests the use of this special procedure;

b) for an administration acting on its own behalf, a service area limited to the territory as contained in its national allotment, or as submitted in the case that a new Member State of the Union does not have an allotment in the Plan and has not submitted a request under § 7.2 of Article 7 of Appendix **30B**, or, in the case of submission of an additional system by an administration acting on behalf of a group of named administrations, a service area limited to the national territories of the named administrations;

[2] Whenever, under this Resolution, an administration acts on behalf of a group of named administrations, all members of that group can no longer apply this procedure or take part in another group of named administrations that requests to apply this procedure. Furthermore, all members of that group shall have no assignment in the List of Appendix **30B** or assignment submitted under § 6.1 of Appendix **30B**.

c) a minimum ellipse for an administration acting on its own behalf, or a beam formed by combining all individual minimum ellipses for a group of named administrations, determined by a set of test points, as specified in the *resolves* part of this Resolution for each participating administration, using the relevant BR software application. An administration, or one acting on behalf of a group of named administrations, may request BR to create such a diagram (see the *resolves* section of this Resolution).

4 If the information submitted under § 3 above is found to be incomplete, BR shall immediately seek from the administration concerned any clarification required and information not provided.

5 An administration, or one acting on behalf of a group of named administrations, using this special procedure shall effect coordination with other administrations as required in § 6 below before:

i) submitting a request under § 6.17[3] of Appendix **30B** to have the satellite network entered in the Appendix **30B** List; and

ii) bringing into use a frequency assignment.

6 Following the successful application of §§ 1 to 4 above, BR shall, ahead of submissions not yet processed under § 6.3 of Appendix **30B**, promptly:

a) examine the information with respect to its conformity with § 6.3 of Appendix **30B**;

b) identify, in accordance with Appendix 1 to this Attachment, any administration with which coordination may need to be effected[4, 5];

c) include their names in the publication under d) below;

d) publish[6], as appropriate, the complete information in its International Frequency Information Circular (BR IFIC) within the time-limit as specified in Appendix **30B**;

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[3] During the coordination with an administration identified as affected, the notifying administration may change the beam to a shaped beam. Therefore, BR shall accept submissions of satellite networks applying this Resolution and containing a shaped beam under § 6.17 of Appendix **30B**, if the characteristics of the submission under § 6.17 of Appendix **30B** are within the envelope of the characteristics of the submission under § 6.1 of Appendix **30B**.

[4] BR shall also identify the specific satellite networks with which coordination needs to be effected.

[5] Whenever an administration acts on behalf of a group of named administrations, all members of that group retain the right to respond in respect of their own allotments or assignments.

[6] If the payments are not received in accordance with the provisions of ITU Council Decision 482, as amended, on the implementation of cost recovery for satellite network filings, BR shall cancel the publication, after informing the administration concerned. BR shall inform all administrations of such action and that the network specified in the publication in question no longer has to be taken into consideration by BR and other administrations. BR shall send a reminder to the notifying administration not later than two months prior to the deadline for the payment in accordance with above-mentioned Council Decision 482 unless the payment has already been received.

e) inform the administrations concerned of its actions and communicate the results of its calculations, drawing attention to the relevant BR IFIC.

7 In applying §§ 6.5, 6.12, 6.14, 6.21 and 6.22 of Appendix **30B**, the criteria in Annex 4 to Appendix **30B** shall be replaced by those given in Appendix 1 to this Attachment.

8 Administrations identified under § *6b)* above, especially with a global coverage in uplink and limited service area, are required to apply all practical measures to overcome coordination difficulties encountered by the incoming network, in accordance with *further resolves* above.

9 If there is still continuing disagreement, the notifying administration may seek the assistance of BR.

10 If there is still continuing disagreement, the notifying administration can resubmit the notice under § 6.25 of Appendix **30B** and insist upon its reconsideration; BR, on the condition of a favourable finding under § 6.21 and § 6.22 of Appendix **30B** with respect to allotments in the Plan, shall enter the assignment provisionally in the List.

11 The administration responsible for the assignment which was the basis of the provisional entry under § 6.25 of Appendix **30B** shall be deemed to have agreed to the proposed assignment if BR is informed that the new assignment in the List has been in use, together with the assignment which was the basis for the disagreement, for at least four months without any complaint of harmful interference being made, and § 6.29 does not apply[7].

12 The start of the four-month period referred to in § 11 above and the conditions for the operation to verify no harmful interference during this period shall be agreed by both administrations. If there is no agreement between administrations, any administration may seek the assistance of BR.

13 If there is no reply under § 8 or § 12 above from the notifying administration of the existing network to the request for collaboration of the notifying administration of the incoming network, or if there are problems in communication between the two administrations, the notifying administration of the incoming network may seek the assistance of BR. In this event, BR shall forthwith send a telefax to the notifying administration of the existing network which has failed to reply, requesting an immediate beginning of collaboration with the notifying administration of the incoming network.

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[7] Should harmful interference be caused at any later time by an assignment submitted under the provisions of this Resolution and for which § 14 has not been applied and which is entered in the List under § 6.25 of Appendix **30B** to any assignment in the List in respect of which § 6.25 of Appendix **30B** was applied, the administrations shall exercise the utmost goodwill and efforts to overcome any difficulties encountered by the incoming network, and the interfered-with administration shall identify appropriate remedial measures to be implemented, taking into account actual operations and cooperation with the incoming network.

14 If there is no acknowledgement of receipt within 30 days after BR's action under § 13 above, BR shall immediately send a reminder providing an additional 15-day period for response. In the absence of such an acknowledgement within 15 days, it shall be deemed that the notifying administration of the existing network which has failed to acknowledge receipt has undertaken that no complaint will be made in respect of any harmful interference affecting its own assignments which may be caused by the assignment of the notifying administration of the incoming network for which coordination was requested.

15 The calculation of the reference situation (*C*/*I*) of an assignment with which agreement has been deemed to have been obtained under § 11 above shall not take into account the interference produced by the assignment for which the provisions of § 6.25 of Appendix **30B** have been applied until an explicit agreement has been reached.

16 The provisions in this Attachment are supplementary to the provisions of Article 6 of Appendix **30B**.

APPENDIX 1 TO ATTACHMENT 1 TO RESOLUTION 170 (REV.WRC-23)

Criteria for determining whether an assignment is considered to be affected by networks submitted under Appendix 30B pursuant to this Resolution

The criteria as contained in Annex 4 to Appendix **30B** continue to apply in order to determine if a proposed new assignment applying the procedures of this Attachment affects:

a) national allotments in the Plan;

b) an assignment stemming from the conversion of an allotment into an assignment without modification or with modification within the envelope of the allotment;

c) an allotment requested under Article 7 of Appendix **30B** by a new Member State of the Union which has received unfavourable findings under Article 7 and has been subsequently treated as a submission under § 6.1 of Appendix **30B**;

d) assignments stemming from the application of § 6.35 of Appendix **30B**;

e) assignments for which the procedures of this Resolution have been previously applied;

f) assignments recorded in the List until 22 November 2019 with a service area limited to the national territories.

An assignment which appears in the List with a service area beyond national territories or which BR has previously examined after receiving complete information and published under § 6.7 of Appendix **30B**, which does not fall into any of the above categories and that is not applying the procedures of this Attachment, is considered as being affected by a proposed new assignment that is applying the procedures of this Attachment:

1) if the orbital spacing between its orbital position and the orbital position of the proposed new assignment is equal to or less than:

1.1) 7° in the frequency bands 4 500-4 800 MHz (space-to-Earth) and 6 725-7 025 MHz (Earth-to-space);

1.2) 6° in the frequency bands 10.70-10.95 GHz (space-to-Earth), 11.20-11.45 GHz (space-to-Earth) and 12.75-13.25 GHz (Earth-to-space);

2) however, an administration is considered as not being affected by a proposed new assignment that is applying the procedures of this Attachment if the conditions listed in 2.1 or 2.2 are satisfied:

2.1) the calculated[8] Earth-to-space single-entry carrier-to-interference $(C/I)_u$ value at each test point associated with the assignment under consideration is greater than or equal to a reference value of 27 dB, or $(C/N)_u$ + 6 dB[9], or any already accepted Earth-to-space single entry (C/I), whichever is the lowest, and the calculated[8] space-to-Earth single-entry $(C/I)_d$ value everywhere within the service area of the assignment under consideration is greater than or equal to a reference value[10] of 23.65 dB, or $(C/N)_d$ + 8.65 dB[11], or any already accepted value, whichever is the lowest, and the calculated[8] overall aggregate $(C/I)_{agg}$ value at each test point associated with the assignment under consideration is greater than or equal to a reference value of 21 dB, or $(C/N)_t$ + 7 dB[12], or any already accepted overall aggregate $(C/I)_{agg}$ value, whichever is the lowest, with a tolerance of 0.45 dB[13] in the case of assignments not stemming from the conversion of an allotment into an assignment without modification, or when the modification is within the envelope characteristics of the initial allotment;

2.2) in the frequency band 4 500-4 800 MHz (space-to-Earth), the power flux-density (pfd) produced under assumed free-space propagation conditions does not exceed the threshold values shown below, anywhere within the service area of the potentially affected assignment:

$0 \leq \theta \leq 0.09$	-240.5	dB(W/(m^2 · Hz))
$0.09 < \theta \leq 3$	$-240.5 + 20\log(\theta/0.09)$	dB(W/(m^2 · Hz))
$3 < \theta \leq 5.5$	$-216.79 + 0.75 \cdot \theta^2$	dB(W/(m^2 · Hz))
$5.5 < \theta \leq 7$	$-194.1 + 25\log(\theta/5.5)$	dB(W/(m^2 · Hz))

where θ denotes nominal geocentric separation (degrees) between interfering and interfered with satellite networks;

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8 Including a computational precision of 0.05 dB.

9 $(C/N)_u$ is calculated as in Appendix 2 to Annex 4 to Appendix **30B**.

10 The reference values within the service area are interpolated from the reference values at the test points.

11 $(C/N)_d$ is calculated as in Appendix 2 to Annex 4 to Appendix **30B**.

12 $(C/N)_t$ is calculated as in Appendix 2 to Annex 4 to Appendix **30B**.

13 Inclusive of the 0.05 dB computational precision.

in the frequency band 6 725-7 025 MHz (Earth-to-space), the pfd produced at the location in the geostationary-satellite orbit (GSO) of the potentially affected assignment under assumed free-space propagation conditions does not exceed $-201.0 - G_{Rx}$ dB(W/(m^2 · Hz)), where G_{Rx} is the relative space station uplink receive antenna gain of the potentially affected assignment at the location of the interfering earth station;

in the frequency bands 10.7-10.95 and 11.2-11.45 GHz (space-to-Earth), the pfd produced under assumed free-space propagation conditions does not exceed the threshold values shown below, anywhere within the service area of the potentially affected assignment:

$0 \leq \theta \leq 0.05$	-235.0	dB(W/(m^2 · Hz))
$0.05 < \theta \leq 3$	$-235.0 + 20\log(\theta/0.05)$	dB(W/(m^2 · Hz))
$3 < \theta \leq 5$	$-207.98 + 0.95 \cdot \theta^2$	dB(W/(m^2 · Hz))
$5 < \theta \leq 6$	$-184.23 + 25\log(\theta/5)$	dB(W/(m^2 · Hz))

where θ denotes nominal geocentric separation (degrees) between interfering and interfered with satellite networks;

in the frequency band 12.75-13.25 GHz (Earth-to-space), the pfd produced at the location in the GSO of the potentially affected assignment under assumed free-space propagation conditions does not exceed $-205.0 - G_{Rx}$ dB(W/(m^2 · Hz)), where G_{Rx} is the relative space station uplink receive antenna gain of the potentially affected assignment at the location of the interfering earth station.

APPENDIX 2 TO ATTACHMENT 1 TO RESOLUTION 170 (REV.WRC-23)

Protection criteria for a new incoming network

Incoming network	Allotments or assignments to be protected	Protection criteria
Assignment applying the special procedure or allotment proposed under Article 7 of Appendix **30B**	Allotment in the Plan	Annex 4 to Appendix **30B**
	Assignment converted from allotment without modification	Annex 4 to Appendix **30B**
	Assignment converted from allotment with modification within the envelope of the allotment	Annex 4 to Appendix **30B**
	Assignment converted from allotment with modification outside the envelope of the allotment and the special procedure applied	Annex 4 to Appendix **30B**
	Assignment converted from allotment with modification outside the envelope of the allotment and the special procedure NOT applied	New criteria specified in this Resolution
	Former existing system	Annex 4 to Appendix **30B**
	Additional system for which the special procedure applied	Annex 4 to Appendix **30B**
	Additional system with frequency assignments recorded in the List until 22 November 2019 with service area limited to national territories for which the special procedure NOT applied	Annex 4 to Appendix **30B**
	Additional system with frequency assignments submitted under item 6.1 of Appendix **30B** with service area limited to national territories for which the special procedure NOT applied	New criteria specified in this Resolution
	Additional system with frequency assignments with service area beyond national territories for which the special procedure NOT applied	New criteria specified in this Resolution
	Request under Article 7 but transferred to Article 6	Annex 4 to Appendix **30B**
	New allotment through the application of § 6.35	Annex 4 to Appendix **30B**
Conversion of allotment or new additional system for which the special procedure NOT applied	All	Annex 4 to Appendix **30B**

ATTACHMENT 2 TO RESOLUTION 170 (REV.WRC-23)

Number of Appendix 30B submissions that have been received by the Radiocommunication Bureau

Number of new submissions

	Request for conversion without change of initial allotment (national service area)	Request for conversion with changes within the envelope of initial allotment (national service area)	Request for conversion with changes outside the envelope of initial allotment (national service area)	Request for conversion with changes outside the envelope of initial allotment (supra national service area)	Request for additional use (national service area)	Request for additional use (with supra national service area and global coverage)	Total
F						103	103
HOL						33	33
RUS/IK						29	29
E						28	28
PNG						28	28
IND					12	14	26
CHN					8	15	23
G						21	21
UAE						19	19
ISR						17	17
RUS					9	7	16
QAT						12	12
ARS/ARB						10	10
LUX						10	10
S						8	8
B			2		2	3	7
D						6	6
INS					3	3	6
J						6	6
USA				1		5	6
BLR	1					4	5
CYP						5	5
BGD	1					3	4

	Request for conversion without change of initial allotment (national service area)	Request for conversion with changes within the envelope of initial allotment (national service area)	Request for conversion with changes outside the envelope of initial allotment (national service area)	Request for conversion with changes outside the envelope of initial allotment (supra national service area)	Request for additional use (national service area)	Request for additional use (with supra national service area and global coverage)	Total
IRN		1				3	4
MCO						4	4
MEX	1				3		4
MLA					1	3	4
TUR						4	4
CAN			1			2	3
KAZ						3	3
BUL	1					1	2
HNG						2	2
LAO						2	2
NCG						2	2
NPL		1			1		2
VTN					1	1	2
ALG						1	1
ARM						1	1
BOL		1					1
CBG						1	1
ETH						1	1
GRC						1	1
IRQ						1	1
MNE	1						1
MNG	1						1
NOR						1	1
PAK						1	1
ROU	1						1
SDN	1						1
Total:	**8**	**3**	**3**	**1**	**40**	**424**	**479**

Number of suppressions

	2009-2019	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019*
ARS/ARB	11						3	1	1	1	2	3
BLR	1										1	
BUL	1					1						
CAN	2						1	1				
CHN	16						15					1
E	1											1
F	14						2	1			6	5
F/EUT	38	15	3	16	2	1			1			
G	9				1			6		1		1
HOL	5								3			2
IND	8			1				6	1			
ISR	4										2	2
KOR	10					10						
LBY	1			1								
LUX	26			1		4	13		2	5	1	
MCO	1					1						
MLA	1								1			
NOR	2						1	1				
PNG	6			3						1	1	1
RUS	12			2	1	1	5	1	2			
RUS/IK	9										6	3
S	4						2		1		1	
SDN	1											1
TUR	2										2	
UAE	4										1	3
USA	2					1		1				
VTN	2				1						1	
Total	**193**	**15**	**3**	**24**	**5**	**19**	**42**	**18**	**12**	**8**	**24**	**23**

* In 2019, the statistics stop at 30 September.

RESOLUTION 176 (REV.WRC-23)

Studies on the use of the frequency bands 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space), or parts thereof, by aeronautical and maritime earth stations in motion in the fixed-satellite service

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the frequency bands 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space) are globally allocated on a primary basis to the fixed-satellite service (FSS);

b) that there is an increasing need for mobile communications, including global broadband satellite services, and that some of this need can be met by allowing aeronautical and maritime earth stations in motion (ESIMs) to communicate with FSS space stations operating in the frequency bands mentioned in *considering a)*;

c) that in the FSS, there are geostationary-satellite (GSO) networks and non-geostationary (non-GSO) systems operating and/or planned for near-term operation in the frequency bands mentioned in *considering a)* that are allocated to the FSS;

d) that some administrations have already deployed, and plan to expand their use of, ESIMs with operational and future FSS GSO networks and non-GSO systems;

e) that the space stations mentioned in *considering c)* in the frequency bands mentioned in *considering a)* are required to be coordinated and notified in accordance with the provisions of Articles **9** and **11**;

f) that the frequency bands in *considering a)* are also allocated to several other services on a primary basis, the allocated services are used by a variety of different systems in many administrations, and these existing services and their future development should be protected without undue constraints;

g) the need to encourage the development and implementation of new technologies in the FSS at frequencies above 30 GHz;

h) that advances in technology, including the use of tracking techniques, allow ESIMs to operate within the characteristics of fixed earth stations of the FSS;

i) that the operation of ESIMs within the territory, including territorial waters and territorial airspace, of an administration shall be carried out only if authorized by that administration,

noting

a) that Article **21** contains power flux-density (pfd) limits for the space stations mentioned in *considering c)*;

b) that WRC-15 adopted No. **5.527A** and Resolution **156 (WRC-15)*** with respect to ESIMs communicating with GSO FSS networks in the frequency bands 19.7-20.2 GHz and 29.5-30.0 GHz;

c) that WRC-19 adopted No. **5.517A** and Resolution **169 (WRC-19)**** with respect to ESIMs communicating with GSO FSS networks in the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz;

d) that this conference has adopted Resolution **121 (WRC-23)** with respect to aeronautical ESIMs (A-ESIMs) and maritime ESIMs (M-ESIMs) communicating with GSO space stations in the FSS in the frequency band 12.75-13.25 GHz;

e) that the ESIMs addressed by this Resolution are not to be used for safety-of-life applications;

f) that the frequency band 48.2-50.2 GHz (Earth-to-space) in Region 2 is identified for use by high-density applications in the FSS (No. **5.516B**);

g) that the provisions of No. **5.550B** apply;

h) that administrations are urged to take all practicable steps to reserve the frequency band 47.2-49.2 GHz for feeder links for the broadcasting-satellite service (BSS) operating in the frequency band 40.5-42.5 GHz (No. **5.552**);

i) that the use of the frequency bands 47.5-47.9 GHz, 48.2-48.54 GHz and 49.44-50.2 GHz by the FSS (space-to-Earth) is limited to GSO satellites (No. **5.554A**);

j) that the pfd in the frequency band 48.94-49.04 GHz produced by any GSO space station in the FSS (space-to-Earth) operating in the frequency bands 48.2-48.54 GHz and 49.44-50.2 GHz shall not exceed −151.8 dB(W/m^2) in any 500 kHz band at the site of any radio astronomy station (No. **5.555B**);

k) that the frequency band 48.94-49.04 GHz is also allocated to the radio astronomy service (RAS) on a primary basis (No. **5.555**);

l) that, in the frequency bands 49.7-50.2 GHz, 50.4-50.9 GHz and 51.4-52.6 GHz, Resolution **750 (Rev.WRC-19)** applies, and Nos. **5.338A**, **5.340** and **5.340.1**, among other provisions of the Radio Regulations, apply;

m) that the fixed and mobile services are allocated on a primary basis in the frequency band 48.2-50.2 GHz on a global basis;

n) that the frequency band 50.2-50.4 GHz is allocated on a primary basis to the Earth exploration-satellite service (EESS) (passive) and space research service (SRS) (passive);

o) that the RAS is extremely susceptible to interference from space and airborne transmitters (see No. **29.12**);

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* *Note by the Secretariat:* This Resolution was revised by WRC-23.

** *Note by the Secretariat:* This Resolution was revised by WRC-23.

p) that in the frequency band 48.94-49.04 GHz, administrations are urged to take all practicable steps to protect the RAS from harmful interference, in accordance with No. **5.149**,

recognizing

a) that the protection of the primary incumbent services in these frequency bands should be studied;

b) that the authorization of land ESIMs remains the prerogative of each administration and, as such, it is not within the scope of this Resolution;

c) that the frequency bands used for reception by A-ESIMs and M-ESIMs shall not impose constraints on other allocated services or claim protection from allocated services operating in accordance with the Radio Regulations,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

1 studies on the spectrum needs and technical and operational characteristics of A-ESIMs and M-ESIMs that plan to operate within FSS allocations in the frequency bands mentioned in *considering a)*, or parts thereof;

2 studies on sharing and compatibility between A-ESIMs and M-ESIMs communicating with space stations in the FSS in the frequency bands mentioned in *considering a)*, or parts thereof, and the stations of primary services allocated in these frequency bands and in adjacent frequency bands, including passive services in adjacent and near-adjacent frequency bands, in order to ensure protection of, and not impose undue constraints on, those services;

3 the development, for M-ESIMs and A-ESIMs, of the technical conditions for their operation, taking into account the results of the studies above;

4 the development, for M-ESIMs and A-ESIMs communicating with GSO networks and non-GSO systems, of regulatory provisions for their operation, taking into account the results of the studies above;

5 consideration of the results of studies within the ITU Radiocommunication Sector (ITU-R) for the development of a new Recommendation for the network control and monitoring centre for ESIM operations;

6 studies on the responsibility of the administrations involved in the operations of the A-ESIMs and M-ESIMs addressed by this Resolution,

invites the 2027 world radiocommunication conference

to consider the results of the above studies and take the necessary actions for GSO and non-GSO ESIMs, as appropriate, provided that the results of the studies referred to in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* are complete and agreed by the ITU-R study groups.

RESOLUTION 205 (REV.WRC-19)

Protection of systems operating in the mobile-satellite service in the frequency band 406-406.1 MHz

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that WARC-79 allocated the frequency band 406-406.1 MHz to the mobile-satellite service (MSS) in the Earth-to-space direction;

b) that No. **5.266** limits the use of the frequency band 406-406.1 MHz to low-power satellite emergency position-indicating radiobeacons (EPIRBs);

c) that WARC Mob-83 made provision in the Radio Regulations for the introduction and development of a global distress and safety system;

d) that the use of satellite EPIRBs is an essential element of this system;

e) that, like any frequency band reserved for a distress and safety system, the frequency band 406-406.1 MHz is entitled to full protection against all harmful interference;

f) that Nos. **5.267** and **4.22** and Appendix **15** (Table **15-2**) require the protection of the MSS within the frequency band 406-406.1 MHz from all emissions of systems, including systems operating in the lower and upper adjacent frequency bands;

g) that Recommendation ITU-R M.1478 provides protection requirements for the various types of instruments mounted on board operational satellites receiving EPIRB signals in the frequency band 406-406.1 MHz against both broadband out-of-band emissions and narrowband spurious emissions;

h) that Report ITU-R M.2359 provides the results of studies covering various scenarios between the MSS and other relevant active services operating in the frequency bands 390-406 MHz and 406.1-420 MHz or in separate parts of these frequency bands;

i) that unwanted emissions from services outside the frequency band 406-406.1 MHz have the potential to cause interference to MSS receivers within 406-406.1 MHz;

j) that long-term protection against harmful interference of the Cospas-Sarsat satellite system operating in the MSS in the frequency band 406-406.1 MHz is vital to the response times of emergency services;

k) that, in most cases, the frequency bands adjacent or near to those used by Cospas-Sarsat will continue to be used for various applications in the services to which they are allocated,

considering further

a) that some administrations have initially developed and implemented an operational low-altitude, near-polar orbiting satellite system (Cospas-Sarsat) operating in the frequency band 406-406.1 MHz to provide alerting and to aid in the locating of distress incidents;

b) that thousands of human lives have been saved through the use of spaceborne distress-beacon detection instruments, initially on 121.5 MHz and 243 MHz, and subsequently in the frequency band 406-406.1 MHz;

c) that the 406 MHz distress transmissions are relayed through many instruments mounted on geostationary, low-Earth and medium-Earth satellite orbits;

d) that the digital processing of these emissions provides accurate, timely and reliable distress alert and location data to help search and rescue authorities assist persons in distress;

e) that the International Maritime Organization has decided that satellite EPIRBs operating in the Cospas-Sarsat system form part of the Global Maritime Distress and Safety System (GMDSS);

f) that observations of the use of frequencies in the frequency band 406-406.1 MHz show that they are being used by stations other than those authorized by No. **5.266**, and that these stations have caused harmful interference to the MSS, and particularly to the reception of satellite EPIRB signals by the Cospas-Sarsat system;

g) that the results of spectrum monitoring and ITU Radiocommunication Sector (ITU-R) studies contained in Report ITU-R M.2359 indicate that emissions from stations operating in the frequency bands 405.9-406 MHz and 406.1-406.2 MHz have the potential to severely impact the performance of MSS systems in the frequency band 406-406.1 MHz;

h) that the results of ITU-R studies indicate that increased deployment of land mobile systems operating in the vicinity of the frequency band 406-406.1 MHz may degrade the receiver performance of mobile-satellite systems operating in the frequency band 406-406.1 MHz;

i) that the maximum permissible level of interference to the MSS in the frequency band 406-406.1 MHz may be exceeded due to frequency drift of the radiosondes operating above 405 MHz,

recognizing

a) that it is essential for the protection of human life and property that frequency bands allocated exclusively to a service for distress and safety purposes be kept free from harmful interference;

b) that the deployment of mobile systems near the frequency band 406-406.1 MHz is ongoing and more such systems are envisaged;

c) that this increased deployment raises significant concerns on the reliability of future distress and safety communications due to the increases in the noise level measured in many areas of the world for the frequency band 406-406.1 MHz;

d) that it is essential to preserve the MSS frequency band 406-406.1 MHz free from out-of-band emissions that would degrade the operation of the 406 MHz satellite transponders and receivers, with the risk that satellite EPIRB signals would go undetected,

noting

a) that the 406 MHz search and rescue system will be enhanced by placing 406-406.1 MHz transponders on global navigation satellite systems such as Galileo, GLONASS and GPS, relaying search and rescue emissions at 406 MHz, in addition to already-operational and future low-Earth orbiting and geostationary satellites, thus providing a large constellation of satellites relaying search and rescue messages;

b) that this enhanced constellation of spaceborne search and rescue instruments was designed to improve geographic coverage and reduce distress-alert transmission delays by means of larger uplink footprints, an increased number of satellites and improvement in the accuracy of the location of the distress signal;

c) that the characteristics of these spacecraft with larger footprints, and the low power available from satellite EPIRB transmitters, means that aggregate levels of electromagnetic noise, including noise from transmissions in adjacent frequency bands, may present a risk of satellite EPIRB transmissions being undetected, or delayed in reception, or lead to reduced accuracy of the calculated locations, thereby putting lives at risk;

d) that Recommendation ITU-R SM.1051 provides a methodology to monitor the electromagnetic environment in the adjacent frequency bands 405.9-406 MHz and 406.1-406.2 MHz,

noting further

a) that the MSS systems contributing to the Cospas-Sarsat emergency location system provide a worldwide emergency location system to the benefit of all countries, even if those mobile-satellite systems are not operated by their country;

b) that many Cospas-Sarsat satellites implement efficient out-of-band filtering, which would be further improved in upcoming satellites,

resolves

1 to request administrations not to make new frequency assignments within the frequency bands 405.9-406.0 MHz and 406.1-406.2 MHz under the mobile and fixed services;

2 that administrations take into account frequency drift characteristics of radiosondes when selecting their operating frequencies above 405 MHz to avoid transmitting in the 406-406.1 MHz frequency band and take all practical steps to avoid frequency drifting close to 406 MHz,

instructs the Director of the Radiocommunication Bureau

1 to continue to organize monitoring programmes in the frequency band 406-406.1 MHz in order to identify the source of any unauthorized emission in that frequency band;

2 to organize monitoring programmes on the impact of unwanted emissions from systems operating in the frequency bands 405.9-406 MHz and 406.1-406.2 MHz on MSS reception in the frequency band 406-406.1 MHz in order to assess the effectiveness of this Resolution, and to report to subsequent world radiocommunication conferences,

encourages administrations

to take measures such as authorizing new assignments to stations in the fixed and mobile services with priority given to selecting channels with greater frequency separation from the frequency band 406 to 406.1 MHz and ensuring that the equivalent isotropically radiated power of new fixed and mobile systems at all but low elevation angles is kept to the minimum required level,

urges administrations

1 to take part in monitoring programmes referred to in *instructs the Director of the Radiocommunication Bureau* above;

2 to ensure that stations other than those operated under No. **5.266** abstain from using frequencies in the frequency band 406-406.1 MHz;

3 to take the appropriate measures to eliminate harmful interference caused to the distress and safety system;

4 when designing Cospas-Sarsat satellite receiver payloads in the frequency band 406-406.1 MHz, to improve, to the extent possible, out-of-band filtering of such receivers, in order to reduce constraints on adjacent services while preserving the ability of the Cospas-Sarsat system to detect all kinds of emergency beacons and to maintain an acceptable rate of detection, which is vital to search and rescue missions;

5 to take all practical steps to limit the levels of unwanted emissions of stations operating within the frequency ranges 403-406 MHz and 406.1-410 MHz in order not to cause harmful interference to mobile-satellite systems operating in the frequency band 406-406.1 MHz;

6 to actively cooperate with the administrations participating in the monitoring programme and the Radiocommunication Bureau to resolve reported cases of interference to the Cospas-Sarsat system.

RESOLUTION 207 (REV.WRC-15)

Measures to address unauthorized use of and interference to frequencies in the frequency bands allocated to the maritime mobile service and to the aeronautical mobile (R) service

The World Radiocommunication Conference (Geneva, 2015),

considering

a) that the HF frequencies currently used by the aeronautical and maritime mobile services for distress, safety and other communications, including allotted operational frequencies, suffer from harmful interference and are often subject to difficult propagation conditions;

b) that WRC-97 considered some aspects of the use of the HF bands for distress and safety communications in the context of the Global Maritime Distress and Safety System (GMDSS), especially with regard to regulatory measures;

c) that unauthorized operations using maritime and aeronautical frequencies in the HF bands are continuing to increase and are already a serious risk to HF distress, safety and other communications;

d) that some administrations have resorted to, for example, transmitting warning messages on operational HF channels as a means of deterring unauthorized users;

e) that provisions of the Radio Regulations prohibit the unauthorized use of certain safety frequencies for communications other than those related to safety;

f) that enforcing compliance with these regulatory provisions is becoming increasingly difficult with the availability of low-cost HF single side-band (SSB) transceivers;

g) that monitoring observations of the use of frequencies in the frequency band 2 170-2 194 kHz and in the frequency bands allocated exclusively to the maritime mobile service between 4 063 kHz and 27 500 kHz and to the aeronautical mobile (R) service between 2 850 kHz and 22 000 kHz show that a number of frequencies in these frequency bands are still being used by stations of other services, many of which are operating in contravention of No. **23.2**;

h) that, in certain situations, HF radio is the sole means of communication for the maritime mobile service and that certain frequencies in the frequency bands mentioned in *considering g)* are reserved for distress and safety purposes;

i) that, in certain situations, HF radio is the sole means of communication for the aeronautical mobile (R) service and that this is a safety service;

j) that WRC-2000 and subsequent conferences have reviewed the use of the HF bands by the aeronautical mobile (R) and maritime mobile services with a view to protecting operational, distress and safety communications;

k) that this Resolution identifies several interference mitigation techniques that can be employed by administrations on a non-mandatory basis,

considering in particular

a) that it is of paramount importance that the distress and safety channels of the maritime mobile service be kept free from harmful interference, since they are essential for the protection of the safety of life and property;

b) that it is also of paramount importance that channels directly concerned with the safe and regular conduct of aircraft operations be kept free from harmful interference, since they are essential for the safety of life and property,

resolves to invite ITU-R and ITU-D, as appropriate

to increase regional awareness of appropriate practices in order to help mitigate interference in the HF bands, especially on distress and safety channels,

invites administrations

1 to ensure that stations of services other than the maritime mobile service abstain from using frequencies in distress and safety channels and their guardbands and in the frequency bands allocated exclusively to that service, except under the conditions expressly specified in Nos. **4.4**, **5.128**, **5.137** and **4.13** to **4.15**; and to ensure that stations of services other than the aeronautical mobile (R) service abstain from using frequencies allocated to that service except under the conditions expressly specified in Nos. **4.4** and **4.13**;

2 to make every effort to identify and locate the source of any unauthorized emission capable of endangering human life or property and the safe and regular conduct of aircraft operations, and to communicate their findings to the Radiocommunication Bureau;

3 to participate, in accordance with item 4 in the Annex, in any monitoring programmes organized by the Bureau or administrations, if so agreed among those administrations, without adversely affecting the rights of other administrations or conflicting with any provisions of the Radio Regulations;

4 to make every effort to prevent unauthorized transmissions in frequency bands allocated to the maritime mobile service and the aeronautical mobile (R) service;

5 to request their competent authorities to take, within their respective jurisdiction, such legislative or regulatory measures which they consider necessary or appropriate in order to prevent stations from unauthorized use of distress and safety channels or from operating in contravention of No. **23.2**;

6 to take all necessary steps in such cases of contravention of No. **23.2** to ensure the cessation of any transmissions contravening the provisions of the Radio Regulations on the frequencies or in the frequency bands referred to in this Resolution;

7 to employ as many of the interference mitigation techniques referred to in the Annex as are appropriate for the maritime mobile and aeronautical mobile (R) services,

instructs the Radiocommunication Bureau

1 to seek the cooperation of administrations in identifying the sources of those emissions by all available means and in securing the cessation of those emissions;

2 when the station of another service transmitting in a frequency band allocated to the maritime mobile service or to the aeronautical mobile (R) service has been identified, to inform the administration concerned;

3 to include the problem of interference to maritime and aeronautical distress and safety channels on the agenda of relevant regional radiocommunication seminars,

instructs the Secretary-General

to bring this Resolution to the attention of the International Maritime Organization and the International Civil Aviation Organization for such actions as they may consider appropriate.

ANNEX TO RESOLUTION 207 (REV.WRC-15)

Interference mitigation techniques

This Annex lists several possible HF interference mitigation techniques that may be used, either in combination or singly, depending on the resources of administrations. Use of any or all of these techniques is not mandatory.

1 Alternative modulation methods

The use of digitally modulated emissions, such as QPSK, to replace or supplement analogue SSB voice (J3E) and data (J2B) emissions. This initiative would need to be adopted internationally to allow the interoperability of equipment. For example, ICAO has adopted an HF data-link standard to provide packet data communications using automated link establishment and adaptive frequency control techniques as a supplement to analogue SSB voice communications (see ICAO Convention, Annex 10).

2 Passive and active/adaptive antenna systems

Use of passive and active/adaptive antenna systems to reject unwanted signals.

3 Channel barring

Administrations should ensure through their licensing, equipment standardization and inspection arrangements that, in compliance with No. **43.1**, HF radio equipment cannot transmit on frequencies exclusively allocated to the aeronautical mobile (R) service, as detailed in Appendix **27**, except for frequencies allocated for worldwide use and shared with the aeronautical mobile (OR) service (see Appendix **26**/3.4).

4 Regional HF monitoring and direction-finding facilities

Collaboration and cooperation between regional administrations to coordinate the use of monitoring and direction-finding facilities.

5 Transmission of warning messages

Transmission of multilanguage warning messages on specific channels affected by strong or persistent interference. Such transmissions should be conducted after coordination with the users of the affected services and the administration(s) or competent authorities concerned.

6 Education and publicity initiatives

Administrations should provide education and publicity initiatives on the proper use of the radio-frequency spectrum in these frequency bands.

RESOLUTION 212 (REV.WRC-23)

Implementation of International Mobile Telecommunications in the frequency bands 1 885-2 025 MHz and 2 110-2 200 MHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that Resolution ITU-R 56 defines the naming for International Mobile Telecommunications (IMT);

b) that the ITU Radiocommunication Sector (ITU-R), for WRC-97, recommended approximately 230 MHz for use by the terrestrial and satellite components of IMT;

c) that ITU-R studies forecast that additional spectrum may be required to support the future services of IMT and to accommodate future user requirements and network deployments;

d) that ITU-R has recognized that the satellite component is an integral part of IMT;

e) that, in No. **5.388**, WARC-92 identified frequency bands to accommodate certain mobile applications defined as IMT,

noting

a) that both the terrestrial and satellite components of IMT have already been deployed or are being considered for deployment within the frequency bands 1 885-2 025 MHz and 2 110-2 200 MHz;

b) that the availability of the satellite component of IMT in the frequency bands 1 980-2 010 MHz and 2 170-2 200 MHz simultaneously with the terrestrial component of IMT in the frequency bands identified in No. **5.388** would improve the overall use of IMT,

noting further

a) that co-coverage, co-frequency deployment of independent satellite and terrestrial IMT components is not feasible unless techniques, such as the use of an appropriate guardband or other mitigation techniques, are applied to ensure coexistence and compatibility between the terrestrial and satellite components of IMT, but that co-coverage, co-frequency deployment of terrestrial and satellite components of IMT could be feasible if deployed as integrated networks supported by a system providing the management of frequency utilization by both components;

b) that, when the satellite and terrestrial components of IMT are deployed in the frequency bands 1 980-2 010 MHz and 2 170-2 200 MHz, technical or operational measures may need to be implemented to avoid harmful interference,

resolves

1 that administrations which implement IMT:

a) should make the necessary frequencies available for system development;

b) should use those frequencies when IMT is implemented;

c) should use the relevant international technical characteristics, as identified by Recommendations of ITU-R and of the ITU Telecommunication Standardization Sector;

2 that administrations should take the technical and operational measures, such as those found in the Annex to this Resolution, to facilitate coexistence and compatibility between the terrestrial and satellite components of IMT in the frequency bands 1 980-2 010 MHz and 2 170-2 200 MHz;

3 that, in the event of harmful interference, the concerned administrations should investigate and take technical and operational measures, as appropriate, to reduce interference to an acceptable level,

invites the ITU Radiocommunication Sector

to study possible technical and operational measures to improve co-existence and compatibility between the terrestrial and satellite components of IMT in the frequency bands 1 980-2 010 MHz and 2 170-2 200 MHz where those frequency bands are shared by the mobile service and the mobile-satellite service in different countries, in particular for the deployment of independent satellite and terrestrial components of IMT and to facilitate development of both the satellite and terrestrial components of IMT,

invites administrations

1 to give due consideration to the accommodation of other services currently operating in these frequency bands when implementing IMT;

2 to facilitate coexistence of the satellite component of IMT with the terrestrial component of IMT in the frequency band 1 980-2 010 MHz, by the concerned administrations, as appropriate, considering the following:

a) to apply an uplink direction from user equipment to IMT base stations as provided in the most recent version of Recommendation ITU-R M.1036, for the user equipment belonging to the terrestrial component of IMT in the frequency band 1 980-2 010 MHz (see the Annex to this Resolution);

b) that, in the event of harmful interference to the satellite component of the IMT space station, the concerned administrations may take additional steps to facilitate the reduction of harmful interference to an acceptable level;

3 to facilitate coexistence of the terrestrial component of IMT stations with the satellite component of IMT in the frequency band 2 170-2 200 MHz, by the concerned administrations, as appropriate, considering the following:

a) to apply an appropriate power flux-density value to the IMT space stations in the frequency band 2 170-2 200 MHz (see the Annex to this Resolution);

b) that, in the event of harmful interference to the terrestrial component of IMT, the concerned administrations may take additional steps to facilitate the reduction of harmful interference to an acceptable level.

ANNEX TO RESOLUTION 212 (REV.WRC-23)

Guidance on the implementation of technical and operational measures to facilitate coexistence between terrestrial and satellite components of International Mobile Telecommunications in the frequency bands 1 980-2 010 MHz and 2 170-2 200 MHz

This Annex provides guidance to concerned administrations on the following technical, operational and other applicable measures in the deployment of terrestrial and satellite components of International Mobile Telecommunications (IMT) for reducing the potential of harmful interference between the terrestrial and satellite components of IMT in the frequency bands 1 980-2 010 MHz and 2 170-2 200 MHz for the interference scenarios indicated in the table below, noting the applicability of any relevant Article **9** coordination procedures for scenarios A2, B1 and B2. The identified measures may be applicable for some scenarios and may not be applicable to other scenarios, and may or may not be implementable in satellite and terrestrial IMT system designs.

Interference scenarios

Scenario	From	To
A1	Terrestrial IMT base station or mobile station	Satellite IMT space station
A2	Terrestrial IMT base station	Satellite IMT mobile earth station
B1	Satellite IMT mobile earth station	Terrestrial IMT base station or user equipment
B2	Satellite IMT space station	Terrestrial IMT user equipment

1) Measures for the terrestrial component of IMT:

a) Use base station antennas with improved sidelobe performance as shown in relevant ITU-R Recommendations and Reports (e.g. improved antenna patterns compared with those contained in the most recent version of Recommendation ITU-R F.1336).

b) Consider the orientation in elevation and/or in azimuth of the IMT base station antenna pointing in the coexistence analysis with a view to reducing the interference level from the IMT base station above the horizon.

c) Consider the impact of the actual deployment scenario, including the activity factor values of the terrestrial component of IMT, on the coexistence.

d) Consider attenuation from terrain and clutter taking into account the deployment environments and propagation effects in the coexistence analysis.

e) Consider reducing the equivalent isotropically radiated power in the frequency band 1 980-2 010 MHz to a level sufficient for coexistence, for example, nominally to −10 dB(W/5 MHz)[1].

[1] See user terminal characteristics in Report ITU-R M.2292.

f) Set the transmission direction for the use of the frequency band 1 980-2 010 MHz with regard to the IMT base station to operate in receive mode as found in relevant ITU-R Recommendations.

g) Implement other applicable interference mitigation techniques.

2) Measures for the satellite component of IMT:

a) Use narrower spot beams and steeper roll-off from the boresight of the satellite antenna (i.e. not only reducing the interference level from the antenna sidelobe but also increasing frequency reuse and resilience to interference).

b) Antenna steering, where such capability exists in the satellite design.

c) Beamforming and/or beam nulling of the satellite antenna (e.g. digital processing of multi-element beamforming technique, which has the capability to suppress received interference from regions on the Earth).

d) Dynamic frequency management paired with geographical separation (e.g. monitoring interference in real time and dynamically assigning channels and/or beams).

e) Consider reducing the power flux-density to a level sufficient for coexistence, for example to nominally −122 dBW/m^2 for 1 MHz[2] for the protection of some base stations or nominally −108.8 dBW/m^2 for 1 MHz for the protection of some user equipment on the Earth's surface on the territories of other administrations using this frequency band for the terrestrial IMT component.

f) Consider an appropriate elevation angle model of an earth station and handover method by a satellite control system in the coexistence analysis.

g) Consider actual activity factor values, which may result in a reduction of interference.

h) Apply a polarization of the satellite antenna different from that of the terrestrial station receiver (for example, use of linear polarization by the terrestrial station receivers and circular polarization by the satellite may provide some benefit).

i) Implement other applicable interference mitigation techniques.

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2 See Resolution **539 (Rev.WRC-19)** for the frequency band 2 605-2 655 MHz.

RESOLUTION 213 (WRC-23)

Use of high-altitude platform stations as International Mobile Telecommunications base stations in the frequency band 694-960 MHz, or portions thereof[1]

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the favourable propagation characteristics of the frequency band 694-960 MHz are beneficial to provide cost-effective solutions for coverage, including for large areas of low population density;

b) that the operation of high-altitude platform stations (HAPS) as International Mobile Telecommunications (IMT) base stations (HIBS) in the same geographical area with existing services may create compatibility issues;

c) that it is necessary to adequately protect existing services in this frequency band;

d) that there is growing demand for access to mobile broadband, requiring more flexibility in approaches to expanding the capacity and coverage provided by IMT systems;

e) that HIBS would be used as part of terrestrial IMT networks and may use the same frequency bands as ground-based IMT base stations in order to provide mobile-broadband connectivity to underserved communities, and in rural and remote areas;

f) that HIBS would offer a new means of providing IMT services with minimal network infrastructure, as they are capable of providing service to a large footprint together with a dense coverage;

g) that the use of HIBS is optional for administrations, and that such use should not have any priority over other terrestrial IMT use;

h) that the mobile station to be served, whether by HIBS or ground-based IMT base stations, is the same, and currently supports a variety of the frequency bands identified for IMT;

i) that, under certain deployment scenarios, platform transmissions in the frequency band 694-960 MHz may occur at altitudes down to 18 km, and some sensitivity studies have shown that the difference of interference at this altitude would be negligible;

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[1] HIBS: High-altitude platform station as IMT base station. The conditions in this Resolution refer to these platforms operating between 18 km and 25 km.

j) that the ITU Radiocommunication Sector (ITU-R) has addressed sharing and compatibility between HIBS and existing systems of primary allocated services in the frequency band 694-960 MHz, and services in the adjacent bands,

recognizing

a) that, in Article **5**, the frequency band 694-960 MHz, or parts thereof, is allocated on a primary basis to various services;

b) that the use of the frequency band 470-862 MHz by the broadcasting service and other primary services in Region 1 (except Mongolia) and the Islamic Republic of Iran is covered by the GE06 Agreement;

c) that a HAPS is defined in No. **1.66A** as a station located on an object at an altitude of 20 to 50 km and at a specified, nominal, fixed point relative to the Earth;

d) that the frequency band 694-960 MHz, or parts thereof, are identified for IMT in accordance with Nos. **5.313A** and **5.317A**;

e) that these frequency bands are allocated to the fixed and mobile services on a co-primary basis,

emphasizing

that the requirements of the different services to which the frequency band is allocated, including the mobile, aeronautical radionavigation (in accordance with Nos. **5.312** and **5.323**), fixed and broadcasting services, shall be taken into account,

resolves

1 that use of the frequency band 694-960 MHz in accordance with Nos. **5.312B** and **5.314A** is subject to agreement obtained under No. **9.21** with respect to the affected aeronautical radionavigation service (ARNS) in countries listed in Nos. **5.312** and **5.323** based on the criteria contained in Annex 1 to this Resolution;

2 that HIBS operating in the frequency band 694/698-862 MHz shall not cause harmful interference to, nor claim protection from, the broadcasting service; where the GE06 Agreement applies, the power flux-density (pfd) level per HIBS shall not exceed −135.8 dB(W/(m^2 · MHz)), produced in the territory of other administrations, at a height of 10 metres unless explicit agreement of the affected administration is provided at the time of the notification of HIBS;

3 that, where the GE06 Agreement does not apply, the use of the frequency band 694/698-862 MHz by HIBS is subject to agreement obtained under No. **9.21** with respect to the broadcasting service in the territory of other administrations; the coordination threshold of a pfd level of −135.8 dB(W/(m^2 · MHz)), produced in the territory of other administrations, per HIBS shall be used at a height of 10 metres;

4 that administrations wishing to implement HIBS shall comply with the following:

4.1 for the purpose of protecting the mobile service, including IMT terrestrial systems, in the territory of neighbouring administrations in the frequency band 694-960 MHz, the following limits shall apply:

– the pfd level per HIBS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limit for the protection of IMT mobile stations, unless explicit agreement of the affected administration is provided:

-114 dB(W/(m^2 · MHz)) for $0° < \theta \leq 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

– the pfd level per HIBS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limit for the protection of IMT base stations, unless explicit agreement of the affected administration is provided:

$-136 + 0.21\ (\theta)^2$ dB(W/(m^2 · MHz)) for $0° \leq \theta \leq 8.3°$

$-121.8 + 0.08\ (\theta)$ dB(W/(m^2 · MHz)) for $8.3° < \theta \leq 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees[2];

4.2 for the purpose of protecting mobile services including IMT terrestrial systems in the territory of Armenia, Azerbaijan, Belarus, the Russian Federation, Kazakhstan, Mongolia, Uzbekistan, Kyrgyzstan, the Democratic People's Republic of Korea, Tajikistan and Turkmenistan in the frequency band 694-960 MHz, the pfd level per HIBS produced at the surface of the Earth in the territory of the countries listed above in this *resolves* shall not exceed the following limits, unless explicit agreement of the affected administration is provided:

-150 dB(W/(m^2 · MHz)) for $0° \leq \theta < 11°$

$-150 + 0.3912\ (\theta\text{-}11)$ dB(W/(m^2 · MHz)) for $11° \leq \theta < 80°$

-123 dB(W/(m^2 · MHz)) for $80° \leq \theta \leq 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

4.3 for the purpose of protecting fixed services in the territory of Armenia, Azerbaijan, Belarus, the Russian Federation, Kazakhstan, Mongolia, Uzbekistan, Kyrgyzstan, the Democratic People's Republic of Korea, Tajikistan and Turkmenistan in the frequency band 694-960 MHz, the pfd level per HIBS produced at the surface of the Earth in the territory of the countries listed above in this *resolves* shall not exceed the following limits, unless explicit agreement of the affected administration is provided:

-150 dB(W/(m^2 · MHz)) for $0° \leq \theta < 11°$

$-150 + 0.3912\ (\theta\text{-}11)$ dB(W/(m^2 · MHz)) for $11° \leq \theta < 80°$

-123 dB(W/(m^2 · MHz)) for $80° \leq \theta \leq 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

[2] The pfd levels to protect IMT base stations will apply unless the affected administration informs the Radiocommunication Bureau that only terminal stations need to be protected.

5 that administrations intending to implement HIBS systems shall notify, in accordance with Article **11**, the frequency assignments to transmitting and receiving HIBS by submitting all mandatory elements of Appendix **4** to the Radiocommunication Bureau for the examination of compliance with the conditions specified in the *resolves* above;

6 that the notifying administration of HIBS at the time of submission of the Appendix **4** information shall provide a firm, objective, actionable, measurable and enforceable commitment to the Bureau to immediately eliminate unacceptable interference to existing primary services or reduce it to an acceptable level should such interference occur,

invites administrations

1 to adopt appropriate frequency arrangements for HIBS in order to consider the benefits of harmonized utilization of the spectrum for HIBS and protection of existing services and systems operating on a primary basis taking into account the *resolves* above and the relevant ITU-R Recommendations and Reports;

2 to review their entries for the broadcasting service in the Master International Frequency Register in the frequency band above 694 MHz and to remove those no longer required according to Article **8**,

instructs the Director of the Radiocommunication Bureau

to take all necessary measures to implement this Resolution.

ANNEX 1 TO RESOLUTION 213 (WRC-23)

Criteria for identifying potentially affected administrations with respect to the aeronautical radionavigation service in countries listed in Nos. 5.312 and 5.323

To identify potentially affected administrations when applying the procedure for seeking agreement under No. **9.21** for HIBS in the mobile service with respect to the aeronautical radionavigation service (ARNS) station operating in countries mentioned in Nos. **5.312** and **5.323**, the coordination distances (between a HIBS in the mobile service and a potentially affected ARNS station) indicated below should be used.

When applying the procedure for seeking agreement under No. **9.21**, notifying administrations may indicate in the notice sent to the Radiocommunication Bureau the list of administrations with which a bilateral agreement has already been reached. The Bureau shall take this into account in determining the administrations with which coordination under No. **9.21** is required.

Coordination distances for transmitting HIBS of MS (km)	**Coordination distances for receiving HIBS of MS (km)**
$4.1\left(\sqrt{h_1}+\sqrt{h_2}\right)$	$4.1\left(\sqrt{h_1}+\sqrt{h_3}\right)+R$

h_1 is ARNS stations height (10 000 m).
h_2 is HIBS stations height (between 18 000 and 25 000 m).
h_3 is IMT mobile stations height (1.5 m).
R is radius of HIBS service area in km.

RESOLUTION 215 (REV.WRC-12)

Coordination process among mobile-satellite systems and efficient use of the allocations to the mobile-satellite service in the 1-3 GHz range

The World Radiocommunication Conference (Geneva, 2012),

considering

a) that space-to-Earth transmissions of mobile-satellite systems are constrained to limit their power flux-density over areas where the frequency band is shared with terrestrial systems;

b) that a number of proposed mobile-satellite systems can provide a good service to users within the power flux-density limits given in Annex 1 to Appendix **5** to the Radio Regulations;

c) that when maximum communication capacity is achieved by systems in the mobile-satellite service (MSS) a major portion of the interference into each of these systems will come from the other mobile-satellite systems sharing the frequency band, and, consequently, if one system starts to transmit at higher power, all others need to do the same in order to overcome mutual interference;

d) that ITU-R is studying the efficient use of the radio spectrum and frequency sharing within the MSS, that Recommendations ITU-R M.1186 and ITU-R M.1187 are a basis for further study, and that additional preliminary texts are available or can be provided by administrations on this matter;

e) that, in a codirectional, co-frequency and co-coverage sharing environment, capacities of systems using spread-spectrum multiple-access techniques are affected by technical and operational characteristics of other MSS systems using similar multiple-access techniques;

f) that in many parts of the world and in certain frequency bands in the 1-3 GHz range, significant congestion already exists due to use by other terrestrial and space services;

g) the need to make most efficient use of frequencies in the MSS allocations,

recognizing

that, as a means to ensure that the frequency bands allocated to the MSS can be used in an efficient manner, there is an urgent demand for:

a) criteria to be established by ITU-R to be used in determining the need to coordinate between mobile-satellite systems; and

b) detailed methods of interference calculation to be used by administrations in the coordination process;

c) ITU-R studies which should not impede the timely deployment of any MSS systems,

resolves to invite ITU-R

1 to continue its studies on this subject and develop, as a matter of urgency, criteria for determining the need to coordinate and calculation methods for determining levels of interference, as well as the required protection ratios between MSS networks;

2 to study, as a matter of urgency, the use of technically and operationally feasible techniques to allow for improvements in spectrum efficiency in MSS systems,

further resolves

1 that ITU-R studies should be focused on the technical and operational characteristics of systems using spread-spectrum multiple-access techniques that can allow co-frequency, co-coverage, codirectional sharing but which involve cooperation among systems' operators to maximize the efficient use of spectrum by multiple MSS systems using such access techniques;

2 that administrations responsible for the introduction of mobile-satellite systems are urged to implement, as practicable, the latest available technologies to improve spectrum efficiency consistent with the requirement to offer viable MSS services;

3 to recommend that administrations be encouraged to use the most advanced technology available when preparing to implement their global MSS systems in the 1-3 GHz range so that they may operate, if necessary, in different frequency bands in different regions, in accordance with the MSS allocations in the 1-3 GHz range decided by WRC-97.

RESOLUTION 217 (REV.WRC-23)

Implementation of wind profiler radars

The World Radiocommunication Conference (Dubai, 2023),

having noted

a request to ITU from the Secretary-General of the World Meteorological Organization (WMO), in May 1989, for advice and assistance in the identification of appropriate frequencies near 50 MHz, 400 MHz and 1 000 MHz in order to accommodate allocations and assignments for wind profiler radars,

considering

a) that wind profiler radars are vertically-directed Doppler radars exhibiting characteristics similar to radiolocation systems;

b) that wind profiler radars are important meteorological systems used to measure wind direction and speed as a function of altitude;

c) that it is necessary to use frequencies in different ranges in order to have options for different performance and technical characteristics;

d) that, in order to conduct measurements up to a height of 30 km, it is necessary to allocate frequency bands for these radars in the general vicinity of 50 MHz (3 to 30 km), 400 MHz (500 m to about 10 km) and 1 000 MHz (100 m to 3 km);

e) that some administrations have either already deployed, or plan to expand their use of, wind profiler radars in operational networks for studies of the atmosphere and to support weather monitoring, forecasting and warning programmes;

f) that the Radiocommunication Study Groups have studied the technical and sharing considerations between wind profiler radars and other services allocated in bands near 50 MHz, 400 MHz and 1 000 MHz,

considering further

a) that some administrations have addressed this matter nationally by assigning frequencies for use by wind profiler radars in existing radiolocation bands or on a non-interference basis in other bands;

b) the work of the Voluntary Group of Experts on the Allocation and Improved Use of the Radio-Frequency Spectrum and Simplification of the Radio Regulations supports increased flexibility in the allocation of frequency spectrum,

noting in particular

a) that wind profiler radars operating in the meteorological aids service in the frequency band 400.15-406 MHz interfere with satellite emergency position-indicating radio beacons operating in the mobile-satellite service in the frequency band 406-406.1 MHz under No. **5.266**;

b) that in accordance with No. **5.267**, any emission capable of causing harmful interference to the authorized uses of the frequency band 406-406.1 MHz is prohibited,

resolves

1 to urge administrations to implement wind profiler radars as radiolocation service systems in the following bands, having due regard to the potential for incompatibility with other services and assignments to stations in these services, thereby taking due account of the principle of geographical separation, in particular with regard to neighbouring countries, and keeping in mind the category of service of each of these services:

46-68 MHz in accordance with No. **5.162A**

440-450 MHz

470-494 MHz in accordance with No. **5.291A**

904-928 MHz in Region 2 only

1 270-1 295 MHz

1 300-1 375 MHz;

2 that, in case compatibility between wind profiler radars and other radio applications operating in the frequency band 440-450 MHz or 470-494 MHz cannot be achieved, the frequency bands 420-435 MHz or 438-440 MHz could be considered for use;

3 to urge administrations to implement wind profiler radars in accordance with the most recent versions of Recommendations ITU-R M.1226, ITU-R M.1085 and ITU-R M.1227 for the frequency bands around 50 MHz, 400 MHz and 1 000 MHz, respectively;

4 to urge administrations not to implement wind profiler radars in the frequency band 400.15-406 MHz;

5 to urge administrations currently operating wind profiler radars in the frequency band 400.15-406 MHz to discontinue them as soon as possible,

instructs the Secretary-General

to bring this Resolution to the attention of the International Civil Aviation Organization, International Maritime Organization and WMO.

RESOLUTION 218 (WRC-23)

Use of high-altitude platform stations as International Mobile Telecommunications base stations in the frequency band 2 500-2 690 MHz, or portions thereof[1]

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that there is growing demand for access to mobile broadband, requiring more flexibility in the approaches to expand the capacity and coverage provided by International Mobile Telecommunications (IMT) systems;

b) that high-altitude platform stations (HAPS) as IMT base stations (HIBS) would be used as part of terrestrial IMT networks and may use the same frequency bands as ground-based IMT base stations in order to provide mobile-broadband connectivity to underserved communities, and in rural and remote areas;

c) that HIBS would offer a new means of providing IMT services with minimal network infrastructure, as they are capable of providing service to a large footprint together with a dense coverage;

d) that the use of HIBS is optional for administrations, and that such use should not have any priority over other terrestrial IMT use;

e) that the mobile station to be served, whether by HIBS or ground-based IMT base stations, is the same, and currently supports a variety of the frequency bands identified for IMT;

f) that, under certain deployment scenarios, platform transmissions in the frequency band 2 500-2 690 MHz may occur at altitudes down to 18 km, and some sensitivity studies have shown that the difference of interference at this altitude would be negligible;

g) that the ITU Radiocommunication Sector (ITU-R) has addressed sharing and compatibility between HIBS and existing systems of primary allocated services in the frequency band 2 500-2 690 MHz and services in the adjacent bands;

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[1] HIBS: High-altitude platform station as IMT base station. The conditions in this Resolution refer to these platforms operating between 18 km and 25 km.

h) that the frequency band 2 690-2 700 MHz is allocated to the Earth exploration-satellite service (passive), the space research service (passive) and the radio astronomy service, and that No. **5.340** applies in this frequency band,

recognizing

a) that a HAPS is defined in No. **1.66A** as a station located on an object at an altitude of 20 to 50 km and at a specified, nominal, fixed point relative to the Earth;

b) that, in Regions 1 and 2, the frequency band 2 500-2 690 MHz (the frequency band 2 500-2 510 MHz is limited to reception by HIBS in Regions 1 and 2), and, in Region 3, the frequency band 2 500-2 655 MHz (the frequency band 2 500-2 535 MHz is limited to reception by HIBS in Region 3) are included in No. **5.409A** for the use of HIBS;

c) that the frequency band 2 500-2 690 MHz, or parts thereof, is identified for IMT in accordance with No. **5.384A**;

d) that this frequency band is allocated to the fixed and mobile services on a co-primary basis;

e) that, in the frequency band 2 700-2 900 MHz, ground-based meteorological radar stations under the radiolocation service are authorized to operate on a basis of equality with stations of the aeronautical radionavigation service, according to No. **5.423**,

resolves

1 that administrations wishing to implement HIBS shall comply with the following:

1.1 for the purpose of protecting the mobile service, including IMT terrestrial systems in the territory of other administrations in the frequency band 2 500-2 690 MHz, the power flux-density (pfd) level per HIBS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limits:

– the pfd level per HIBS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limit for the protection of IMT mobile stations, unless explicit agreement of the affected administration is provided:

-109 dB(W/(m^2 · MHz)) for $0° < \theta \leq 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

– the pfd level per HIBS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limits for the protection of IMT base stations, unless explicit agreement of the affected administration is provided:

-144.55 dB(W/(m^2 · MHz)) for $0° \leq \theta < 11°$

$-144.55 + 0.45\,(\theta - 11)$ dB(W/(m^2 · MHz)) for $11° \leq \theta < 80°$

-113.55 dB(W/(m^2 · MHz)) for $80° \leq \theta \leq 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees[2];

[2] The pfd levels to protect IMT base stations will apply unless the affected administration informs the Radiocommunication Bureau that only terminal stations need to be protected.

1.2 for the purpose of protecting the mobile service including IMT terrestrial systems in the territories of Armenia, Azerbaijan, Belarus, the Russian Federation, Kazakhstan, Mongolia, Uzbekistan, Kyrgyzstan, the Democratic People's Republic of Korea, Tajikistan and Turkmenistan in the frequency band 2 500-2 690 MHz, the pfd level per HIBS produced at the surface of the Earth in the territories of the countries listed above in this *resolves* shall not exceed the following limits, unless explicit agreement is received from the administration affected:

-147	dB(W/(m^2 · MHz))	for	$0° \le \theta < 11°$
$-147 + 0.45\ (\theta - 11)$	dB(W/(m^2 · MHz))	for	$11° \le \theta < 80°$
-116	dB(W/(m^2 · MHz))	for	$80° \le \theta < 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

1.3 for the purpose of protecting fixed-service systems in the territory of other administrations in the frequency band 2 500-2 690 MHz, the pfd level per HIBS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limits, unless explicit agreement of the affected administration is provided:

-148	dB(W/(m^2 · MHz))	for	$0° < \theta \le 2°$
$-148 + 0.71\ (\theta - 2)$	dB(W/(m^2 · MHz))	for	$2° < \theta \le 47°$
-116	dB(W/(m^2 · MHz))	for	$47° < \theta \le 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

1.4 for the purpose of protecting the broadcasting-satellite service (BSS) in the territory of other administrations in the frequency band 2 520-2 630 MHz, the pfd level per HIBS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limits, unless explicit agreement is received from the administration affected:

-130.5	dB(W/(m^2 · MHz))	for	$0° < \theta \le 20°$
-139.8	dB(W/(m^2 · MHz))	for	$20° < \theta < 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

1.4.1 in addition, in Region 3, in the frequency band 2 520-2 630 MHz, the use of HIBS shall not cause unacceptable interference to, nor claim protection from, the BSS operating in Region 3;

1.5 for the purpose of protecting aeronautical-radionavigation service systems in the territory of other administrations in the frequency band 2 700-2 900 MHz, the pfd level per HIBS operating in the frequency band 2 500-2 690 MHz produced at the surface of the Earth in the territory of other administrations shall not exceed the following unwanted emissions limits, unless explicit agreement of the affected administration is provided:

-156.2	dB(W/(m^2 · MHz))	for	$\theta \le 7°$
$-163 + 15 \cdot \log_{10} (\theta - 4)$	dB(W/(m^2 · MHz))	for	$7° < \theta < 30.5°$
$-141 + 2.7 \cdot \log_{10} (\theta - 4)$	dB(W/(m^2 · MHz))	for	$\theta = 30.5°$
$-157 + 14 \cdot \log_{10} (\theta - 4)$	dB(W/(m^2 · MHz))	for	$30.5° < \theta \le 40.5°$
-101.5	dB(W/(m^2 · MHz))	for	$\theta > 40.5°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

1.6 for the purpose of protecting radiolocation service systems in the territory of other administrations, in particular those systems operating in accordance with No. **5.423** in the frequency band 2 700-2 900 MHz, the pfd level per HIBS operating in the frequency band 2 500-2 690 MHz produced at the surface of the Earth in the territory of other administrations shall not exceed the following unwanted emissions limits, unless explicit agreement of the affected administration is provided:

-165.6	dB(W/(m^2 · MHz))	for	$\theta \leq 37°$
$-165.6 + 5.5\ (\theta - 37)$	dB(W/(m^2 · MHz))	for	$37° < \theta < 45°$
$-121.6 + (\theta - 45) / 3$	dB(W/(m^2 · MHz))	for	$45° < \theta \leq 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

1.7 for the purpose of protecting radio astronomy service stations in the frequency band 2 690-2 700 MHz, the pfd level of HIBS operating in the frequency band 2 500-2 690 MHz produced at any radio astronomy observatory site shall not exceed the following unwanted emissions limit, unless explicit agreement of the affected administration is provided:

-177 dB(W/(m^2 · 10 MHz));

1.8 *resolves* 1.7 applies at any radio astronomy station that was in operation prior to 15 December 2023 and has been notified to the Radiocommunication Bureau in the frequency band 2 690-2 700 MHz before 17 May 2024, or at any radio astronomy station that was notified before the date of receipt of the complete Appendix **4** information for notification, for the HIBS system to which *resolves* 1.6 applies; for radio astronomy stations notified after these dates an agreement needs to be sought with administrations that have notified HIBS;

1.9 for the purpose of protecting the mobile-satellite service (MSS) (space-to-Earth) and radiodetermination-satellite service (space-to-Earth) in the frequency band 2 483.5-2 500 MHz, the use of HIBS in the frequency band 2 500-2 690 MHz shall comply with an unwanted emission limit of −30 dBm/MHz in the frequency band 2 483.5-2 500 MHz;

1.10 for the purpose of protecting MSS (Earth-to-space) in the frequency band 2 655-2 690 MHz in Region 3, the notifying administration of HIBS shall ensure an enforceable commitment that, in case of causing unacceptable interference, it undertakes to immediately cease emission or reduce the interference to an acceptable level;

2 that administrations intending to implement HIBS systems shall notify, in accordance with Article **11**, the frequency assignments to transmitting and receiving HIBS stations by submitting all mandatory elements of Appendix **4** to the Bureau for the examination of compliance with the conditions specified in the *resolves* above;

3 that the notifying administration of HIBS at the time of submission of the Appendix **4** information shall provide a firm, objective, actionable, measurable and enforceable commitment to the Bureau to immediately eliminate unacceptable interference to existing primary services or reduce it to an acceptable level should such interference occur,

invites administrations

to adopt appropriate frequency arrangements for HIBS in order to consider the benefits of harmonized utilization of the spectrum for HIBS and protection of existing services and systems operating on a primary basis taking into account the *resolves* above and the relevant ITU-R Recommendations and Reports,

instructs the Director of the Radiocommunication Bureau

to take all necessary measures to implement this Resolution.

RESOLUTION 219 (WRC-23)

Terrestrial component of International Mobile Telecommunications in the frequency band 10-10.5 GHz in Region 2

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that International Mobile Telecommunications (IMT), including IMT-2000, IMT-Advanced and IMT-2020, is intended to provide telecommunication services on a worldwide scale, regardless of location and type of network or terminal;

b) that adequate and timely availability of spectrum and supporting regulatory provisions are essential to realize the objectives set out in Recommendation ITU-R M.2083;

c) that there is a need to continually take advantage of technological developments in order to increase the efficient use of spectrum and facilitate spectrum access;

d) that IMT systems are now evolving to cover diverse usage scenarios and applications, such as enhanced mobile broadband, massive machine-type communications and ultra-reliable and low-latency communications,

recognizing

a) that timely availability of wide and contiguous blocks of spectrum is important to support the development of IMT;

b) that the frequency band 10.6-10.68 GHz is allocated on a primary basis to both active and passive services with the specific conditions outlined in Resolution **751 (WRC-07)**, based on the conclusions of the studies contained in Report ITU-R RS.2096, which allow for sharing with the Earth exploration-satellite service (EESS) (passive);

c) that the frequency band 10.68-10.7 GHz is globally allocated to passive services, including the radio astronomy service, and No. **5.340** applies;

d) that the frequency band 10-10.4 GHz is allocated to the EESS (active), whose capability to perform very high-resolution cloud-free imaging offers a multitude of benefits to society, such as topographic and cadastral mapping, urban planning, emergency management, climate change monitoring and enhanced maritime monitoring;

e) that the use of the frequency band 10-10.5 GHz for IMT is only intended for microcell base stations,

resolves

1 that administrations wishing to implement IMT consider use of the frequency band 10-10.5 GHz identified for IMT in No. **5.480A** in countries in Region 2, taking into account the most recent versions of relevant ITU-R Recommendations;

2 that administrations shall take practical measures to ensure that transmitting antennas of outdoor base stations are normally pointing below the horizon when deploying IMT base stations within the frequency band 10-10.5 GHz; the mechanical pointing needs to be at or below the horizon;

3 that the maximum equivalent isotropically radiated power (e.i.r.p.) per base station shall not exceed 30 dB(W/100 MHz) and that the maximum e.i.r.p. per base station for elevation angles higher than 34 degrees shall not exceed 0.5 dB(W/100 MHz);

4 that, for the purposes of protecting the EESS (passive), and considering the conditions under *resolves* 3, the total radiated power (TRP)[1] produced per IMT base station operating in the frequency band 10-10.5 GHz shall not exceed −37.9 dB(W/100 MHz) in the frequency band 10.6-10.7 GHz;

5 that, for the purposes of protecting the EESS (passive), the TRP produced by IMT user equipment operating in the frequency band 10-10.5 GHz shall not exceed −39 dB(W/100 MHz) in the frequency band 10.6-10.7 GHz;

6 that IMT stations within the frequency range 10-10.5 GHz shall be used only for applications of the land mobile service,

invites the ITU Radiocommunication Sector

1 to develop harmonized frequency arrangements to facilitate IMT deployment in the frequency band 10-10.5 GHz, taking into account the results of sharing and compatibility studies conducted in preparation for WRC-23;

2 to continue providing guidance to ensure that IMT can meet the telecommunication needs of developing countries;

3 to develop an ITU Radiocommunication Sector (ITU-R) Report and/or Recommendation on methodologies for calculating coordination zones around radio astronomy stations operating in the frequency band 10.6-10.7 GHz in order to avoid harmful interference from IMT systems operating in the frequency band 10-10.5 GHz;

4 to review existing ITU-R Recommendations/Reports and, as appropriate, to update them or develop new ITU-R Recommendations to provide information and assistance to the administrations concerned regarding possible coordination measures for fixed-service stations with IMT stations in the frequency band 10-10.5 GHz,

instructs the Director of the Radiocommunication Bureau

to bring this Resolution to the attention of relevant international organizations.

[1] The TRP is to be understood here as the integral of the power transmitted from all antenna elements in different directions over the entire radiation sphere.

RESOLUTION 220 (WRC-23)

Terrestrial component of International Mobile Telecommunications (IMT) within the frequency band 6 425-7 125 MHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that International Mobile Telecommunications (IMT), including IMT-2000, IMT-Advanced and IMT-2020, is the ITU vision for global mobile access, and is intended to provide telecommunication services on a worldwide scale, regardless of location and type of network or terminal;

b) that harmonized worldwide frequency bands for IMT are desirable in order to achieve global roaming and the benefits of economies of scale;

c) that identification of frequency bands allocated to the mobile service for IMT may change the sharing situation regarding applications of services to which the frequency band is already allocated, and may require regulatory actions;

d) that it is assumed that only a very limited number of IMT base stations will be communicating with a positive elevation angle towards IMT indoor mobile stations;

e) that the frequency band 6 425-7 125 MHz, or parts thereof, is allocated on a primary basis to the fixed, mobile, fixed-satellite (Earth-to-space) (space-to-Earth) and space operation services (Earth-to-space);

f) that, in the frequency band 6 650-6 675.2 MHz, radio astronomy observations are carried out under No. **5.149** for measurement of methanol spectral lines;

g) that No. **5.458** states that, in the band 6 425-7 075 MHz, "passive microwave sensor measurements are carried out over the oceans. In the band 7 075-7 250 MHz, passive microwave sensor measurements are carried out. Administrations should bear in mind the needs of the Earth exploration-satellite (passive) and space research (passive) services in their future planning of the bands 6 425-7 075 MHz and 7 075-7 250 MHz";

h) that existing satellite networks of the fixed-satellite service (FSS) (Earth-to-space) are used within the frequency band 6 425-7 075 MHz, or parts thereof, and their characteristics may evolve in the future;

i) that the frequency band 6 425-7 125 MHz, or parts thereof, is also used by other applications in the mobile service;

j) that the frequency band 7 100-7 155 MHz is allocated on a primary basis to the space operation services (Earth-to-space) in the Russian Federation, in accordance with No. **5.459**;

k) that the frequency band 7 145-7 190 MHz is allocated on a primary basis to the space research service (SRS) (deep space);

l) that the frequency band 6 725-7 025 MHz is included in Appendix **30B** and used to provide a plan to guarantee in practice, for all countries, equitable access to the geostationary satellite orbit (GSO) in the frequency bands of the FSS;

m) that expected equivalent isotropically radiated power (e.i.r.p.) limits have been established which require assessment for compliance in equipment conformance tests;

n) that the frequency band 6 700-7 075 MHz (space-to-Earth) is used for feeder links of non-geostationary satellite systems of the mobile-satellite service (MSS), in accordance with No. **5.458B**;

o) that the frequency band 6 425-7 075 MHz in the FSS can be used to provide feeder links in the MSS;

p) that the FSS is currently used to provide feeder links in the MSS to enhance maritime services within the frequency band 6 425-6 575 MHz,

noting

a) Resolutions **223 (Rev.WRC-23)**, **224 (Rev.WRC-23)**, **225 (Rev.WRC-23)**, **241 (Rev.WRC-23)**, **242 (Rev.WRC-23)** and **243 (Rev.WRC-23)**, which also relate to IMT;

b) that the IMT terrestrial radio interfaces as defined in Recommendations ITU-R M.1457, ITU-R M.2012 and ITU-R M.2150 are expected to evolve within the framework of the ITU Radiocommunication Sector (ITU-R) beyond those initially specified, to provide enhanced services and services beyond those envisaged in the initial implementation;

c) that Recommendation ITU-R M.2160 outlines the framework and overall objectives of the future development of IMT for 2030 and beyond;

d) that Recommendation ITU-R M.2083 provides the IMT Vision – Framework and overall objectives of the future development of IMT for 2020 and beyond,

recognizing

a) that the identification of a frequency band for IMT does not establish priority in the Radio Regulations and does not preclude the use of the frequency band by any application of the services to which it is allocated;

b) that studies have shown that the protection of feeder links for the non-GSO FSS (space-to-Earth) requires the determination of protection distances ranging between a few kilometres to tens of kilometres; these protection distances are site-specific and depend on several elements, such as the propagation parameters, local terrain topography, and station and orbital parameters of the feeder links for the non-GSO FSS (space-to-Earth);

c) that studies have shown that co-channel coexistence between IMT and the fixed service can be achieved but may require cross-border coordination between countries;

d) that studies have shown that co-channel coexistence between IMT and the fixed service can be achieved but would require site-by-site coordination if IMT and the fixed service are deployed in the same or adjacent geographical areas;

e) that a later deployment of IMT may be considered by those administrations wishing to migrate the fixed service to other frequency bands,

resolves

1 that administrations wishing to implement IMT in accordance with Nos. **5.457D**, **5.457E**, and **5.457F** consider use of the frequency bands referred to in those footnotes, taking into account the most recent versions of the relevant ITU-R Recommendations;

2 that, in order to ensure protection for the FSS (Earth-to-space), and taking into account *considering d)*, the level of expected e.i.r.p. spectral density emitted by an IMT base station as a function of the vertical angle above the horizon shall not exceed the following values (No. **21.5** does not apply):

Vertical angle range $\theta_L \leq \theta < \theta_H$ (vertical angle θ above horizon)	Expected e.i.r.p. (dBm/MHz) (See NOTES 1, 2 and 3)
$0° \leq \theta < 5°$	27
$5° \leq \theta < 10°$	23
$10° \leq \theta < 15°$	19
$15° \leq \theta < 20°$	18
$20° \leq \theta < 30°$	16
$30° \leq \theta < 60°$	15
$60° \leq \theta \leq 90°$	15

NOTE 1: The expected e.i.r.p. is defined as the average value of the e.i.r.p., with the averaging being performed:

– over horizontal angles from −180° to +180°, with the IMT base station beamforming in a specific direction within its horizontal and vertical steering range,

– over different beamforming directions within the IMT base station horizontal and vertical steering range, and

– over the specified vertical angle range $\theta_L \leq \theta < \theta_H$.

NOTE 2: An IMT base station shall comply with the specified limits on expected e.i.r.p. spectral density for all mechanical tilts with which it can be deployed, taking into account *considering m)*.

NOTE 3: See the Annex to this Resolution for additional details on how the expected e.i.r.p. can be calculated for this frequency band.

3 that administrations wishing to implement IMT in the frequency band 6 700-7 075 MHz shall ensure the protection, continued use and future development of FSS (space-to-Earth) stations through the adoption of site-specific coordination,

invites administrations

1 to take into account the benefits of harmonized utilization of the spectrum for the terrestrial component of IMT;

2 to ensure that provisions for the implementation of IMT do not adversely affect the operation of FSS earth stations and their future development;

3 to take all practical steps to protect the radio astronomy service (RAS) from harmful interference in the frequency band 6 650-6 675.2 MHz, which covers spectral lines of importance for current astronomical investigations, in accordance with No. **5.149**,

invites the ITU Radiocommunication Sector

1 to develop harmonized frequency arrangements to facilitate IMT deployment within the frequency band 6 425-7 125 MHz;

2 to continue providing guidance to ensure that IMT can meet the telecommunication needs of developing countries;

3 to develop a Recommendation to address methods for the determination of the protection area around a non-GSO earth station in the frequency band 6 700-7 075 MHz from an IMT base station;

4 to update existing ITU-R Recommendations/Reports or develop new ITU-R Recommendations/Reports, as appropriate, to provide information and assistance to the administrations concerned on possible coordination of stations in the fixed service with IMT stations in the frequency band 6 425-7 125 MHz;

5 to regularly review, as appropriate, the impact of evolving technical and operational characteristics of IMT systems (including base-station density) on sharing and compatibility with space services, and to take into account the results of these reviews in the development and/or revision of ITU-R Recommendations/Reports addressing, *inter alia*, if necessary, applicable measures to mitigate the risk of interference into space services;

6 to develop an ITU-R Recommendation to address methods for the determination of the protection area around existing RAS stations from IMT stations in the frequency band 6 650-6 675.2 MHz;

7 to update existing ITU-R Recommendations/Reports or develop new ITU-R Recommendations/Reports, as appropriate, to provide information and assistance to the administrations concerned on possible coordination of SRS (deep space) stations operating in the band 7 145-7 190 MHz with IMT stations operating in the frequency band 6 425-7 125 MHz,

instructs the Director of the Radiocommunication Bureau

to bring this Resolution to the attention of relevant international organizations.

ANNEX TO RESOLUTION 220 (WRC-23)

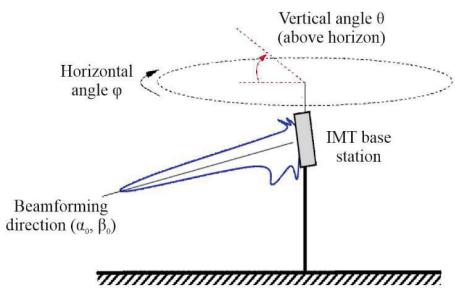
Details for the calculation of the expected equivalent isotropically radicated power of an International Mobile Telecommunications base station operating within the frequency band 6 425-7 125 MHz

This annex outlines the theoretical calculation of the expected equivalent isotropically radiated power (e.i.r.p.) of an International Mobile Telecommunications (IMT) base station for assessing the compliance of IMT base station equipment with the limit on expected e.i.r.p.

The e.i.r.p. of an IMT base station in the horizontal (azimuth) direction $-\pi \leq \varphi \leq \pi$ and vertical (elevation) direction $0 \leq \theta \leq \pi/2$ above the horizon can be written as $P(\theta, \varphi; \alpha, \beta)$. The parameters α and β are the horizontal and vertical beamforming directions, i.e. the angles towards which the base station electronically steers a beam. These are illustrated in Figure 1 below.

FIGURE 1

Illustration of horizontal (azimuth) angle, vertical (elevation) angle and beamforming directions



The expected e.i.r.p. $\bar{P}_{\theta_L \theta_H}$ of an IMT base station within a vertical angle range $\theta_L \leq \theta < \theta_H$ can be calculated by averaging the e.i.r.p. $P(\theta, \varphi; \alpha, \beta)$ of the base station as follows:

1) **Averaging over beamforming directions for a given vertical angle θ_0 and horizontal angle φ_0: for an AAS base station within a given horizontal and vertical steering range,** a sufficient sampling of N beamforming directions (α_n, β_n) $n = 1 \ldots N$ is necessary to allow an accurate averaging of the expected e.i.r.p.

The beamforming directions (α_n, β_n) have a uniform statistical angular distribution within the steering range of the IMT base station. In other words:

$$P_1(\theta_0, \varphi_0) = \sum_{n=1}^{N} w_n P(\theta_0, \varphi_0; \alpha_n, \beta_n)$$

where w_n refers to the weight for the nth beamforming direction, i.e. the fraction of the steering range represented by the nth beamforming direction. For example, $w_n = 1/N$ in the case that N uniform equispaced beams are assumed in the azimuth and elevation, respectively, and where each beam covers an equal range of angles.

The set of base station configurations over which the base station complies with the limits on expected e.i.r.p. (for example, power of steering range as one of the parameters) shall be declared and the BS shall be used within one of these configurations.

The set of e.i.r.p. values used to calculate the expected e.i.r.p. for each vertical angle range shall be a mathematical summation of both polarization states of the IMT base station antenna with no polarization discrimination.

For a non-AAS base station, $P_1(\theta_0, \varphi_0) = P(\theta_0, \varphi_0; \alpha_1, \beta_1)$ where $\alpha_1 = 0$ and β_1 is the electrical tilt.

It is noted that the compliance with the limits on expected e.i.r.p. should be limited to a defined range of electrical tilts.

2) **Averaging over horizontal and vertical angles**: the expected e.i.r.p. is then calculated by averaging the results of step 1 over horizontal angles φ from $-\pi$ to $+\pi$ with respect to the base station horizontal boresight, and vertical angles θ within vertical angle range $\theta_L \leq \theta < \theta_H$ with respect to the horizon. In other words:

$$\bar{P}_{\theta_L \theta_H} = \frac{1}{2\pi(\sin\theta_H - \sin\theta_L)} \int_{\theta_L}^{\theta_H} \int_{-\pi}^{\pi} P_1(\theta, \varphi) \cos(\theta) d\varphi d\theta$$

The averaging processes in steps 1 and 2 shall allow for accurate averaging of the expected e.i.r.p. (e.g. to the confidence interval of 95%).

RESOLUTION 221 (REV.WRC-23)

Use of high altitude platform stations as International Mobile Telecommunications base stations in the frequency bands 1 710-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz[1]

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that there is growing demand for access to mobile broadband, requiring more flexibility in approaches to expanding the capacity and coverage provided by International Mobile Telecommunications (IMT) systems;

b) that high-altitude platform stations (HAPS) as IMT base stations (HIBS) would be used as part of terrestrial IMT networks and may use the same frequency bands as ground-based IMT base stations in order to provide mobile-broadband connectivity to underserved communities, and in rural and remote areas;

c) that HIBS would offer a new means of providing IMT services with minimal network infrastructure as they are capable of providing service to a large footprint together with a dense coverage;

d) that the use of HIBS is optional for administrations, and that such use should not have any priority over other terrestrial IMT use;

e) that the mobile station to be served, whether by HIBS or ground-based IMT base stations, is the same, and currently supports a variety of the frequency bands identified for IMT;

f) that, under certain deployment scenarios, platform transmissions in the frequency bands 1 710-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz may occur at altitudes down to 18 km, and some sensitivity studies have shown that the difference of interference at this altitude would be negligible;

g) that the ITU Radiocommunication Sector (ITU-R) has addressed sharing and compatibility between HIBS and existing systems of primary allocated services in the frequency bands 1 710-2 025 MHz and 2 110-2 200 MHz and services in the adjacent bands;

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[1] HIBS: High-altitude platform station as IMT base station. The conditions in this Resolution refer to these platforms operating between 18 km and 25 km.

h) that the conclusion of the compatibility studies between HIBS operating above 1 710 MHz and meteorological-satellite service (MetSat) operations in the adjacent frequency band 1 670-1 710 MHz has assumed that the use of HIBS in the frequency band 1 710-1 785 MHz is limited to reception by HIBS;

i) that the conclusion of the compatibility studies between HIBS operating above 2 110 MHz and space research service (SRS)/space operation service/Earth exploration-satellite service operations in the adjacent frequency band 2 025-2 110 MHz and the conclusion of the sharing studies between HIBS and SRS in the frequency band 2 110-2 120 MHz have both assumed that the use of HIBS in the frequency band 2 110-2 170 MHz is limited to transmission from HIBS,

recognizing

a) that a HAPS is defined in No. **1.66A** as a station located on an object at an altitude of 20 to 50 km and at a specified, nominal, fixed point relative to the Earth;

b) that, in Regions 1 and 3, the frequency bands 1 710-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz and, in Region 2, the frequency bands 1 710-1 980 MHz and 2 110-2 160 MHz are included in No. **5.388A** for the use of HIBS;

c) that the frequency bands 1 710-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz, or parts thereof, are identified for IMT in accordance with Nos. **5.384A** and **5.388**;

d) that these frequency bands are allocated to the fixed and mobile services on a co-primary basis,

resolves

1 that administrations wishing to implement HIBS shall comply with the following:

1.1 for the purpose of protecting the mobile service, including IMT terrestrial systems, in the territory of neighbouring administrations in the frequency band 1 710-1 885 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz, the following limits on power flux-density (pfd) shall apply:

– the pfd level per HIBS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limit for the protection of IMT mobile stations, unless explicit agreement of the affected administration is provided:

$$-111 \quad \text{dB(W/(m}^2 \cdot \text{MHz))} \quad \text{for} \quad 0° < \theta \leq 90°$$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

– the pfd level per HIBS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limit for the protection of IMT base stations, unless explicit agreement of the affected administration is provided:

−144.55	dB(W/(m^2 · MHz))	for	$0° \le \theta < 11°$
−144.55 + 0.45 (θ − 11)	dB(W/(m^2 · MHz))	for	$11° \le \theta < 80°$
−113.55	dB(W/(m^2 · MHz))	for	$80° \le \theta \le 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees[2].

1.2 for the purpose of protecting mobile service systems including IMT terrestrial systems in the territories of Armenia, Azerbaijan, Belarus, the Russian Federation, Kazakhstan, Mongolia, Uzbekistan, Kyrgyzstan, the Democratic People's Republic of Korea, Tajikistan and Turkmenistan, in the frequency bands 1 710-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz, the pfd level per HIBS produced at the surface of the Earth in the territories of the countries listed above in this *resolves* shall not exceed the following limits, unless explicit agreement of the affected administration is provided:

−145	dB(W/(m^2 · MHz))	for	$0° \le \theta < 11°$
−145 + 0.4347 (θ − 11)	dB(W/(m^2 · MHz))	for	$11° \le \theta < 80°$
−115	dB(W/(m^2 · MHz))	for	$80° \le \theta < 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

1.3 for the purpose of protecting fixed-service systems in the territory of other administrations in the frequency bands 1 710-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz, the pfd level per HIBS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limits, unless explicit agreement of the affected administration is provided:

−150	dB(W/(m^2 · MHz))	for	$0° < \theta \le 2°$
−150 + 1.78 (θ − 2)	dB(W/(m^2 · MHz))	for	$2° < \theta \le 20°$
−118 + 0.215 (θ − 20)	dB(W/(m^2 · MHz))	for	$20° < \theta \le 48°$
−112	dB(W/(m^2 · MHz))	for	$48° < \theta \le 90°$

[2] The pfd levels to protect IMT base stations will apply unless the affected administration informs the Radiocommunication Bureau that only terminal stations need to be protected.

1.4 for the purpose of protecting fixed-service systems in the territories of Armenia, Azerbaijan, Belarus, the Russian Federation, Kazakhstan, Mongolia, Uzbekistan, Kyrgyzstan, the Democratic People's Republic of Korea, Tajikistan and Turkmenistan in the frequency bands 1 710-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz, the pfd level per HIBS produced at the surface of the Earth in the territories of the countries listed above in this *resolves* shall not exceed the following limits, unless explicit agreement of the affected administration is provided:

-165	dB(W/(m^2 · MHz))	for	$0° < \theta \leq 5°$
$-165 + 1.75\ (\theta - 5)$	dB(W/(m^2 · MHz))	for	$5° < \theta \leq 25°$
-130	dB(W/(m^2 · MHz))	for	$25° < \theta \leq 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

1.5 in order to protect fixed-service systems in Armenia, Azerbaijan, Belarus, the Russian Federation, Kazakhstan, Mongolia, Uzbekistan, Kyrgyzstan, Tajikistan and Turkmenistan from interference, a HIBS shall not exceed the following limits on out-of-band pfd at the surface of the Earth in the territories of the countries listed above in this *resolves* in the frequency band 2 025-2 110 MHz:

-165	dB(W/(m^2 · MHz))	for	$0° < \theta \leq 5°$
$-165 + 1.75\ (\theta - 5)$	dB(W/(m^2 · MHz))	for	$5° < \theta \leq 25°$
-130	dB(W/(m^2 · MHz))	for	$25° < \theta \leq 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees;

1.6 for the purpose of protecting mobile earth stations operating in the territory of other administrations in the frequency bands 2 160-2 200 MHz in Region 2 and 2 170-2 200 MHz in Regions 1 and 3, the pfd of the unwanted emissions per HIBS operating in the frequency bands 2 110-2 160 MHz in Region 2 and 2 110-2 170 MHz in Regions 1 and 3 produced at the surface of the Earth in the territory of other administrations shall not exceed the following limit:

-165 dB(W/(m^2 · 4 kHz));

1.7 for the protection of aeronautical mobile service systems operating in the frequency band 1 780-1 850 MHz from harmful interference, administrations planning to implement HIBS operating within 1 135 km of the border of the territory of other administrations in this frequency band shall obtain agreement with all affected administrations prior to implementation of HIBS unless otherwise agreed between the administrations concerned; this condition does not apply in the countries within the African Broadcasting Area, as described in Nos. **5.10**, **5.11**, **5.12** and **5.13**, and Algeria, Egypt, Libya and Morocco in Region 1;

2 that administrations intending to implement HIBS systems shall notify, in accordance with Article **11**, the frequency assignments to transmitting and receiving HIBS stations by submitting all mandatory elements of Appendix **4** to the Radiocommunication Bureau for the examination of compliance with the conditions specified in the *resolves* above;

3 the notifying administration of HIBS at the time of submission of the Appendix **4** information shall provide a firm, objective, actionable, measurable, and enforceable commitment to the Bureau to immediately eliminate unacceptable interference to existing primary services or reduce it to an acceptable level should such interference occur,

invites administrations

to adopt appropriate frequency arrangements for HIBS in order to consider the benefits of harmonized utilization of the spectrum for HIBS and protection of existing services and systems operating on a primary basis taking into account the *resolves* above and the relevant ITU-R Recommendations and Reports,

instructs the Director of the Radiocommunication Bureau

to take all necessary measures to implement this Resolution.

RESOLUTION 222 (REV.WRC-23)

Use of the frequency bands 1 525-1 559 MHz and 1 626.5-1 660.5 MHz by the mobile-satellite service, and procedures to ensure long-term spectrum access for the aeronautical mobile-satellite (R) service

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that prior to WRC-97, the frequency bands 1 530-1 544 MHz (space-to-Earth) and 1 626.5-1 645.5 MHz (Earth-to-space) were allocated to the maritime mobile-satellite service and the frequency bands 1 545-1 555 MHz (space-to-Earth) and 1 646.5-1 656.5 MHz (Earth-to-space) were allocated on an exclusive basis to the aeronautical mobile-satellite (R) service (AMS(R)S) in most countries;

b) that WRC-97 allocated the frequency bands 1 525-1 559 MHz (space-to-Earth) and 1 626.5-1 660.5 MHz (Earth-to-space) to the mobile-satellite service (MSS) to facilitate the assignment of spectrum to multiple MSS systems in a flexible and efficient manner;

c) that WRC-97 adopted No. **5.353A** giving priority to accommodating spectrum requirements for, and protecting from unacceptable interference, distress, urgency and safety communications of the global maritime distress and safety system (GMDSS) in the frequency bands 1 530-1 544 MHz and 1 626.5-1 645.5 MHz and No. **5.357A** giving priority to accommodating spectrum requirements for, and protecting from unacceptable interference, AMS(R)S communications as defined within priority categories 1 to 6 in Article **44** for the frequency bands 1 545-1 555 MHz and 1 646.5-1 656.5 MHz;

d) that AMS(R)S systems are an essential element of the International Civil Aviation Organization (ICAO) standardized communication infrastructure used in air traffic management for the provision of safety and regularity of flight in civil aviation;

e) that currently some MSS systems provide distress, emergency and safety communications under the MSS allocations in the frequency bands 1 525-1 559 MHz (space-to-Earth) and 1 626.5-1 660.5 MHz (Earth-to-space);

f) that it is necessary to ensure the long-term availability of the spectrum for AMS(R)S;

g) that it is necessary to retain unchanged the generic allocation for the MSS in the frequency bands 1 525-1 559 MHz and 1 626.5-1 660.5 MHz without placing undue constraints on the existing systems operating in accordance with the Radio Regulations,

further considering

a) that frequency coordination between satellite networks is required on a bilateral basis in accordance with the Radio Regulations, and that, in the frequency bands 1 525-1 559 MHz (space-to-Earth) and 1 626.5-1 660.5 MHz (Earth-to-space), frequency coordination is partially assisted by regional multilateral meetings;

b) that, in these frequency bands, geostationary mobile-satellite system operators currently use a capacity-planning approach at frequency coordination meetings, with the guidance and support of their administrations, to periodically coordinate access to the spectrum needed to accommodate their requirements;

c) that spectrum requirements for MSS networks, including the GMDSS and AMS(R)S, are currently accommodated through the capacity-planning approach and that, in the frequency bands to which Nos. **5.353A** or **5.357A** apply, this approach, supplemented, in the case of AMS(R)S, by additional procedures contained in the Annex to this Resolution, may assist in accommodating the long-term spectrum requirements for GMDSS and AMS(R)S;

d) that Report ITU-R M.2073 has concluded that prioritization and inter-system pre-emption between different mobile-satellite systems is not practical and, without a significant advance in technology, is unlikely to be feasible for technical, operational and economic reasons;

e) that there is existing and increasing demand for spectrum for AMS(R)S and non-AMS(R)S by several mobile satellite systems in the frequency bands 1 525-1 559 MHz and 1 626.5-1 660.5 MHz, and that the application of this Resolution may impact the provision of services by non-AMS(R)S systems in the MSS;

f) that according to the ITU-R studies, the long-term AMS(R)S spectrum requirements for communications within priority categories 1 to 6 of Article **44** have been estimated, at the year 2025, to be less than the available 2 × 10 MHz identified by No. **5.357A**;

g) that future requirements for GMDSS spectrum may require additional allocations,

recognizing

a) that Article 40 of the ITU Constitution establishes the priority of telecommunications concerning safety of life;

b) that ICAO has adopted standards and recommended practices addressing satellite communications with aircraft in accordance with the Convention on International Civil Aviation;

c) that all air traffic communications as defined in Annex 10 to the Convention on International Civil Aviation fall within priority categories 1 to 6 of Article **44**;

d) that Table 15-2 of Appendix **15** identifies the frequency bands 1 530-1 544 MHz (space-to-Earth) and 1 626.5-1 645.5 MHz (Earth-to-space) for distress and safety purposes in the maritime mobile-satellite service as well as for routine non-safety purposes;

e) that any administration having difficulty in applying the procedures of Articles **9** and **11** with respect to No. **5.357A** and this Resolution may at any time request assistance from the Radiocommunication Bureau and the Board under the relevant provisions of the Radio Regulations, including Article **7**, the relevant provisions of Articles **9** and **11**, as well as Articles **13** and **14**;

f) that ICAO has knowledge of aviation communication requirements,

noting

that, since spectrum resources are limited, there is a need to use them in the most efficient manner within and amongst various MSS systems, including GMDSS and AMS(R)S,

resolves

1 that, in frequency coordination of MSS networks in the frequency bands 1 525-1 559 MHz and 1 626.5-1 660.5 MHz, the notifying administrations of mobile-satellite networks shall ensure that the spectrum needed for distress, urgency and safety communications of GMDSS, as elaborated in Articles **32** and **33**, in the frequency bands where No. **5.353A** applies, and for the AMS(R)S communications within priority categories 1 to 6 of Article **44** in the frequency bands where No. **5.357A** applies, is accommodated;

2 that notifying administrations of mobile-satellite networks shall ensure the use of the latest technical advances in their mobile-satellite systems, in order to achieve the most flexible, efficient and practical use of the generic allocations;

3 that the notifying administrations of mobile-satellite networks shall ensure that, in the event that the spectrum requirements of MSS, including AMS(R)S, networks are decreasing relative to the previous frequency coordination meeting, the corresponding unused spectrum resources shall be released to facilitate efficient use of spectrum;

4 that the notifying administrations of mobile-satellite networks shall ensure that MSS operators carrying non-safety-related traffic yield capacity, as and when necessary, to accommodate the spectrum requirements for distress, urgency and safety communication of GMDSS communications, as elaborated in Articles **32** and **33**, and for AMS(R)S communications within priority categories 1 to 6 of Article **44**; this could be achieved in advance through the coordination process in *resolves* 1, and in the case of AMS(R)S the procedures contained in the Annex to this Resolution shall apply,

invites

1 administrations, if they so desire, to have their AMS(R)S traffic requirements submitted to ICAO before the frequency coordination meeting;

2 ICAO to evaluate and, as appropriate, comment on the AMS(R)S traffic requirements received from individual administrations, on the basis of the known global and regional aviation traffic requirements, including the time-scale of regional and global communication requirements,

instructs the Secretary-General

to bring this Resolution to the attention of ICAO.

ANNEX TO RESOLUTION 222 (REV.WRC-23)

Procedures to implement No. 5.357A and Resolution 222 (Rev.WRC-23)

1 The notifying administrations of planned MSS, including AMS(R)S, networks shall submit to the Radiocommunication Bureau (BR) the required technical characteristics and other relevant information of their MSS networks in accordance with Appendix **4**. Coordination of these MSS networks with other affected satellite networks operating in the frequency bands 1 525-1 559 MHz and 1 626.5-1 660.5 MHz shall proceed in accordance with Articles **9** and **11** and other relevant provisions of the Radio Regulations, as appropriate.

2 To further facilitate coordination under Articles **9** and **11**, the notifying administrations of MSS, including AMS(R)S, networks may authorize their respective MSS satellite operators, including AMS(R)S satellite operators, to enter into bilateral and multilateral coordination processes to obtain operator agreements on access to spectrum for their satellite networks.

3 At frequency coordination meetings, including operator meetings as referred to in 2 above, the notifying administration of each AMS(R)S network claiming priority under No. **5.357A**, or its respective satellite operator, shall present the spectrum requirements of each AMS(R)S network translated from their traffic requirements in accordance with an agreed methodology that considers the most recent version of Recommendation ITU-R M.2091 and was developed in response to Resolution **422 (WRC-12)**, and accompanied with the information justifying such requirements.

The participants to the frequency coordination meeting then collectively validate the requirements.

The notifying administrations or their authorized MSS operators shall accommodate validated AMS(R)S spectrum requirements in accordance with No. **5.357A** without placing undue constraints on the existing systems operating in accordance with the Radio Regulations.

4 The notifying administrations of MSS networks, including AMS(R)S, have responsibility to ensure that their respective assignments are compatible in the relevant bilateral or multilateral frequency coordination meetings (in particular when those networks span various geographic area(s)).

5 The notifying administrations shall inform BR about the total amount of spectrum assigned to AMS(R)S systems after each coordination meeting where the total AMS(R)S assignments are affected.

6 If a notifying AMS(R)S administration is of the opinion that its spectrum requirements have not been met in the frequency coordination process as per No. **5.357A**, the notifying administration may notify the Director of BR of this and request that a Reassessment Meeting be called.

7 If the Bureau receives an announcement from an administration that their AMS(R)S spectrum requirements have not been met, the Director of the Bureau shall invite the notifying administrations of mobile-satellite networks involved in step 2 for a Reassessment Meeting to be held normally within three months. The Reassessment Meeting shall limit its task to consideration of the application of No. **5.357A** and shall not enter into specific coordination activities for the modification of the assignments to individual operators. The Reassessment Meeting shall be attended by the notifying administrations. These administrations may decide to invite other parties or BR in an advisory role if agreed by all notifying administrations.

8 If the Reassessment Meeting concludes that the AMS(R)S spectrum requirements of the concerned system have not been met, the Reassessment Meeting may call for an additional specific frequency coordination meeting of the notifying administrations of mobile-satellite networks involved in step 2 and their representative MSS operators, which is requested to adapt the coordination agreement, taking due account of the advice of the Reassessment Meeting. This frequency coordination meeting should take place as soon as possible and preferably immediately following the Reassessment Meeting.

9 At the conclusion of the Reassessment Meeting, a report containing information about the issue discussed and the conclusions shall be prepared by the participating notifying administrations and submitted to BR for publication.

10 If the matter remains unresolved at the administrations' frequency coordination meeting referred to in 8 above, the notifying AMS(R)S administration shall seek the assistance of the Radiocommunication Bureau pursuant to Articles **7** and **13** and notify the respective administrations indicating that its AMS(R)S requirements have not been satisfied. The Radiocommunication Bureau shall provide a report and assistance in accordance with No. **13.3**.

11 If the matter remains unresolved after the Bureau has communicated its conclusions to the notifying AMS(R)S administration involved, the notifying AMS(R)S administration may request review of the decision of the Bureau in accordance with Article **14**.

RESOLUTION 223 (REV.WRC-23)

Additional frequency bands identified for International Mobile Telecommunications

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that International Mobile Telecommunications (IMT), including IMT-2000, IMT-Advanced and IMT-2020, is the ITU vision of global mobile access;

b) that IMT systems provide telecommunication services on a worldwide scale regardless of location, network or terminal used;

c) that IMT provides access to a wide range of telecommunication services supported by fixed telecommunication networks (e.g. public switched telephone network (PSTN)/integrated services digital network (ISDN), high bit rate Internet access), and to other services which are specific to mobile users;

d) that the technical characteristics of IMT are specified in ITU Radiocommunication Sector (ITU-R) and ITU Telecommunication Standardization Sector (ITU-T) Recommendations, including Recommendations ITU-R M.1457 and ITU-R M.2012, which contain the detailed specifications of the terrestrial radio interfaces of IMT;

e) that the evolution of IMT is being studied within ITU-R;

f) that the review of IMT-2000 spectrum requirements at WRC-2000 concentrated on the frequency bands below 3 GHz;

g) that at WARC-92, 230 MHz of spectrum was identified for IMT-2000 in the frequency bands 1 885-2 025 MHz and 2 110-2 200 MHz, including the frequency bands 1 980-2 010 MHz and 2 170-2 200 MHz for the satellite component of IMT-2000, in No. **5.388** and under the provisions of Resolution **212 (Rev.WRC-23)**;

h) that since WARC-92 there has been a tremendous growth in mobile communications including an increasing demand for broadband multimedia capability;

i) that the frequency bands identified for IMT are currently used by mobile systems or applications of other radiocommunication services;

j) that Recommendation ITU-R M.1308 addresses the evolution of existing mobile communication systems to IMT-2000, and that Recommendation ITU-R M.1645 addresses the evolution of the IMT systems and maps out their future development;

k) that harmonized worldwide frequency bands for IMT are desirable in order to achieve global roaming and the benefits of economies of scale;

l) that the frequency bands 1 710-1 885 MHz, 2 500-2 690 MHz and 3 300-3 400 MHz are allocated to a variety of services in accordance with the relevant provisions of the Radio Regulations;

m) that the frequency band 2 300-2 400 MHz is allocated to the mobile service on a co-primary basis in the three ITU Regions;

n) that the frequency band 2 300-2 400 MHz, or portions thereof, is used extensively in a number of administrations by other services including the aeronautical mobile service (AMS) for telemetry in accordance with the relevant provisions in the Radio Regulations;

o) that IMT has already been deployed or is being considered for deployment in some countries in the frequency bands 1 710-1 885 MHz, 2 300-2 400 MHz and 2 500-2 690 MHz and equipment is readily available;

p) that the frequency bands 1 710-1 885 MHz, 2 300-2 400 MHz and 2 500-2 690 MHz, or parts thereof, are identified for use by administrations wishing to implement IMT;

q) that technological advancement and user needs will promote innovation and accelerate the delivery of advanced communication applications to consumers;

r) that changes in technology may lead to the further development of communication applications, including IMT;

s) that timely availability of spectrum is important to support future applications;

t) that IMT systems are envisaged to provide increased peak data rates and capacity that may require a larger bandwidth;

u) that ITU-R studies forecasted that additional spectrum may be required to support the future services of IMT and to accommodate future user requirements and network deployments;

v) that the frequency band 1 427-1 429 MHz is allocated to the mobile, except aeronautical mobile, service in all three Regions on a primary basis;

w) that the frequency band 1 429-1 525 MHz is allocated to the mobile service in Regions 2 and 3 and to the mobile, except aeronautical mobile, service in Region 1 on a primary basis;

x) that the frequency band 1 518-1 559 MHz is allocated in all three Regions to the mobile-satellite service (MSS) on a primary basis[1];

y) that WRC-15 identified the frequency band 1 427-1 518 MHz for use by administrations wishing to implement terrestrial IMT systems;

z) that there is a need to ensure the continued operations of the MSS in the frequency band 1 518-1 525 MHz;

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[1] See Table **21-4** for applicable pfd limits.

aa) that appropriate technical measures to facilitate adjacent frequency band compatibility between the MSS in the frequency band 1 518-1 525 MHz and IMT in the frequency band 1 492-1 518 MHz need to be studied;

ab) Report ITU-R RA.2332, on compatibility and sharing studies between the radio astronomy service and IMT systems in the frequency bands 608-614 MHz, 1 330-1 400 MHz, 1 400-1 427 MHz, 1 610.6-1 613.8 MHz, 1 660-1 670 MHz, 2 690-2 700 MHz, 4 800-4 990 MHz and 4 990-5 000 MHz;

ac) that WRC-15, WRC-19 and this conference have identified the frequency band 3 300-3 400 MHz for use by administrations wishing to implement terrestrial IMT systems in Nos. **5.429B**, **5.429D** and **5.429F**;

ad) that the frequency band 3 100-3 400 MHz is allocated worldwide on a primary basis to the radiolocation service;

ae) that a number of administrations use the frequency band 3 300-3 400 MHz, or portions thereof, which is allocated to the fixed and mobile services on a primary basis in No. **5.429**;

af) that the frequency band 4 800-4 990 MHz is allocated worldwide to the mobile and fixed services on a primary basis;

ag) that the frequency band 4 800-4 990 MHz is identified for use by administrations wishing to implement terrestrial IMT systems in countries listed in Nos. **5.441A** and **5.441B**;

ah) that appropriate technical measures may be considered by administrations at a national level to facilitate adjacent frequency band compatibility between radio astronomy receivers in the frequency band 4 990-5 000 MHz and IMT systems in the frequency band 4 800-4 990 MHz;

ai) that Report ITU-R M.2481 addresses in-band and adjacent-band coexistence and compatibility studies between IMT systems in the frequency band 3 300-3 400 MHz and radiolocation systems in the frequency band 3 100-3 400 MHz, and that further studies were carried out in preparation for this conference;

aj) that the development of new ITU-R Recommendations and/or Reports could provide guidance to support administrations planning to implement IMT, to ensure co-existence with the radiolocation service operating in neighbouring countries in the frequency band 3 300-3 400 MHz,

emphasizing

a) that flexibility must be afforded to administrations:

– to determine, at a national level, how much spectrum to make available for IMT from within the identified frequency bands;

– to develop their own transition plans, if necessary, tailored to meet their specific deployment of existing systems;

– to have the ability for the identified frequency bands to be used by all services having allocations in those frequency bands;

– to determine the timing of availability and use of the frequency bands identified for IMT, in order to meet particular user demand and other national considerations;

b) that the particular needs of developing countries must be met;

c) that Recommendation ITU-R M.819 describes the objectives to be met by IMT-2000 in order to meet the needs of developing countries,

noting

a) Resolutions **224 (Rev.WRC-23)** and **225 (Rev.WRC-23)**, which also relate to IMT;

b) that the sharing implications between services sharing the frequency bands identified for IMT in No. **5.384A**, as relevant, will need further study in ITU-R;

c) that studies regarding the availability of the frequency band 2 300-2 400 MHz for IMT are being conducted in many countries, the results of which could have implications for the use of those frequency bands in those countries;

d) that, due to differing requirements, not all administrations may need all of the IMT frequency bands identified at WRC-07, or, due to the usage by and investment in existing services, may not be able to implement IMT in all of those frequency bands;

e) that the spectrum for IMT identified by WRC-07 may not completely satisfy the expected requirements of some administrations;

f) that currently operating mobile communication systems may evolve to IMT in their existing frequency bands;

g) that services such as the fixed service, the mobile service (second-generation systems), the space operation service, the space research service and the AMS are in operation or planned in the frequency band 1 710-1 885 MHz, or portions thereof;

h) that in the frequency band 2 300-2 400 MHz, or portions thereof, there are services such as the fixed, mobile, amateur and radiolocation services which are currently in operation or planned to be in operation in the future;

i) that services such as the broadcasting-satellite service (BSS), the BSS (sound), the MSS (in Region 3) and the fixed service (including multipoint distribution/communication systems) are in operation or planned in the frequency band 2 500-2 690 MHz, or portions thereof;

j) that the identification of several frequency bands for IMT allows administrations to choose the best frequency band or parts thereof for their circumstances;

k) that further study of the technical and operational measures regarding adjacent frequency band compatibility between IMT systems operating below 3 400 MHz and fixed-satellite service earth stations operating above 3 400 MHz may be required;

l) that ITU-R has identified additional work to address further developments in IMT;

m) that the IMT terrestrial radio interfaces as defined in Recommendations ITU-R M.1457 and ITU-R M.2012 are expected to evolve within the framework of ITU-R beyond those initially specified, in order to provide enhanced services and services beyond those envisaged in the initial implementation;

n) that the identification of a frequency band for IMT does not establish priority in the Radio Regulations and does not preclude the use of the frequency band for any application of the services to which it is allocated;

o) that the provisions of Nos. **5.317A**, **5.384A**, **5.388**, **5.429B**, **5.429D**, **5.429F**, **5.441A** and **5.441B** do not prevent administrations from having the choice to implement other technologies in the frequency bands identified for IMT, based on national requirements,

recognizing

that, for some administrations, the only way of implementing IMT would be spectrum refarming, requiring significant financial investment,

resolves

1 to invite administrations planning to implement IMT to make available, based on user demand and other national considerations, additional frequency bands or portions of the frequency bands above 1 GHz identified in Nos. **5.341B**, **5.384A**, **5.429B**, **5.429D**, **5.429F**, **5.441A** and **5.441B** for the terrestrial component of IMT; due consideration should be given to the benefits of harmonized utilization of the spectrum for the terrestrial component of IMT, taking into account the services to which the frequency band is currently allocated;

2 to acknowledge that the differences in the texts of Nos. **5.341B**, **5.384A** and **5.388** do not confer differences in regulatory status;

3 that, in the frequency bands 4 800-4 825 MHz and 4 835-4 950 MHz, in order to identify potentially affected administrations when applying the procedure for seeking agreement under No. **9.21** for IMT stations in relation to aircraft stations, a coordination distance from an IMT station to the border of another country equal to 300 km (for land path)/450 km (for sea path) applies;

4 that in the frequency band 4 800-4 990 MHz, in order to identify potentially affected administrations when applying the procedure for seeking agreement under No. **9.21** for IMT stations in relation to fixed-service stations or other ground-based stations of the mobile service, a coordination distance from an IMT station to the border of another country equal to 70 km applies;

5 that the power flux-density (pfd) limits in No. **5.441B** shall not apply to the following countries: Armenia, Brazil, Cambodia, China, Russian Federation, Kazakhstan, Lao P.D.R., Uzbekistan, South Africa, Viet Nam and Zimbabwe,

invites the ITU Radiocommunication Sector

1 to continue providing guidance to ensure that IMT can meet the telecommunication needs of developing countries and rural areas;

2 to continue providing guidance to administrations planning to facilitate the implementation of IMT in the frequency band 3 300-3 400 MHz, taking into account *considering aj*;

3 to include the results of the studies mentioned in *invites the ITU Radiocommunication Sector* above in one or more ITU-R Recommendations and Reports, as appropriate.

RESOLUTION 224 (REV.WRC-23)

Frequency bands for the terrestrial component of International Mobile Telecommunications below 1 GHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that International Mobile Telecommunications (IMT) is the root name that encompasses IMT-2000, IMT-Advanced and IMT-2020 collectively (see Resolution ITU-R 56);

b) that IMT systems are intended to provide telecommunication services on a worldwide scale, regardless of location, network or terminal used;

c) that parts of the frequency band 790-960 MHz are extensively used in the three Regions by mobile systems;

d) that IMT systems have already been deployed in the frequency band 694/698-960 MHz in some countries of the three Regions;

e) that some administrations of Regions 2 and 3 are planning to use the frequency band 470-694/698 MHz, or part of that frequency band, for IMT;

f) that the frequency band 450-470 MHz is allocated to the mobile service on a primary basis in the three Regions and that IMT systems have already been deployed in some countries of the three Regions;

g) that results of the sharing studies for the frequency band 450-470 MHz are contained in Report ITU-R M.2110;

h) that cellular-mobile systems in the three Regions in the frequency bands below 1 GHz operate using various frequency arrangements;

i) that, where cost considerations warrant the installation of fewer base stations, such as in rural and/or sparsely populated areas, frequency bands below 1 GHz are generally suitable for implementing mobile systems, including IMT;

j) that frequency bands below 1 GHz are important, especially for some developing countries and countries with large areas where economic solutions for low population density areas are necessary;

k) that Recommendation ITU-R M.819 describes the objectives to be met by IMT-2000 in order to meet the needs of developing countries, and in order to assist them to “bridge the gap” between their communication capabilities and those of developed countries;

l) that Recommendation ITU-R M.1645 also describes the coverage objectives of IMT,

recognizing

a) that the evolution of cellular-based mobile networks to IMT can be facilitated if they are permitted to evolve within their current frequency bands;

b) that some of the frequency bands or parts of the frequency bands identified for IMT below 1 GHz are used extensively in many countries by various other terrestrial mobile systems and applications, including public protection and disaster relief radiocommunications (see Resolution **646 (Rev.WRC-19)**);

c) that there is a need, in many developing countries and countries with large areas of low population density, for the cost-effective implementation of IMT, and that the propagation characteristics of frequency bands below 1 GHz identified in Nos. **5.286AA**, **5.295**, **5.308A** and **5.317A** result in larger cells;

d) that the frequency band 450-470 MHz, or parts thereof, is also allocated to services other than the mobile service;

e) that the frequency band 460-470 MHz is also allocated to the meteorological-satellite service in accordance with No. **5.290**;

f) that the frequency band 470-890 MHz, except the frequency band 608-614 MHz in Region 2, is allocated to the broadcasting service on a primary basis in all three Regions as contained in Article **5** of the Radio Regulations, and parts of this frequency band are used predominantly by this service;

g) that, in the frequency band 470-862 MHz, the GE06 Agreement applies in all Region 1 countries, except Mongolia, and in the Islamic Republic of Iran, and that this Agreement contains provisions for the terrestrial broadcasting service and other primary terrestrial services, a Plan for digital television, and a list of stations of other primary terrestrial services;

h) that the transition from analogue to digital television is expected to result in situations where the frequency band 470-806/862 MHz will be used extensively for both analogue and digital terrestrial transmission, and the demand for spectrum during the transition period may be even greater than the standalone usage of analogue broadcasting systems;

i) that the time-frame and transition period for analogue to digital television switchover may not be the same for all countries;

j) that, after analogue to digital television switchover, some administrations may decide to use all or parts of the frequency band 470-806/862 MHz for other services to which the frequency band is allocated on a primary basis, in particular the mobile service for the implementation of IMT, while in other countries the broadcasting service will continue to operate in that frequency band;

k) that in the frequency band 470-890 MHz, or parts thereof, there is an allocation on a primary basis for the fixed service;

l) that, in some countries, the frequency band 470-862 MHz, or parts thereof, for Regions 2 and 3 and the frequency band 694-862 MHz in Region 1 are allocated to the mobile service on a primary basis;

m) that the frequency band 645-862 MHz is allocated on a primary basis to the aeronautical radionavigation service in the countries listed in No. **5.312**;

n) that Recommendation ITU-R M.1036 provides frequency arrangements for implementation of the terrestrial component of IMT in the frequency bands identified for IMT in the Radio Regulations;

o) that Reports ITU-R M.2241, ITU-R BT.2215, ITU-R BT.2247, ITU-R BT.2248, ITU-R BT.2265, ITU-R BT.2301, ITU-R BT.2337 and ITU-R BT.2339 contain material relevant to compatibility studies between IMT and other services;

p) that Report ITU-R BT.2338 describes the implications of a co-primary allocation to the mobile service in the frequency band 694-790 MHz in Region 1 for the use of that frequency band by applications ancillary to broadcasting and programme-making,

emphasizing

a) that in all administrations terrestrial broadcasting is a vital part of the communication and information infrastructure;

b) that flexibility must be afforded to administrations:

– to determine, at a national level, how much spectrum to make available for IMT from within the identified frequency bands, taking into account current uses of the spectrum and the needs of other applications;

– to develop their own transition plans, if necessary, tailored to meet their specific deployment of existing systems;

– to have the ability for the identified frequency bands to be used by all services having allocations in those frequency bands;

– to determine the timing of availability and use of the frequency bands identified for IMT, in order to meet particular market demand and other national considerations;

c) that the particular needs and national conditions and circumstances of developing countries, including least-developed countries, highly-indebted poor countries with economies in transition, and countries with large territories and territories with a low subscriber density, must be met;

d) that due consideration should be given to the benefits of harmonized utilization of the spectrum for the terrestrial component of IMT, taking into account the current and planned use of these frequency bands by all services to which these frequency bands are allocated;

e) that the use of frequency bands below 1 GHz for IMT also helps to “bridge the gap” between sparsely-populated areas and densely-populated areas in various countries;

f) that the identification of a frequency band for IMT does not preclude the use of this frequency band by other services or applications to which it is allocated;

g) that the use of the frequency band 470-862 MHz by the broadcasting service and other primary services is also covered by the GE06 Agreement;

h) that the requirements of the different services to which the frequency band is allocated, including the mobile and broadcasting services, need to be taken into account,

resolves

1 that administrations which are implementing or planning to implement IMT consider the use of frequency bands identified for IMT below 1 GHz and the possibility of cellular-based mobile network evolution to IMT, in the frequency band identified in Nos. **5.286AA**, **5.317A**, and in some countries of Regions 2 and 3, the frequency band(s) identified in Nos. **5.295**, **5.296A** and **5.308A**, and in some countries of Region 1 in the frequency band identified in No. **5.307A,** based on user demand and other considerations;

2 to encourage administrations to take into account results of the existing relevant ITU Radiocommunication Sector studies, when implementing IMT applications/systems in the frequency bands 694-862 MHz in Region 1, in the frequency band 470-806 MHz in Region 2, in the frequency band 790-862 MHz in Region 3, in the frequency band 470-698 MHz, or portions thereof, for those administrations mentioned in No. **5.296A**, in the frequency band 698-790 MHz, or portions thereof, for those administrations mentioned in No. **5.313A,** and in the frequency band 614-694 MHz, for those administrations mentioned in No. **5.307A**;

3 that administrations should take into account the need to protect existing and future broadcasting stations, both analogue and digital, except analogue in the GE06 planning area, in the frequency band 470-806/862 MHz, as well as other primary terrestrial services;

4 that administrations planning to implement IMT in the frequency bands mentioned in *resolves* 2 shall effect coordination, as required, with all neighbouring administrations prior to implementation;

5 that in Region 1 (excluding Mongolia) and in the Islamic Republic of Iran, the implementation of stations in the mobile service shall be subject to the applications of procedures contained in the GE06 Agreement; in so doing:

a) administrations which deploy stations in the mobile service for which coordination was not required, or without having obtained the prior consent of those administrations that may be affected, shall not cause unacceptable interference to, nor claim protection from, stations of the broadcasting service of administrations operating in conformity with the GE06 Agreement; this should include a signed commitment as required under § 5.2.6 of the GE06 Agreement;

b) administrations which deploy stations in the mobile service for which coordination was not required, or without having obtained the prior consent of those administrations that may be affected, shall not object to nor prevent the entry into the GE06 plan or recording in the MIFR of additional future broadcasting allotments or assignments of any other administration in the GE06 Plan with reference to those stations;

6 that, in Region 2, implementation of IMT shall be subject to the decision of each administration on the transition from analogue to digital television,

invites the Director of the Telecommunication Development Bureau

to draw the attention of the ITU Telecommunication Development Sector to this Resolution.

RESOLUTION 225 (REV.WRC-23)

Use of additional frequency bands for the satellite component of IMT

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the frequency bands 1 980-2 010 MHz and 2 170-2 200 MHz are identified for use by the satellite component of International Mobile Telecommunications (IMT) through No. **5.388** and Resolution **212 (Rev.WRC-23)**;

b) Resolutions **212 (Rev.WRC-23)**, **223 (Rev.WRC-23)** and **224 (Rev.WRC-23)** on the implementation of the terrestrial and satellite components of IMT;

c) that the bands 1 518-1 544 MHz, 1 545-1 559 MHz, 1 610-1 626.5 MHz, 1 626.5-1 645.5 MHz, 1 646.5-1 660.5 MHz, 1 668-1 675 MHz and 2 483.5-2 500 MHz are allocated on a co-primary basis to the mobile-satellite service and other services in accordance with the Radio Regulations;

d) that, in Region 3, the bands 2 500-2 520 MHz and 2 670-2 690 MHz are allocated on a co-primary basis to the mobile-satellite service and other services in accordance with the Radio Regulations;

e) that distress, urgency and safety communications of the Global Maritime Distress and Safety System and the aeronautical mobile-satellite (R) service have priority over all other mobile-satellite service communications in accordance with Nos. **5.353A** and **5.357A**,

recognizing

a) that services such as broadcasting-satellite, broadcasting-satellite (sound), mobile-satellite, fixed (including point-to-multipoint distribution/communication systems) and mobile are in operation or planned in the band 2 500-2 690 MHz, or in portions of that band;

b) that other services such as the mobile service, the radio astronomy service and radiodetermination-satellite service are in operation or planned, in accordance with the Table of Frequency Allocations, in the bands 1 518-1 559/1 626.5-1 660.5 MHz, 1 610-1 626.5/2 483.5-2 500 MHz and 1 668-1 670 MHz, or in portions of those bands, and that those bands, or portions thereof, are intensively used in some countries by applications other than the IMT satellite component, and the sharing studies within ITU-R are not finished;

c) that studies of potential sharing and coordination between the satellite component of IMT and the terrestrial component of IMT, mobile-satellite service applications and other high-density applications in other services such as point-to-multipoint communication/distribution systems in the bands 2 500-2 520 MHz and 2 670-2 690 MHz are not finished;

d) that the bands 2 520-2 535 MHz and 2 655-2 670 MHz are allocated to the mobile-satellite, except aeronautical mobile-satellite, service for operation limited to within national boundaries pursuant to Nos. **5.403** and **5.420**;

e) Resolution ITU-R 47 on studies under way on satellite radio transmission technologies for IMT,

resolves

1 that, in addition to the frequency bands indicated in *considering a)* and *resolves* 2, the frequency bands 1 518-1 544 MHz, 1 545-1 559 MHz, 1 610-1 626.5 MHz, 1 626.5-1 645.5 MHz, 1 646.5-1 660.5 MHz, 1 668-1 675 MHz and 2 483.5-2 500 MHz may be used by administrations wishing to implement the satellite component of IMT, subject to the regulatory provisions related to the mobile-satellite service in these frequency bands;

2 that the bands 2 500-2 520 MHz and 2 670-2 690 MHz as identified for IMT in No. **5.384A** and allocated to the mobile-satellite service in Region 3 may be used by administrations in that Region wishing to implement the satellite component of IMT; however, depending on user demand, it may be possible in the longer term that the administrations decide to use these bands for the terrestrial component of IMT (see the Preamble of the ITU Constitution);

3 that this identification of frequency bands for the satellite component of IMT does not preclude the use of these bands by any applications of the services to which they are allocated and does not establish priority in the Radio Regulations,

invites the ITU Radiocommunication Sector

1 to study the sharing and coordination issues in the above bands related to use of the mobile-satellite service allocations for the satellite component of IMT and the use of this spectrum by the other allocated services, including the radiodetermination-satellite service;

2 to report the results of these studies to a future world radiocommunication conference,

invites the Director of the Telecommunication Development Bureau

to draw the attention of the ITU Telecommunication Development Sector to this Resolution.

RESOLUTION 229 (REV.WRC-23)

Use of the frequency bands 5 150-5 250 MHz, 5 250-5 350 MHz and 5 470-5 725 MHz by the mobile service for the implementation of wireless access systems including radio local area networks

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that WRC-03 allocated the frequency bands 5 150-5 350 MHz and 5 470-5 725 MHz on a primary basis to the mobile service for the implementation of wireless access systems (WAS), including radio local area networks (RLANs);

b) that WRC-03 decided to make an additional primary allocation for the Earth exploration-satellite service (EESS) (active) in the frequency band 5 460-5 570 MHz and the space research service (SRS) (active) in the frequency band 5 350-5 570 MHz;

c) that WRC-03 decided to upgrade the radiolocation service to a primary status in the frequency band 5 350-5 650 MHz;

d) that the frequency band 5 150-5 250 MHz is allocated worldwide on a primary basis to the fixed-satellite service (FSS) (Earth-to-space), this allocation being limited to feeder links of non-geostationary-satellite (non-GSO) systems in the mobile-satellite service (MSS) (No. **5.447A**);

e) that the frequency band 5 150-5 250 MHz is also allocated to the mobile service, on a primary basis, in some countries (No. **5.447**) subject to agreement obtained under No. **9.21**;

f) that the frequency band 5 250-5 460 MHz is allocated to the EESS (active) and the frequency band 5 250-5 350 MHz to the SRS (active) on a primary basis;

g) that the frequency band 5 250-5 725 MHz is allocated on a primary basis to the radiodetermination service;

h) that there is a need to protect the existing primary services in the frequency bands 5 150-5 350 MHz and 5 470-5 725 MHz;

i) that results of studies in the ITU Radiocommunication Sector (ITU-R) indicate that sharing in the frequency band 5 150-5 250 MHz between WAS, including RLANs, and the FSS is feasible under specified conditions;

j) that studies have shown that sharing between the radiodetermination and mobile services in the frequency bands 5 250-5 350 MHz and 5 470-5 725 MHz is only possible with the application of mitigation techniques such as dynamic frequency selection;

k) that there is a need to specify an appropriate equivalent isotropically radiated power (e.i.r.p.) limit and, where necessary, operational restrictions for WAS, including RLANs, in the mobile service in the frequency bands 5 250-5 350 MHz and 5 470-5 570 MHz in order to protect systems in the EESS (active) and SRS (active);

l) that the deployment density of WAS, including RLANs, will depend on a number of factors including intrasystem interference and the availability of other competing technologies and services;

m) that the means to measure or calculate the aggregate power flux-density (pfd) level at FSS satellite receivers specified in Recommendation ITU-R S.1426 are currently under study;

n) that certain parameters contained in Recommendation ITU-R M.1454 related to the calculation of the number of RLANs tolerable by FSS satellite receivers operating in the frequency band 5 150-5 250 MHz require further study;

o) that an aggregate pfd level has been developed in Recommendation ITU-R S.1426 for the protection of FSS satellite receivers in the frequency band 5 150-5 250 MHz;

p) that the attenuation offered by the car and train hulls, when WAS including RLANs are located inside automobiles and trains, could facilitate a level of protection to incumbent services from WAS including RLANs,

considering further

a) that the interference from a single WAS, including RLANs, complying with the operational restrictions under *resolves* 2 will not on its own cause any unacceptable interference to FSS receivers on board satellites in the frequency band 5 150-5 250 MHz;

b) that such FSS satellite receivers may experience an unacceptable effect due to the aggregate interference from these WAS, including RLANs, especially in the case of a prolific growth in the number of these systems;

c) that the aggregate effect on FSS satellite receivers will be due to the global deployment of WAS, including RLANs, and it may not be possible for administrations to determine the location of the source of the interference and the number of WAS, including RLANs, in operation simultaneously,

noting

a) that, prior to WRC-03, a number of administrations developed regulations to permit indoor and outdoor WAS, including RLANs, to operate in the various frequency bands under consideration in this Resolution;

b) that, in response to Resolution **229 (WRC-03)**[*, 1], ITU-R developed Report ITU-R M.2115, which provides testing procedures for implementation of dynamic frequency selection,

recognizing

a) that in the frequency band 5 600-5 650 MHz, ground-based meteorological radars are extensively deployed and support critical national weather services, according to footnote No. **5.452**;

b) that the performance and interference criteria of spaceborne active sensors in the EESS (active) are given in Recommendation ITU-R RS.1166;

c) that a mitigation technique to protect radiodetermination systems is given in Recommendation ITU-R M.1652;

d) that Recommendation ITU-R RS.1632 identifies a suitable set of constraints for WAS, including RLANs, in order to protect the EESS (active) in the frequency band 5 250-5 350 MHz;

e) that Recommendation ITU-R M.1653 identifies the conditions for sharing between WAS, including RLANs, and the EESS (active) in the frequency band 5 470-5 570 MHz;

f) that the stations in the mobile service should also be designed to provide, on average, a near-uniform spread of the loading of the spectrum used by stations across the frequency band or bands in use to improve sharing with satellite services;

g) that WAS, including RLANs, provide effective broadband solutions;

h) that the demand for WAS/RLAN, including outdoor services, has increased since WRC-03;

i) that there is a need for administrations to ensure that WAS, including RLANs, meet the required mitigation techniques, for example, through equipment or standards compliance procedures;

j) that some sharing studies submitted to ITU-R between WAS/RLANs and the FSS for non-GSO MSS feeder uplinks, in the frequency band 5 150-5 250 MHz, have shown that WAS/RLAN outdoor relaxation up to 3 per cent of the total number of WAS/RLANs can be feasible;

k) that measures to control the number of outdoor WAS/RLANs, in the frequency band 5 150-5 250 MHz, can include: authorization approach, registration procedures, domestic notification, limited application, limitation to fixed WAS/RLAN access points, etc.,

resolves

1 that the use of these frequency bands by the mobile service is for the implementation of WAS, including RLANs, as described in the most recent version of Recommendation ITU-R M.1450;

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[*] *Note by the Secretariat:* This Resolution was revised by WRC-12, WRC-19 and WRC-23.

[1] Reference to Resolution **229 (WRC-03)** is provided as background information.

2 that, in the frequency band 5 150-5 250 MHz, stations in the mobile service shall be restricted to indoor use, including inside trains, with a maximum mean e.i.r.p.[2] of 200 mW and a maximum mean e.i.r.p. density of 10 mW/MHz in any 1 MHz band or equivalently 0.25 mW/25 kHz in any 25 kHz band; mobile stations inside automobiles shall operate with a maximum e.i.r.p. of 40 mW;

3 that in the frequency band 5 150-5 250 MHz, administrations may exercise some flexibility by taking appropriate measures that would allow controlled and/or limited outdoor usage with a maximum mean e.i.r.p.[2] of 200 mW; administrations have a further option to permit stations in the mobile service, for indoor or controlled outdoor use, to operate up to a maximum mean e.i.r.p of 30 dBm; in the case of indoor or controlled outdoor use, administrations are requested to either ensure that the maximum e.i.r.p. at any elevation angle above 5 degrees as measured from the horizon shall not exceed 200 mW (23 dBm), or to ensure that the maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon shall not exceed 125 mW (21 dBm) or to apply the emission mask described in *resolves* 5 below to maintain protection to the incumbent services; in that case, administrations shall take all appropriate measures, such as those described in *recognizing k)*, to control the number of these higher power outdoor WAS/RLAN stations up to 2 per cent of the estimated total amount of WAS/RLAN stations; if the maximum e.i.r.p. is raised above 200 mW, unwanted emissions shall not increase above the existing levels already authorized within administrations for the existing systems that operate with an in-band e.i.r.p. of not greater than 200 mW; in all cases, administrations are requested to maintain protection to the other primary services;

4 that administrations may monitor whether the aggregate pfd levels given in Recommendation ITU-R S.1426[3] are exceeded as a consequence of a prolific growth in the number of WAS/RLANs;

5 that, in the frequency band 5 250-5 350 MHz, stations in the mobile service shall be limited to a maximum mean e.i.r.p. of 200 mW and a maximum mean e.i.r.p. density of 10 mW/MHz in any 1 MHz band; administrations are requested to take appropriate measures that will result in the predominant number of stations in the mobile service being operated in an indoor environment; furthermore, stations in the mobile service that are permitted to be used either indoors or outdoors may operate up to a maximum mean e.i.r.p. of 1 W and a maximum mean e.i.r.p. density of 50 mW/MHz in any 1 MHz band, and, when operating above a mean e.i.r.p. of 200 mW, these stations shall comply with the following e.i.r.p. elevation angle mask, where θ is the angle above the local horizontal plane (of the Earth):

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[2] In the context of this Resolution, "mean e.i.r.p." refers to the e.i.r.p. during the transmission burst which corresponds to the highest power, if power control is implemented.

[3] $-124 - 20 \log (h_{SAT}/1\,414)$ dB(W/(m^2 · 1 MHz)), or equivalently, $-140 - 20 \log (h_{SAT}/1\,414)$ dB(W/(m^2 · 25 kHz)), at the FSS satellite orbit, where h_{SAT} is the altitude of the satellite (km).

−13 dB(W/MHz)	for	$0° \leq \theta < 8°$
−13 − 0.716(θ − 8) dB(W/MHz)	for	$8° \leq \theta < 40°$
−35.9 − 1.22(θ − 40) dB(W/MHz)	for	$40° \leq \theta \leq 45°$
−42 dB(W/MHz)	for	$45° < \theta$;

6 that administrations may exercise some flexibility in adopting other mitigation techniques, provided that they develop national regulations to meet their obligations to achieve an equivalent level of protection to the EESS (active) and the SRS (active) based on their system characteristics and interference criteria as stated in Recommendation ITU-R RS.1632;

7 that, in the frequency band 5 470-5 725 MHz, stations in the mobile service shall be restricted to a maximum transmitter power of 250 mW[4] with a maximum mean e.i.r.p. of 1 W and a maximum mean e.i.r.p. density of 50 mW/MHz in any 1 MHz band;

8 that, in the frequency bands 5 250-5 350 MHz and 5 470-5 725 MHz, systems in the mobile service shall either employ transmitter power control to provide, on average, a mitigation factor of at least 3 dB on the maximum average output power of the systems, or, if transmitter power control is not in use, then the maximum mean e.i.r.p. shall be reduced by 3 dB;

9 that, in the frequency bands 5 250-5 350 MHz and 5 470-5 725 MHz, the mitigation measures for systems in the mobile service found in Annex 1 to Recommendation ITU-R M.1652-1 as well as the characteristics and interference criteria for systems in the radiolocation service stated in Annex 5 to Recommendation ITU-R M.1652-1 shall be used by systems in the mobile service to ensure compatible operation with radiodetermination systems,

invites administrations

1 to consider appropriate measures, when allowing the operation of stations in the mobile service using the e.i.r.p. elevation angle mask referred in *resolves* 5 above, to ensure the equipment is operated in compliance with this mask;

2 to take appropriate measures, such as the examples in *recognizing k)*, to control the number of outdoor stations in the frequency band 5 150-5 250 MHz, if implementing *resolves* 3 above, in order to ensure the protection of incumbent services.

[4] Administrations with existing regulations prior to WRC-03 may exercise some flexibility in determining transmitter power limits.

RESOLUTION 235 (REV.WRC-23)

Review of the spectrum use of the frequency band 470-694 MHz or parts thereof for some countries in Region 1

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the favourable propagation characteristics in the frequency bands below 1 GHz are beneficial in providing cost-effective solutions for coverage;

b) that there is a need to continually take advantage of technological developments in order to increase the efficient use of the spectrum and facilitate spectrum access;

c) that the frequency band 470-694 MHz is a harmonized band used to provide terrestrial television broadcasting services on a worldwide scale;

d) that, in many countries, there is a sovereign national obligation on the provision of broadcasting services;

e) that terrestrial broadcasting networks have a long life cycle and a stable regulatory environment is necessary to provide protection of investment and future development;

f) that there is a need for investment in the next decade in broadcasting service development within the frequency band 470-694 MHz and for the implementation of new-generation broadcasting technologies and new applications (e.g. ultra-high definition (UHD), 5G Broadcast);

g) that there are countries where terrestrial broadcasting is the only viable means of delivery of broadcasting services;

h) that there are countries with decreasing use of digital terrestrial television broadcasting (DTTB) due to the evolution, broader availability and increased use of alternative media distribution platforms;

i) that International Mobile Telecommunications (IMT) systems utilize, among others, the frequency band 614-694 MHz to provide telecommunication services in some countries;

j) that, in accordance with No. **5.296**, there are countries where applications ancillary to broadcasting and programme-making are operating under the land mobile service (LMS) on a secondary basis and will continue to operate in the frequency band 470-694 MHz or in parts of that frequency band, but that the availability of spectrum for these applications will be affected by the implementation of other applications of the mobile service;

k) that the frequency band 645-862 MHz is allocated on a primary basis to the aeronautical radionavigation service (ARNS) in the countries listed in No. **5.312**;

l) that, in some countries, parts of the frequency band are also allocated to the radiolocation service on a secondary basis, limited to the operation of wind profiler radars (No. **5.291A**);

m) that, in the African Broadcasting Area (see Nos. **5.10** to **5.13**), the frequency band 606-614 MHz is allocated to the radio astronomy service (RAS) on a primary basis (No. **5.304**), and in the rest of Region 1 the frequency band 608-614 MHz is allocated to the RAS on a secondary basis (No. **5.306**);

n) that this conference has allocated the frequency band 470-694 MHz in some countries in Region 1 to the mobile/mobile, except aeronautical mobile, services on a secondary basis by a footnote, which enables some countries to implement mobile-based applications in order to address their national needs and interests;

o) that this conference has allocated the frequency band 614-694 MHz in some countries in Region 1 to the mobile, except aeronautical mobile, service on a primary basis by a footnote, which enables some countries to implement mobile-based applications in order to address their national needs and interests;

p) that in the Russian Federation and Kazakhstan, the frequency band 625-650 MHz is used for the space operation service (space-to-Earth), under No. **4.4**,

recognizing

a) that the GE06 Agreement applies in all Region 1 countries, except Mongolia, and in Iran (Islamic Republic of), in particular for the frequency band 470-862 MHz;

b) that the GE06 Agreement contains provisions for the terrestrial broadcasting service and other primary terrestrial services, a Plan for digital television and a list of stations of other primary terrestrial services;

c) that a digital entry in the GE06 Plan may also be used for transmissions in a service other than the broadcasting service under the conditions set out in § 5.1.3 of the GE06 Agreement ;

d) that the sharing and compatibility studies carried out in preparation for this conference and previous relevant world radiocommunication conferences may need to be updated for applications already considered, in cases of significantly changed technical characteristics;

e) that there may be some changes over the coming years in the spectrum use and needs of broadcasting and mobile services;

f) that No. **5.149** urges administrations to take all practicable steps to protect the radio astronomy service from harmful interference in the frequency band 608-614 MHz;

g) the ongoing needs of the LMS with allocations on a secondary basis used for applications ancillary to broadcasting and programme-making in No. **5.296** in the frequency band 470-694 MHz, and that stations in the LMS in the countries listed in this footnote shall not cause harmful interference to other existing or planned stations, considering the need to assess the demand of these applications in various administrations,

noting

a) the ongoing development of new applications and technologies of both the broadcasting and mobile services;

b) the studies regarding spectrum use and spectrum needs of existing services within the frequency band 470-960 MHz in Region 1, in particular the spectrum requirements of the broadcasting and mobile, except aeronautical mobile, services, carried out in preparation for this conference and relevant previous world radiocommunication conferences;

c) that the ITU Radiocommunication Sector (ITU-R) is studying possible solutions for global/regional harmonization of frequency bands and tuning ranges for electronic news gathering (ENG)[1] in accordance with Resolution ITU-R 59, to facilitate services ancillary to broadcasting (SAB)/services ancillary to programme-making (SAP) operations;

d) that coexistence between applications of existing secondary services (e.g. SAB/SAP, radio astronomy and wind profiler radars) and other applications of the mobile service requires suitable sharing methods,

resolves to invite the ITU Radiocommunication Sector after this conference and in time for the 2031 world radiocommunication conference

1 to review spectrum use and needs of applications of broadcasting and mobile services, taking into account *recognizing g)*, within the frequency band 470-694 MHz or parts thereof for countries listed in No. **5.295A**;

2 based on the review referred to in *resolves to invite the ITU Radiocommunication Sector, after this conference and in time for the 2031 world radiocommunication conference* 1, to update sharing and compatibility studies for coexistence conditions and develop new studies, as appropriate, taking into account existing primary and secondary services and No. **5.295A**, and to propose technical and regulatory conditions,

encourages administrations

1 to participate actively in the studies by submitting contributions to ITU-R;

2 to consider making spectrum available for continued SAB/SAP operation, taking into account Resolution ITU-R 59;

3 to take appropriate measures for the protection of stations in the RAS (see Nos. **5.304** and **5.306**) from stations in the mobile service, in accordance with the Radio Regulations,

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[1] ENG within Resolution ITU-R 59 represents all applications ancillary to broadcasting and programme-making, such as terrestrial electronic news gathering, electronic field production, TV outside broadcast, wireless radio microphones and radio outside production and broadcast.

invites the 2031 world radiocommunication conference

to consider, based on the results of ITU-R studies:

a) possible regulatory actions, including a review of the allocation of the frequency band 614-694 MHz to the mobile service for countries listed in No. **5.295A**;

b) and then also, a possible regulatory action to protect the RAS to which the frequency band 608-614 MHz is allocated in some countries in Region 1, taking into account the outcomes of *invites the 2031 world radiocommunication conference a)* above,

further invites the ITU Radiocommunication Sector

to ensure intersectoral collaboration with the ITU Telecommunication Development Sector in the implementation of this Resolution.

RESOLUTION 240 (WRC-19)

Spectrum harmonization for railway radiocommunication systems between train and trackside within the existing mobile-service allocations

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that railway transportation contributes to global economic and social development, especially for developing countries;

b) that the term "railway radiocommunication systems between train and trackside" (RSTT) refers to radiocommunication systems providing improved railway traffic control, passenger safety and improved security for train operations;

c) that the main categories of RSTT applications are train radio, train positioning information, train remote and train surveillance;

d) that spectrum harmonization of the train radio application of RSTT may have priority among the four categories of RSTT applications, because the train radio application provides for train dispatching, train control and other important railway services which are used to ensure the safety of passengers and train operations and require high reliability and high quality of services;

e) that there may be a need to integrate different technologies across multiple bands in order to facilitate various functions, for instance dispatching commands, operating control and data transmission, into railway train and trackside systems to also meet the needs of a high-speed railway environment;

f) that the technologies for RSTT are evolving, and international or regional organizations, such as the 3rd Generation Partnership Project (3GPP), the International Union of Railways (UIC), the European Telecommunications Standards Institute (ETSI), the European Union Agency for Railways (ERA), etc., are developing specifications for technologies and new functions to evolve RSTT;

g) that the implementation of evolving RSTT needs to take account of the development of the railway industry;

h) that some administrations wish to facilitate RSTT interoperability, in particular for cross-border operations, to ensure spectrum resources are used effectively and to minimize the risk of interference;

i) that deployment of RSTT requires significant long-term investment and a stable radio regulatory environment;

j) that international standards and harmonized spectrum could facilitate deployment of RSTT and provide economies of scale for the railway industry;

k) that the harmonization of frequency bands for RSTT does not preclude the use of these frequency bands by any other application of services to which they are allocated,

recognizing

a) that Report ITU-R M.2418 provides the generic architecture, main applications, current technologies and generic operating scenarios of RSTT;

b) that Report ITU-R M.2442 provides detailed technical and operational characteristics of RSTT and also provides spectrum usage of current and planned RSTT in some countries;

c) that devices used for the train positioning information application of RSTT may be based on short-range devices, using some frequency bands contained in the most recent version of Recommendation ITU-R SM.1896;

d) that, as indicated in Report ITU-R M.2442, most of the current radiocommunication systems for train radio and train remote applications are widely deployed in the frequency bands below 1 GHz, and higher frequency bands such as millimetric bands are used for train radio and train surveillance applications of RSTT in some countries;

e) that the ITU Radiocommunication Sector (ITU-R) is developing an ITU-R Recommendation to facilitate the spectrum harmonization of current and evolving RSTT within the existing mobile-service allocations,

noting

a) that Report ITU-R M.2442 indicates that several particular frequency bands are in common use for train radio applications of RSTT by some administrations;

b) that administrations have flexibility to determine how much spectrum to make available for RSTT as well as the conditions for usage at the national level in order to meet their particular national and/or regional requirements,

resolves

to encourage administrations, when planning for their RSTT, to consider the study results as per *invites the ITU Radiocommunication Sector* 1, as well as other relevant ITU-R Recommendations/Reports, with a view to facilitating spectrum harmonization for RSTT, in particular for train radio applications,

invites the ITU Radiocommunication Sector

1 to continue development of the ITU-R Recommendation referred in *recognizing e)* addressing spectrum harmonization for RSTT in a timely manner;

2 to further develop and update ITU-R Recommendations/Reports concerning the technical and operational implementation of RSTT, as appropriate,

instructs the Director of the Radiocommunication Bureau

to support administrations in their work towards the harmonization of spectrum for RSTT pursuant to *resolves* above,

invites administrations

to encourage railway agencies and organizations to utilize relevant ITU-R publications in implementing technologies and systems supporting RSTT,

invites Member States, Sector Members, Associates and Academia

to participate actively in the study by submitting contributions to ITU-R,

instructs the Secretary-General

to bring this Resolution to the attention of UIC, 3GPP and other relevant international and regional organizations.

RESOLUTION 241 (REV.WRC-23)

Use of the frequency band 66-71 GHz for International Mobile Telecommunications and coexistence with other applications of the mobile service

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that International Mobile Telecommunications (IMT), including IMT-2000, IMT-Advanced and IMT-2020, and other wireless access systems are intended to provide telecommunication services on a worldwide scale regardless of location and type of network or terminal;

b) that the evolution of IMT is being studied within the ITU Radiocommunication Sector (ITU-R);

c) that harmonized worldwide frequency bands and harmonized frequency arrangements are highly desirable in order to achieve global roaming and the benefits of economies of scale;

d) that adequate and timely availability of spectrum for IMT and supporting regulatory provisions are essential to realize the objectives in Recommendation ITU-R M.2083;

e) that IMT systems are envisaged to provide increased peak data rates and capacity that may require a larger bandwidth;

f) that there is a need to protect existing services and to allow for their continued development,

noting

a) Recommendation ITU-R M.2083, on the IMT Vision – framework and overall objectives of the future development of IMT for 2020 and beyond;

b) Recommendation ITU-R M.2003, on multiple gigabit wireless systems in frequencies around 60 GHz;

c) Report ITU-R M.2227, on the use of multiple gigabit wireless systems in frequencies around 60 GHz,

recognizing

Resolutions 176 (Rev. Bucharest, 2022) and 203 (Rev. Bucharest, 2022) of the Plenipotentiary Conference,

resolves

1 that administrations wishing to implement IMT make available the frequency band 66-71 GHz identified in No. **5.559AA** for use by the terrestrial component of IMT;

2 that administrations wishing to implement IMT in the frequency band 66-71 GHz, identified for IMT under the provisions in No. **5.559AA**, which also wish to implement other applications of the mobile service, including other wireless access systems in the same frequency band, consider coexistence between IMT and these applications,

invites the ITU Radiocommunication Sector

1 to develop ITU-R Recommendations and/or Reports, as appropriate, to assist administrations in ensuring the efficient use of the frequency band through coexistence mechanisms between IMT and other applications of the mobile service, including other wireless access systems, as well as between the mobile service and other services;

2 to regularly review, as appropriate, the impact of evolving technical and operational characteristics of IMT systems (including base-station density) and those of systems of space services on sharing and compatibility, and to take into account the results of these reviews in the development and/or revision of ITU-R Recommendations/Reports addressing, *inter alia*, if necessary, applicable measures to mitigate the risk of interference into space receivers,

instructs the Director of the Radiocommunication Bureau

to bring this Resolution to the attention of relevant international organizations.

RESOLUTION 242 (REV.WRC-23)

Terrestrial component of International Mobile Telecommunications in the frequency band 24.25-27.5 GHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that International Mobile Telecommunications (IMT), including IMT-2000, IMT-Advanced and IMT-2020, is the ITU vision of global mobile access and is intended to provide telecommunication services on a worldwide scale, regardless of location and type of network or terminal;

b) that the evolution of IMT is being studied within the ITU Radiocommunication Sector (ITU-R);

c) that harmonized worldwide frequency bands for IMT are desirable in order to achieve global roaming and the benefits of economies of scale;

d) that IMT systems are now being evolved to support diverse usage scenarios such as enhanced mobile broadband, massive machine-type communications and ultra-reliable and low-latency communications;

e) that ultra-low latency and very high bit-rate applications of IMT will require larger contiguous blocks of spectrum than those available in frequency bands that are currently identified for use by administrations wishing to implement IMT;

f) that the properties of higher frequency bands, such as shorter wavelength, would better enable the use of advanced antenna systems, including multiple input, multiple output (MIMO) and beam-forming techniques, in supporting enhanced broadband;

g) that identification of frequency bands allocated to the mobile service for IMT may change the sharing situation regarding applications of services to which the frequency band is already allocated, and may require regulatory actions;

h) that there is a need to protect existing services and to allow for their continued development;

i) that ITU-R has studied, in preparation for WRC-19, sharing and compatibility with services allocated in the frequency band 24.25-27.5 GHz and its adjacent band, based on characteristics available at that time, and results may change if these characteristics change;

j) that it is assumed that a very limited number of IMT base stations will be communicating with a positive elevation angle towards IMT indoor mobile stations;

k) that the allocations of frequency bands to the Earth exploration-satellite service (EESS) (passive) are defined solely by the fundamental properties of the Earth and its atmosphere, and related measurements are beneficial and used globally and extensively in meteorology, climatology and other scientific purposes for the protection of human life and natural resources; and although EESS (passive) satellites and sensors are operated by few countries, they benefit the whole international community and are hence to be protected on a worldwide basis;

l) that sharing studies were conducted considering applications in the land mobile service,

noting

a) that Recommendation ITU-R M.2083 provides the framework and overall objectives of the future development of IMT for 2020 and beyond;

b) that Recommendation ITU-R SA.2142 provides the methodologies for calculating coordination areas around EESS and space research service (SRS) earth stations to avoid harmful interference from IMT-2020 systems in the frequency bands 25.5-27 GHz and 37-38 GHz;

c) that Recommendation ITU-R M.2161 provides guidelines to assist administrations to mitigate in-band interference from FSS earth stations operating in the frequency bands 24.65-25.25 GHz, 27-27.5 GHz, 42.5-43.5 GHz and 47.2-48.2 GHz into IMT stations,

recognizing

a) that the identification of a frequency band for IMT does not establish priority in the Radio Regulations and does not preclude the use of the frequency band by any application of the services to which it is allocated;

b) Resolutions 176 (Rev. Bucharest, 2022) and 203 (Rev. Bucharest, 2022) of the Plenipotentiary Conference;

c) that Resolution **750 (Rev.WRC-19)** establishes limits on unwanted emissions in the frequency band 23.6-24 GHz from IMT base stations and IMT mobile stations within the frequency band 24.25-27.5 GHz;

d) that the spurious emission limits of Recommendation ITU-R SM.329 Category B (−60 dB(W/MHz)) are sufficient to protect the EESS (passive) in the frequency bands 50.2-50.4 GHz and 52.6-54.25 GHz from the second harmonic of IMT base station emissions in the frequency band 24.25-27.5 GHz;

e) that ITU-R has conducted sharing studies between IMT and the inter-satellite service (ISS)/fixed-satellite service (FSS) (Earth-to-space) in the frequency band 24.25-27.5 GHz based on a number of baseline assumptions, (e.g. equivalent isotropically radiated power (e.i.r.p.) of 18 dB(W/200 MHz), base station densities of 1 200 per 10 000 km^2 and other deployment scenarios), as well as sensitivity analysis for some of them, and these baseline assumptions, as well as other assumptions, influence the sharing study results;

f) that the frequency bands immediately below the passive frequency band 23.6-24 GHz are not intended to be used for high-density mobile applications,

resolves

1 that administrations wishing to implement IMT consider use of the frequency band 24.25-27.5 GHz identified for IMT in No. **5.532AB**, and the benefits of harmonized utilization of the spectrum for the terrestrial component of IMT, taking into account the latest relevant ITU-R Recommendations;

2 that administrations shall apply the following conditions for the frequency band 24.25-27.5 GHz:

2.1 take practical measures to ensure the transmitting antennas of outdoor base stations are normally pointing below the horizon, when deploying IMT base stations within the frequency band 24.25-27.5 GHz; the mechanical pointing needs to be at or below the horizon;

2.2 as far as practicable, sites for IMT base stations within the frequency band 24.45-27.5 GHz employing values of e.i.r.p. per beam exceeding 30 dB(W/200 MHz) should be selected so that the direction of maximum radiation of any antenna will be separated from the geostationary-satellite orbit, within line-of-sight of the IMT base station, by ±7.5 degrees;

3 that protection of EESS/SRS earth stations in the frequency band 25.5-27 GHz and radio astronomy service (RAS) stations in the frequency band 23.6-24 GHz and coexistence between FSS earth stations in the frequency bands 24.65-25.25 GHz and 27-27.5 GHz and IMT stations should be facilitated through bilateral agreements for cross-border coordination as necessary;

4 that the operation of IMT within the frequency band 24.25-27.5 GHz shall protect existing and future EESS (passive) systems in the frequency band 23.6-24 GHz;

5 that IMT stations within the frequency range 24.25-27.5 GHz are used for applications of the land mobile service,

encourages administrations

1 to ensure that provisions for the implementation of IMT allow for the continued use of EESS, SRS and FSS earth stations and their future development;

2 to keep the antenna pattern of IMT base stations within the limits of the approximation envelope according to the most recent version of Recommendation ITU-R M.2101;

3 to apply the spurious emission limits of Recommendation ITU-R SM.329 Category B for the frequency bands 50.2-50.4 GHz and 52.6-54.25 GHz when making the frequency band 24.25-27.5 GHz available for IMT;

4 that for the future development of EESS (passive) in the frequency band 23.6-24 GHz, administrations should consider additional mitigation techniques (e.g. guardbands) beyond the limits specified in Resolution **750 (Rev.WRC-19)**, as appropriate,

invites the ITU Radiocommunication Sector

1 to update existing ITU-R Recommendations or develop a new ITU-R Recommendation, as appropriate, to provide information and assistance to the concerned administrations on possible coordination and protection measures for the RAS in the frequency band 23.6-24 GHz from IMT deployment;

2 to regularly review, as appropriate, the impact of evolving technical and operational characteristics of IMT systems (including base-station density) and those of systems of space services on sharing and compatibility, and to take into account the results of these reviews in the development and/or revision of ITU-R Recommendations/Reports addressing, *inter alia*, if necessary, applicable measures to mitigate the risk of interference into space receivers,

instructs the Director of the Radiocommunication Bureau

to bring this Resolution to the attention of relevant international organizations.

RESOLUTION 243 (REV.WRC-23)

Terrestrial component of International Mobile Telecommunications in the frequency bands 37-43.5 GHz and 47.2-48.2 GHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that International Mobile Telecommunications (IMT), including IMT-2000, IMT-Advanced and IMT-2020, is intended to provide telecommunication services on a worldwide scale, regardless of location and type of network or terminal;

b) that adequate and timely availability of spectrum and supporting regulatory provisions are essential to realize the objectives in Recommendation ITU-R M.2083;

c) that there is a need to continually take advantage of technological developments in order to increase the efficient use of spectrum and facilitate spectrum access;

d) that IMT systems are now being evolved to provide diverse usage scenarios and applications such as enhanced mobile broadband, massive machine-type communications and ultra-reliable and low-latency communications;

e) that ultra-low latency and very high bit-rate applications of IMT will require larger contiguous blocks of spectrum than those available in frequency bands that are currently identified for use by administrations wishing to implement IMT;

f) that the properties of higher frequency bands, such as shorter wavelength, would better enable the use of advanced antenna systems, including multiple-input and multiple-output (MIMO) and beam-forming techniques, in supporting enhanced broadband;

g) that harmonized worldwide frequency bands for IMT are desirable in order to achieve global roaming and the benefits of economies of scale;

h) that the ITU Radiocommunication Sector (ITU-R) has studied, in preparation for WRC-19, sharing and compatibility with services allocated in the frequency ranges 37-43.5 GHz and 47.2-48.2 GHz and their adjacent frequency bands, based on the characteristics available at that time, and the results may change if these characteristics change;

i) that identification of frequency bands allocated to the mobile service for IMT may change the sharing situation regarding applications of services to which the frequency band is already allocated, and may require regulatory actions;

j) that there is a need to protect existing services and to allow for their continued development;

k) that it is assumed that a very limited number of IMT base stations will be communicating with a positive elevation angle towards IMT indoor mobile stations;

l) that the use of this frequency band by the mobile service for IMT is intended for land mobile service use and sharing studies were conducted based on that assumption,

noting

a) that Recommendation ITU-R M.2083 provides the framework and overall objectives of the future development of IMT for 2020 and beyond;

b) that Report ITU-R M.2320 addresses future technology trends of terrestrial IMT systems;

c) that Report ITU-R M.2370 addresses trends impacting future IMT traffic growth beyond the year 2020 and estimates global traffic demand for the period 2020 to 2030;

d) that Resolution **143 (Rev.WRC-19)** establishes the guidelines for the implementation of high-density applications in the fixed-satellite service (HDFSS) in frequency bands identified for these applications;

e) that Recommendation ITU-R SA.2142 addresses the methodologies for calculating coordination areas around Earth exploration-satellite service (EESS) and space research service (SRS) earth stations to avoid harmful interference from IMT-2020 systems in the frequency bands 25.5-27 GHz and 37-38 GHz;

f) that Recommendation ITU-R M.2161 provides guidelines to assist administrations to mitigate in-band interference from FSS earth stations operating in the frequency bands 24.65-25.25 GHz, 27-27.5 GHz, 42.5-43.5 GHz and 47.2-48.2 GHz into IMT stations,

recognizing

a) that timely availability of wide and contiguous blocks of spectrum is important to support the development of IMT;

b) Resolutions 176 (Rev. Bucharest, 2022) and 203 (Rev. Bucharest, 2022) of the Plenipotentiary Conference;

c) the identification of HDFSS in the space-to-Earth direction in the frequency bands 39.5-40 GHz in Region 1, 40-40.5 GHz in all Regions, 40.5-42 GHz in Region 2 and 47.5-47.9 GHz in Region 1 (see No. **5.516B**);

d) that No. **5.149** applies for the purpose of protecting the radio astronomy service (RAS) in the frequency band 42.5-43.5 GHz, which is allocated on a primary basis;

e) that the frequency band 47.2-48.2 GHz is allocated to the fixed, mobile and fixed-satellite services, including planned non-geostationary-satellite (non-GSO) uplinks,

resolves

1 that administrations wishing to implement IMT consider use of the frequency band 37-43.5 GHz, or portions thereof, and the frequency band 47.2-48.2 GHz, identified for IMT in No. **5.550B** and No. **5.553B**, and the benefits of harmonized utilization of the spectrum for the terrestrial component of IMT taking into account the latest relevant ITU-R Recommendations;

2 that, in order to ensure coexistence between IMT in the frequency bands 37-43.5 GHz and 47.2-48.2 GHz as identified by WRC-19 in Article **5** and other services to which the frequency band is allocated, including the protection of these other services, administrations shall apply the following condition(s):

2.1 in order to protect the EESS (passive) in the frequency band 36-37 GHz, the following unwanted emissions of IMT stations operating in the frequency band 37-40.5 GHz apply as specified in Table 1 below:

TABLE 1

Frequency band for the EESS (passive)	**Frequency band for IMT stations**	**Unwanted emission mean power for IMT stations[1]**	**Recommended limits for IMT stations[1]**
36-37 GHz	37-40.5 GHz	−43 dB(W/MHz) and −23 dB(W/GHz) within the frequency band 36-37 GHz	−30 dB(W/GHz)

[1] The unwanted emission power level is considered in terms of total radiated power (TRP). The TRP is to be understood here as the integral of the power transmitted from all antenna elements in different directions over the entire radiation sphere.

2.2 protection of SRS earth stations in the frequency band 37-38 GHz and RAS stations in the frequency band 42.5-43.5 GHz from IMT stations should be facilitated through bilateral agreements for cross-border coordination as necessary;

2.3 protection of and coexistence with fixed-satellite service (FSS) earth stations within the frequency ranges 37.5-43.5 GHz and 47.2-48.2 GHz should be facilitated through bilateral agreements for cross-border coordination as necessary;

2.4 take practical measures to ensure the transmitting antennas of outdoor base stations are normally pointing below the horizon, when deploying IMT base stations within the frequency bands 42.5-43.5 GHz and 47.2-48.2 GHz; the mechanical pointing needs to be at or below the horizon;

2.5 as far as practicable, sites for IMT base stations in the frequency bands 42.5-43.5 GHz and 47.2-48.2 GHz employing values of equivalent isotropically radiated power (e.i.r.p.) per beam exceeding 30 dB(W/200 MHz) should be selected so that the direction of maximum radiation of any antenna will be separated from the geostationary-satellite orbit, within line-of-sight of the IMT base station, by ±7.5 degrees;

3 that IMT stations within the frequency ranges 37-43.5 GHz and 47.2-48.2 GHz are used for applications of the land mobile service,

invites administrations

to ensure that, when considering the spectrum to be used for IMT, due attention is paid to the need for spectrum for ubiquitous earth stations at unspecified points, as well as those used for gateways, taking into account spectrum identified in the frequency bands 39.5-40 GHz in Region 1, 40-40.5 GHz in all Regions, 40.5-42 GHz in Region 2 and 47.5-47.9 GHz in Region 1 for the HDFSS, in accordance with No. **5.516B**,

encourages administrations

1 to ensure that provisions for the implementation of IMT allow for the continued development of EESS, SRS, FSS and broadcasting-satellite service (BSS) earth stations and RAS stations and their future development;

2 to keep the antenna pattern of IMT base stations within the limits of the approximation envelope according to the most recent version of Recommendation ITU-R M.2101,

encourages administrations of Region 1

to consider implementing IMT in the frequency band 40.5-43.5 GHz in order to better accommodate the needs of other services below 40.5 GHz, taking into account protection of the FSS within the frequency band 37.5-40.5 GHz in Region 1,

invites the ITU Radiocommunication Sector

1 to continue providing guidance to ensure that IMT can meet the telecommunication needs of the developing countries;

2 to develop ITU-R Reports and Recommendations, as appropriate, to assist administrations in ensuring coexistence between IMT and BSS and FSS, including HDFSS in accordance with No. **5.516B**, within the frequency ranges 37-43.5 GHz and 47.2-48.2 GHz, as appropriate;

3 to develop a new ITU-R Recommendation, as appropriate, to provide information and assistance to the concerned administrations on possible coordination and protection measures for the RAS in the frequency band 42.5-43.5 GHz from IMT deployment;

4 to regularly review, as appropriate, the impact of evolving technical and operational characteristics of IMT systems (including base-station density) and those of systems of space services on sharing and compatibility, and to take into account the results of these reviews in the development and/or revision of ITU-R Recommendations/Reports addressing, *inter alia*, if necessary, applicable measures to mitigate the risk of interference into space receivers,

instructs the Director of the Radiocommunication Bureau

to bring this Resolution to the attention of relevant international organizations.

RESOLUTION 244 (REV.WRC-23)

International Mobile Telecommunications in the frequency band 45.5-47 GHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that International Mobile Telecommunications (IMT), including IMT-2000, IMT-Advanced and IMT-2020, is intended to provide telecommunication services on a worldwide scale, regardless of location and type of network or terminal;

b) that the evolution of IMT is being studied within the ITU Radiocommunication Sector (ITU-R);

c) that adequate and timely availability of spectrum and supporting regulatory provisions are essential to realize the objectives in Recommendation ITU-R M.2083;

d) that there is a need to continually take advantage of technological developments in order to increase the efficient use of spectrum and facilitate spectrum access;

e) that IMT systems are now being evolved to provide diverse usage scenarios and applications such as enhanced mobile broadband, massive machine-type communications and ultra-reliable and low-latency communications;

f) that ultra-low latency and very high bit-rate applications of IMT will require larger contiguous blocks of spectrum than those available in frequency bands that are currently identified for use by administrations wishing to implement IMT;

g) that the properties of higher frequency bands, such as shorter wavelength, would better enable the use of advanced antenna systems, including multiple-input and multiple-output (MIMO) and beam-forming techniques, in supporting enhanced broadband;

h) that harmonized worldwide frequency bands for IMT are desirable in order to achieve global roaming and the benefits of economies of scale,

noting

that Recommendation ITU-R M.2083 provides the framework and overall objectives of the future development of IMT for 2020 and beyond,

recognizing

that the identification of a frequency band for IMT does not establish priority in the Radio Regulations and does not preclude the use of the frequency band by any application of the services to which it is allocated,

resolves

that administrations wishing to implement IMT consider use of the frequency band 45.5-47 GHz, identified for IMT in No. **5.553A**, and the benefits of harmonized utilization of the spectrum for the terrestrial component of IMT taking into account the latest relevant ITU-R Recommendations,

invites the ITU Radiocommunication Sector

to continue providing guidance to ensure that IMT can meet the telecommunication needs of the developing countries in the context of the studies referred to above.

RESOLUTION 249 (REV.WRC-23)

Study of technical and operational issues and regulatory provisions for space-to-space transmissions in the frequency bands 1 518-1 544 MHz, 1 545-1 559 MHz, 1 610-1 645.5 MHz, 1 646.5-1 660 MHz, 1 670-1 675 MHz and 2 483.5-2 500 MHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that many non-geostationary-satellite orbit (non-GSO) satellites operate with limited and non-real-time connectivity to earth stations;

b) that, by utilizing space-to-space communication between such non-GSO satellites and mobile-satellite service (MSS) satellites operating at higher orbital altitudes, including in the geostationary-satellite orbit (GSO), to relay data to or from the ground, data can be made available in near-real time, enhancing the availability and value of instrument data for low latency applications;

c) that all MSS allocations in the frequency bands 1 518.0-1 544.0 MHz, 1 545.0-1 559.0 MHz, 1 610.0-1 645.5 MHz, 1 646.5-1 660.0 MHz, 1 670.0-1 675.0 MHz and 2 483.5-2 500.0 MHz include a space-to-Earth or Earth-to-space direction indicator but do not include a space-to-space direction indicator;

d) that the ITU Radiocommunication Sector (ITU-R) has begun preliminary studies on the technical and operational issues associated with the operation of space-to-space links between non-GSO MSS satellites and GSO MSS satellites in some of the above frequency bands, but no studies have been conducted on the technical and operational issues associated with the operation of space-to-space links between non-GSO MSS satellites and non-GSO MSS satellites in the above frequency bands to determine whether space-to-space operations are compatible;

e) that it is technically feasible for a lower orbital altitude non-GSO space station to transmit data to and receive data from a higher orbital altitude non-GSO or GSO space station when passing within the satellite antenna coverage beam that is directed towards the Earth;

f) that several satellite systems operate space-to-space transmissions in some of the above frequency bands under No. **4.4**, without defined regulatory protection mechanisms, subject to the application of No. **8.5**;

g) that there is growing interest for utilizing space-to-space satellite links for a variety of applications;

h) that a precedent for space-to-space links sharing with Earth-to-space links or space-to-Earth links exists for other space services, for example, the space operation, Earth exploration-satellite, and space research services in the frequency bands 2 025-2 110 MHz and 2 200-2 290 MHz through the inclusion of a space-to-space direction indicator,

recognizing

a) that it is necessary to study the impact on, and to protect, other services, including Earth-to-space and space-to-Earth operation within the MSS, from the operation of space-to-space links in the above frequency bands, taking into account applicable footnotes to the Table of Frequency Allocations, to ensure compatibility with all primary allocated services in these frequency bands and the adjacent frequency bands and avoid harmful interference;

b) that there should be no additional regulatory or technical constraints imposed on primary services to which the frequency bands and adjacent frequency bands are currently allocated;

c) that it is necessary to study whether space-to-Earth direction transmissions from space stations at higher orbital altitudes, including GSO, can be successfully received by lower orbital altitude non-GSO satellites, without imposing any additional constraints on all allocated services in these frequency bands;

d) that the sharing scenarios may vary widely because of the wide variety of orbital characteristics of the non-GSO MSS space stations;

e) that out-of-band emissions, signals due to antenna pattern sidelobes, and in-band unintentional radiation due to Doppler shifts may impact services operating in the same and adjacent or nearby frequency bands,

recognizing further

a) that the use of frequency bands by the MSS in the frequency range 1-3 GHz is subject to existing Resolutions, coordination requirements and country footnotes taking into account, in particular, the protection of safety services and aeronautical mobile-satellite (R) services, and of the Global Maritime Distress and Safety System (GMDSS);

b) that the fixed and mobile services are allocated on a primary basis in the frequency bands 2 483.5-2 500 MHz on a global basis and that the fixed service is also allocated on a primary basis in the frequency band 1 525-1 530 MHz in Regions 1 and 3;

c) that the radionavigation-satellite service is allocated on a primary basis in the frequency band 1 559-1 610 MHz for both space-to-Earth and space-to-space use;

d) that No. **5.356** states that the use of the frequency band 1 544-1 545 MHz by the MSS (space-to-Earth) is limited to distress and safety communications (see Article **31**);

e) that Nos. **5.357A** and **5.362A** provide priority for accommodating the spectrum requirements of the aeronautical mobile-satellite (R) service in the frequency bands 1 545-1 555 MHz and 1 646.5-1 656.5 MHz, and 1 555-1 559 MHz and 1 656.5-1 660.5 MHz, respectively;

f) that No. **5.353A** provides priority for distress, urgency and safety communications of the GMDSS in the frequency bands 1 530-1 544 MHz and 1 626.5-1 645.5 MHz;

g) that the radio astronomy service is allocated on a primary basis in the frequency bands 1 610.6-1 613.8 MHz and 1 660-1 670 MHz, and No. **5.149** applies;

h) that according to No. **5.366** the frequency band 1 610-1 626.5 MHz is reserved on a worldwide basis for the use and development of airborne electronic aids to air navigation and any directly associated ground-based or satellite-borne facilities, and such satellite use is subject to agreement obtained under No. **9.21**;

i) that, according to No. **5.368**, the provisions of No. **4.10** do not apply with respect to the radiodetermination-satellite and mobile-satellite services in the frequency band 1 610-1 626.5 MHz; however, No. **4.10** applies in the frequency band 1 610-1 626.5 MHz with respect to the aeronautical radionavigation-satellite service when operating in accordance with No. **5.366**, the aeronautical mobile satellite (R) service when operating in accordance with No. **5.367**, and in the frequency band 1 621.35-1 626.5 MHz with respect to the maritime mobile-satellite service when used for GMDSS;

j) that according to No. **5.343** in Region 2, the frequency band 1 435-1 525 MHz is used by the aeronautical mobile service for telemetry;

k) that, in the frequency band 1 518-1 525 MHz, Nos. **5.348**, **5.348A** and **5.348B** provide that the MSS shall not claim protection from the fixed service, stations in the mobile service in the territory of Japan, and aeronautical mobile telemetry stations in the mobile service in the territory of the United States;

l) that Resolution **744 (Rev.WRC-23)** applies to use of the frequency band 1 670-1 675 MHz by the mobile-satellite service;

m) that the meteorological aids and meteorological-satellite (space-to-Earth) services are allocated on a primary basis in the frequency band 1 670-1 675 MHz,

noting

that section 3.1.3.2 of the Director's Report to WRC-19 highlighted that the Radiocommunication Bureau has received an increased number of Advance Publication Information (API) submissions for non-GSO networks in frequency bands which are not allocated by Article **5** for the type of service foreseen, including satellite network filings for inter-satellite links in frequency bands allocated to MSS only in the Earth-to-space or space-to-Earth directions,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

1 studies of the technical and operational characteristics of different types of non-GSO space stations that operate or plan to operate space-to-space links with GSO networks in the following frequency bands, with the limitation that these space-to-space links only operate in the same direction as the existing MSS allocations:

a) Earth-to-space direction in the frequency bands 1 626.5-1 645.5 MHz and 1 646.5-1 660 MHz; and

b) space-to-Earth direction in the frequency bands 1 525-1 544 MHz and 1 545-1 559 MHz;

2 studies of the technical and operational characteristics of different types of non-GSO space stations that operate or plan to operate space-to-space links with non-GSO systems or GSO networks in the following frequency bands, with the limitation that these space-to-space links only operate in the same direction as the existing MSS allocations:

a) Earth-to-space direction in the frequency bands 1 610-1 626.5 MHz and 1 670-1 675 MHz; and

b) space-to-Earth direction in the frequency bands 1 518-1 525 MHz, 1 613.8-1 626.5 MHz and 2 483.5-2 500 MHz;

3 studies of sharing and compatibility between space-to-space links in the cases described in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* 1 and 2 and

– current and planned stations of the MSS, taking into account, in particular, *recognizing further e)* and *f)*;

– other existing primary services allocated in the same frequency bands;

– other existing primary services allocated in adjacent frequency bands; and

– existing passive services allocated in adjacent frequency bands;

in order to ensure protection of other MSS operations and other services allocated in those frequency bands and in adjacent frequency bands, taking into account *recognizing further a)* to *m)*;

4 development of technical conditions and regulatory provisions for the operation of space-to-space links in these frequency bands, including MSS (space-to-space) allocations or the addition of inter-satellite service (ISS) allocations, in all or parts of the frequency bands identified in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* 1 and 2 above, with the condition that stations operating in an MSS (space-to-space) or ISS allocation shall not cause harmful interference to, or claim protection from, the MSS (space-to-Earth) or MSS (Earth-to-space), while ensuring the protection of other services allocated in those and adjacent frequency bands, taking into account the results of the studies called for in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* 1, 2, and 3 above,

invites administrations

to participate in the studies by submitting contributions to ITU-R,

invites the 2027 world radiocommunication conference

to consider the results of the above studies and take necessary regulatory actions, as appropriate.

RESOLUTION 251 (REV.WRC-23)

Studies to consider a possible primary allocation in the frequency bands [694-960 MHz, or parts thereof, in Region 1], 890-942 MHz, or parts thereof, in Region 2, and [3 400-3 700 MHz, or parts thereof, in Region 3] to the aeronautical mobile service for the use of International Mobile Telecommunications (IMT) user equipment in terrestrial IMT networks by non-safety applications*

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that there is a demand for greater connectivity for passengers and aeronautical communications of aeronautical vehicles;

b) that current and future International Mobile Telecommunications (IMT) networks can provide connectivity services to helicopters, small aircraft, commercial aircraft and unmanned aircraft systems (UAS);

c) that current and future IMT networks may provide communication functions for the beyond visual line-of-sight operation of UAS;

d) that future IMT networks may provide connectivity services to commercial airplanes with specific equipment on board airplanes;

e) that the IMT network capacities identified in the *considering* paragraphs above have been considered by several studies and are being developed by standards development organizations,

noting

a) that ITU Radiocommunication Sector (ITU-R) sharing and compatibility studies supporting the identification of specific frequency bands for IMT did not consider the use cases described in *considering b)* to *e)*;

b) that the frequency band 694-960 MHz is allocated on a primary basis to the mobile, except aeronautical mobile, service in Region 1;

c) that the frequency bands 890-902 MHz and 928-942 MHz are allocated on a primary basis to the mobile, except aeronautical mobile, service in Region 2 and that the frequency band 902-928 MHz is allocated on a secondary basis to the mobile, except aeronautical mobile, service in Region 2;

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* The appearance of square brackets around certain frequency bands in this Resolution is understood to mean that WRC-27 will consider and review the inclusion of these frequency bands with square brackets and decide, as appropriate.

d) that Nos. **5.312** and **5.323** allocate the frequency band 645-960 MHz, or parts thereof, to the aeronautical radionavigation service on a primary basis in several countries of Region 1;

e) that the frequency band 694-960 MHz is allocated on a primary basis to the broadcasting service in Region 1;

f) that Resolution **224 (Rev.WRC-23)** addresses frequency bands for the terrestrial component of IMT below 1 GHz;

g) that Resolution **749 (Rev.WRC-23)** addresses the use of the frequency band 790-862 MHz in countries of Region 1 and the Islamic Republic of Iran by mobile applications and by other services;

h) that Resolution **760 (Rev.WRC-23)** addresses provisions relating to the use of the frequency band 694-790 MHz in Region 1 by the mobile, except aeronautical mobile, service and by other services;

i) that the frequency bands under consideration are identified for use by IMT in accordance with No. **5.317A**;

j) that, for countries listed in No. **5.318**, the frequency bands 849-851 MHz and 894-896 MHz are also allocated to the aeronautical mobile service (AMS) on a primary basis, for public correspondence with aircraft; the use of the frequency band 894-896 MHz is limited to transmissions from aircraft stations;

k) that, for one country listed in No. **5.325**, the frequency bands 890-902 MHz and 928-942 MHz are allocated to the radiolocation service on a primary basis;

l) that the frequency band 3 500-3 600 MHz is identified for use by IMT in some countries in accordance with No. **5.433A**;

m) that the frequency bands 3 400-3 500 MHz, 3 500-3 600 MHz and 3 600-3 700 MHz are also allocated to the fixed, fixed-satellite (space-to-Earth) and mobile, except aeronautical mobile, services on a primary basis and that those allocations are used by a variety of incumbent systems in many administrations;

n) that, under Nos. **5.432** and **5.432B**, the frequency band 3 400-3 500 MHz is allocated on a primary basis to the mobile, except aeronautical mobile, service and identified for use by IMT in some countries in Region 3;

o) that Report ITU-R M.2282 addresses systems for public mobile communications with aircraft,

recognizing

that new primary allocations to the AMS in the frequency bands proposed may enable the unified use of these allocations by airborne user equipment in terrestrial IMT networks throughout the Regions,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference

1 assessment of relevant AMS scenarios for connectivity for airborne user equipment in IMT networks to be addressed in compatibility and sharing studies;

2 identification of the relevant technical parameters associated with the aeronautical mobile systems to be used for studies;

3 sharing and compatibility studies with existing incumbent services, including in-band and adjacent frequency bands and between neighbouring Regions, to determine the suitability of new primary allocations of the following frequency bands to the AMS, in the countries for which there is an IMT identification, for the use of IMT user equipment by non-safety applications:

– [694-960 MHz, or parts thereof, in Region 1];

– 890-942 MHz, or parts thereof, in Region 2;

– [3 400-3 700 MHz, or parts thereof, in Region 3],

invites administrations

to participate actively in the studies and provide the information required for the studies listed under *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference* by submitting contributions to ITU-R,

invites the 2031 world radiocommunication conference

to consider, based on results of studies, possible allocations on a primary basis of all or part of the frequency bands listed in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference* 3 to the AMS, in the countries for which there is an IMT identification, for the use of IMT user equipment in terrestrial IMT networks by non-safety applications, and/or any other regulatory provisions.

RESOLUTION 252 (WRC-23)

Studies on potential new allocations to, and regulatory actions for, the mobile-satellite service in the frequency bands 1 427-1 432 MHz (space-to-Earth), 1 645.5-1 646.5 MHz (space-to-Earth) (Earth-to-space), 1 880-1 920 MHz (space-to-Earth) (Earth-to-space) and 2 010-2 025 MHz (space-to-Earth) (Earth-to-space) required for the future development of low-data-rate non-geostationary mobile-satellite systems

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that low-data-rate mobile-satellite service (MSS) systems, in the context of this Resolution, refer to non-geostationary (non-GSO) systems not delivering telephony that transmit data in bursts and can therefore operate with periodic or intermittent data transmission and maintain a service while experiencing packet loss;

b) that there is a need for low-data-rate MSS systems for the purpose of developing the Internet of Things;

c) that there are insufficient spectrum opportunities for new non-voice low-data-rate non-GSO MSS systems to operate in existing MSS frequency bands below 5 000 MHz;

d) that the number of mobile-satellite systems using small satellites is growing and the spectrum demand for suitable MSS allocations is increasing,

noting

a) that the frequency band 1 427-1 429 MHz is currently allocated to the space operations (Earth-to-space), fixed, and mobile, except aeronautical mobile, services on a primary basis;

b) that the frequency band 1 429-1 452 MHz is currently allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis in Region 1, and to the fixed and mobile services on a primary basis in Regions 2 and 3;

c) that the frequency band 1 400-1 427 MHz is currently allocated to the Earth exploration-satellite (passive), radio astronomy and space research (passive) services on a primary basis;

d) that the frequency band 1 645.5-1 646 5 MHz is currently allocated to the MSS (Earth-to-space) on a primary basis;

e) that the frequency band 1 880-1 920 MHz is currently allocated to the fixed and mobile services on a primary basis;

f) that the frequency band 2 010-2 025 MHz is currently allocated to the fixed and mobile services on a primary basis;

g) that the frequency band 2 010-2 025 MHz is currently allocated to the MSS on a primary basis in Region 2 only;

h) that in Regions 1 and 3, the frequency band 2 010-2 025 MHz may be used by high-altitude platform stations as base stations to provide International Mobile Telecommunications (IMT), in accordance with No. **5.388A**;

i) that the frequency band 1 427-1 432 MHz is identified for IMT globally, in accordance with Resolution **223 (Rev.WRC-23)**;

j) that the frequency bands 1 880-1 920 MHz and 2 010-2 025 MHz are identified for IMT globally in accordance with Resolution **212 (Rev.WRC-23)** and are included in arrangement B1 for implementation of IMT in Recommendation ITU-R M.1036;

k) that Report ITU-R SA.2312 provides technical characteristics and benefits of some low-data-rate MSS satellites and suggests that MSS frequency bands already allocated above 5 000 MHz are not suited to the inherent size, weight and power restrictions of small satellites (usually having a mass of less than 100 kg);

l) the need for regulatory certainty regarding the available spectrum for both satellite and earth station design and planning purposes,

recognizing

a) that the frequency bands 1 427-1 432 MHz, 1 645.5-1 646.5 MHz, 1 880-1 920 MHz and 2 010-2 025 MHz, and adjacent frequency bands, are also allocated to other radiocommunication services on a primary basis and that those allocations are used by a variety of incumbent systems in many administrations, and that the protection of these services should be studied;

b) that, for the determination of the incumbent services, the relevant provisions of the Radio Regulations in force apply;

c) that low-data-rate MSS systems in non-GSO orbits should, in the context of this Resolution have the following properties:

– not including telephony;

– transmitting data in bursts;

– capable of operating with periodic or intermittent data transmission;

– capable of maintaining a service while experiencing packet loss;

d) that MSS systems use different modes of operation and employ interference-mitigating measures to facilitate spectrum sharing and compatibility between systems and other services;

e) that new allocations for MSS systems are needed,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

1 studies on spectrum requirements, technical and operational characteristics and conditions for non-GSO low-data-rate MSS systems, including mitigation techniques, that allow coexistence of these systems in the same frequency bands;

2 studies on sharing and compatibility between the non-GSO low-data-rate MSS systems and the existing primary services operating in the frequency bands 1 427-1 432 MHz (space-to-Earth), 1 645.5-1 646.5 MHz (space-to-Earth) (Earth-to-space), 1 880-1 920 MHz (space-to-Earth) (Earth-to-space) and 2 010-2 025 MHz (space-to-Earth) (Earth-to-space) and in the relevant adjacent frequency bands, in order to ensure protection of existing services,

invites administrations

to participate actively in the studies and provide the information required for the studies listed under *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* by submitting contributions to the ITU Radiocommunication Sector,

invites the 2027 world radiocommunication conference

to consider, based on the results of studies, possible allocations to the MSS and possible regulatory actions in the frequency bands referred to in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference*.

RESOLUTION 253 (WRC-23)

Studies on possible new allocations to the mobile-satellite service for direct connectivity between space stations and International Mobile Telecommunications (IMT) user equipment to complement terrestrial IMT network coverage

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that International Mobile Telecommunications (IMT) systems support terrestrial and satellite components, including the capability to enable direct communication to IMT user equipment;

b) that the mobile-satellite system may provide alternative network resilience and mobile connectivity to underserved communities and in rural and remote areas, in particular in the event of network failures of terrestrial IMT and natural disasters;

c) that the expected usage of the mobile-satellite service (MSS) in IMT frequency bands in specific service areas is based on the authorization by administrations within the territory under their jurisdiction,

noting

a) that Report ITU-R M.2077-0 indicated a shortfall of spectrum available for the satellite component of IMT and systems beyond IMT-2000 of more than 144 MHz (space-to-Earth) and more than 19 MHz (Earth-to-space);

b) that Report ITU-R M.2218-0 estimated the spectrum requirement in the frequency range 4-16 GHz for MSS broadband applications between 240 MHz and 355 MHz;

c) that Report ITU-R M.2514-0, on vision, requirements and evaluation guidelines for satellite radio interfaces of IMT-2020, defined the minimum technical requirements for satellite systems which can be part of the IMT-2020 ecosystem, including bandwidth requirements;

d) that Report ITU-R M.2041-0 addressed sharing and adjacent band compatibility in the 2.5 GHz band between the terrestrial and satellite components of IMT-2000;

e) that Recommendation ITU-R M.1182-1 considered the integration of terrestrial and satellite mobile communication systems;

f) that Recommendation ITU-R M.1036-6 addressed frequency arrangements for the implementation of the terrestrial component of IMT in the bands identified for IMT in the Radio Regulations;

g) that Recommendation ITU-R RA.769-2 contains the protection criteria used for radio astronomical measurements;

h) that Recommendation ITU-R RA.1513-2 provides the acceptable levels of data loss to radio astronomy observations and percentage-of-time criteria resulting from degradation by interference for frequency bands allocated to the radio astronomy service (RAS) on a primary basis;

i) that Recommendation ITU-R M.1808-1 also applies for the studies of frequency bands allocated for the mobile service below 960 MHz;

j) that Resolution **646 (Rev.WRC-19)** also applies in frequency bands below 960 MHz;

k) that the GE06 Agreement applies for countries in Region 1, except Mongolia, and including the Islamic Republic of Iran,

recognizing

a) that the growth in demand for mobile-satellite systems is making it difficult to sustain MSS services on a long-term basis in the existing bands;

b) that MSS systems may provide direct connectivity between space stations and IMT user equipment to complement terrestrial IMT network coverage;

c) that new allocations to the MSS would be consistent with the International Telecommunication Union's objective of promoting access to telecommunication services, particularly in remote and rural areas;

d) that there is a need to concentrate the studies on the frequency bands allocated to the mobile service on a primary basis and used for IMT or identified for IMT by country footnotes or on a regional or multi-regional basis;

e) that for the determination of the incumbent services, the relevant provisions of the Radio Regulations in force apply;

f) that unwanted emissions in the spurious domain may be considered regarding RAS frequency allocations,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

1 studies on possible allocations to the MSS in the frequency range between 694/698 MHz and 2.7 GHz, taking into account the IMT frequency arrangements addressed in the most recent version of Recommendation ITU-R M.1036;

2 studies on spectrum requirements and on technical, operational and regulatory matters related to the implementation of the mobile-satellite service for direct connectivity to the IMT user equipment to complement the terrestrial IMT network coverage,

further resolves

1 to conduct studies on sharing and compatibility between incumbent services, including in adjacent frequency bands, ensuring the protection of incumbent services in accordance with the Radio Regulations;

2 to study possible technical and operational measures to ensure that the stations in the MSS do not cause harmful interference to, or claim protection from, stations operating in the mobile service,

invites administrations

to participate actively in the studies and provide the information required for the studies listed in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* by submitting contributions to the ITU Radiocommunication Sector,

invites the 2027 world radiocommunication conference

to consider, based on the results of studies, the appropriate regulatory actions, including possible new allocations to the MSS for direct connectivity between space stations and IMT user equipment to complement terrestrial IMT network coverage.

RESOLUTION 254 (WRC-23)

Studies on possible new frequency allocations to the mobile-satellite service in the frequency bands 2 010-2 025 MHz (Earth-to-space) and 2 160-2 170 MHz (space-to-Earth) in Regions 1 and 3 and 2 120-2 160 MHz (space-to-Earth) in all Regions

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that demand for mobility communications has driven an increasing demand for mobile-satellite service and connectivity anywhere;

b) that the range of mobile-satellite service applications has expanded manifold since the last mobile-satellite service (MSS) allocations were made, and the number of MSS systems is growing and the spectrum demand for suitable MSS allocations is increasing;

c) that MSS systems implementing various applications, including data applications, are a proven, practical and cost-effective method of providing telecommunication service that contributes to global economic and social development especially in remote and underserved areas;

d) that recent advances in technology and the development of external standards are facilitating the integration of mobile-satellite solutions to address connectivity, which increases the range of potential users of the MSS;

e) that MSS systems play a part in reducing the digital divide;

f) that MSS systems have the capability of overcoming practical and logistical difficulties associated with terrestrial infrastructure;

g) that contiguous spectrum for the MSS would enable efficiencies in spectrum management;

h) the need for regulatory certainty regarding the available spectrum for both satellite and earth station design and planning purposes;

i) that new MSS allocations in the frequency bands 2 010-2 025 MHz (Earth-to-space) and 2 160-2 170 MHz (space-to-Earth) in Regions 1 and 3 and 2 120-2 160 MHz (Earth-to-space) in all Regions may help to address MSS spectrum demands;

j) that it may be possible to provide additional MSS capacity by amending some existing secondary MSS allocations to primary,

noting

a) that MSS characteristics can be found in ITU-R Recommendations and Reports, such as Recommendation ITU-R M.1184;

b) that Report ITU-R M.2514, "Vision, requirements and evaluation guidelines for satellite radio interface(s) of IMT-2020", has been approved;

c) that the frequency band 2 010-2 025 MHz is allocated to the MSS on a primary basis for Earth-to-space operations in Region 2;

d) that the frequency bands 2 025-2 110 MHz and 2 200-2 290 MHz are allocated to the fixed and mobile services on a primary basis;

e) that the frequency band 2 120-2 160 MHz is allocated to the MSS on a secondary basis for space-to-Earth operations in Region 2;

f) that the frequency band 2 160-2 170 MHz is allocated to the MSS on a primary basis for space-to-Earth operations in Region 2;

g) that the frequency bands 2 010-2 025 MHz, 2 160-2 170 MHz and 2 200-2 215 MHz are adjacent to bands that are allocated to the MSS on a primary basis and identified for the satellite component of IMT-2020;

h) that the frequency bands 2 010-2 025 MHz, 2 120-2 160 MHz and 2 160-2 170 MHz are adjacent to bands allocated to the MSS on a primary basis globally or in Region 2;

i) that, under Recommendation ITU-R M.1036, the frequency bands 1 920-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz are included as arrangements B1, B4, B5 and B7 for the implementation of IMT; some administrations have used these bands in Regions 1, 2 and 3, and terrestrial mobile operators have deployed IMT systems, and also in some countries portions of these bands have been implemented for railway control and dispatching systems, which are critical for the safety of railway operations; the frequency band 2 110-2 170 MHz is used for downlink transmission from terrestrial IMT base stations; and IMT systems in the frequency range 2 010-2 025 MHz are operated in time-division duplex (TDD) mode;

j) that, in accordance with No. **5.388**, the frequency bands 1 885-2 025 MHz and 2 110-2 200 MHz are intended for use, on a worldwide basis, by administrations wishing to implement IMT; such use does not preclude the use of these frequency bands by other services to which they are allocated; these frequency bands should be made available for IMT in accordance with Resolution **212 (Rev.WRC-23)**;

k) that, in accordance with Resolution **212 (Rev.WRC-23)**, both the terrestrial and the satellite components of IMT have already been deployed or are being planned for deployment within the frequency bands 1 885-2 025 MHz and 2 110-2 200 MHz, and that the availability of the satellite component of IMT in the frequency bands 1 980-2 010 MHz and 2 170-2 200 MHz simultaneously with the terrestrial component of IMT in the frequency bands identified in No. **5.388** could improve the overall use of IMT;

l) that the frequency bands 2 025-2 110 MHz and 2 200-2 290 MHz are allocated to the space operation, Earth-exploration satellite and space research services on a primary basis in the Earth-to-space, space-to-Earth and space-to-space directions and are currently heavily used by most satellite systems for telecommand, telemetry and precision tracking, as well as by launchers and manned or unmanned space research missions,

recognizing

a) that some existing satellite allocations may be adapted to provide further MSS capacity;

b) that the introduction of applications of the possible new allocation to the MSS should not adversely affect existing primary services allocated in the frequency bands being considered and adjacent frequency bands that operate in accordance with the Radio Regulations,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

1 studies on relevant spectrum requirements and technical, operational and regulatory matters for the MSS in connection with possible new allocations to the MSS in the frequency bands 2 010-2 025 MHz (Earth-to-space) and 2 160-2 170 MHz (space-to-Earth) in Regions 1 and 3 and 2 120-2 160 MHz (space-to-Earth) in all Regions;

2 studies on sharing and compatibility of possible new allocations to the MSS in the frequency bands being studied to ensure the protection of existing services allocated on a primary basis, and also in adjacent frequency bands, without adversely affecting those services;

3 studies on possible technical, operational and regulatory measures that ensure the protection of existing services and their continued operation and future development without imposing additional regulatory or technical constraints on those services, while ensuring their protection from harmful interference, when considering possible additional allocations to the MSS,

invites administrations

to participate actively in the studies and provide the information required for the studies referred to in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* by submitting contributions to the ITU Radiocommunication Sector,

invites the 2027 world radiocommunication conference

to consider, based on results of studies conducted under *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference*, possible new allocations and associated regulatory conditions for the MSS, while ensuring the protection of existing primary services.

RESOLUTION 255 (WRC-23)

Studies on frequency-related matters for International Mobile Telecommunications (IMT) identification in the frequency bands [102-109.5 GHz, 151.5-164 GHz, 167-174.8 GHz, 209-226 GHz and 252-275 GHz] for the future development of IMT*

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that International Mobile Telecommunications (IMT) is intended to provide telecommunication services on a worldwide scale, regardless of location and type of network or terminal;

b) that IMT systems have contributed to global economic and social development;

c) that IMT systems are now evolving to provide diverse usage scenarios and applications, such as enhanced mobile broadband, massive machine-type communications and ultra-reliable and low-latency communications;

d) that ultra-low latency and very high bit-rate applications of IMT will require larger contiguous blocks of spectrum than those available in frequency bands that are currently identified for use by administrations wishing to implement IMT;

e) that it may be suitable to examine higher frequency bands for these larger blocks of spectrum;

f) that there is a need to continually take advantage of technological developments in order to increase the efficient use of spectrum and facilitate spectrum access;

g) that the properties of higher frequency bands, such as shorter wavelength, would better enable the use of advanced antenna systems, including multiple input, multiple output (MIMO) and beam-forming techniques in supporting enhanced broadband;

h) that harmonized worldwide bands and harmonized frequency arrangements for IMT are highly desirable in order to achieve global roaming and the benefits of economies of scale;

i) that identification of frequency bands allocated to the mobile service for IMT may change the sharing situation regarding applications of services to which the frequency band is already allocated and may require additional regulatory actions,

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* The appearance of square brackets around certain frequency bands in this Resolution is understood to mean that WRC-27 will consider and review the inclusion of these frequency bands with square brackets and decide, as appropriate.

noting

a) that IMT encompasses IMT-2000, IMT-Advanced, IMT-2020, IMT-2030 and future generations of IMT collectively;

b) that Report ITU-R M.2516 addresses future technology trends of terrestrial systems for IMT for 2030 and beyond;

c) that there are ongoing studies within the ITU Radiocommunication Sector (ITU-R) on propagation characteristics for mobile systems in higher frequency bands,

recognizing

a) that there is a lead time between the allocation of frequency bands by world radiocommunication conferences and the deployment of systems in those bands, and that timely availability of wide and contiguous blocks of spectrum is therefore important to support the development of IMT;

b) that any identification of frequency bands for IMT should take into account the use of the frequency bands by other services and the evolving needs of those services, including the space research service (passive) in frequency bands 105-109.5 GHz and 217-226 GHz;

c) that there should be no additional regulatory or technical constraints imposed on services to which the frequency band is currently allocated on a primary basis;

d) that frequency bands adjacent to those listed in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference* 2 below are allocated to passive services and that No. **5.340** applies in many of those adjacent frequency bands,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference

1 the appropriate studies to determine the spectrum needs for the terrestrial component of IMT in the frequency bands listed in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference* 2, taking into account:

– technical and operational characteristics of terrestrial IMT systems that would operate in those frequency bands, including the evolution of IMT through advances in technology and spectrally efficient techniques;

– the deployment scenarios envisaged for IMT-2030 systems and the related requirements of high data traffic, such as in dense urban areas and/or at peak times; and

– the needs of developing countries and the time-frame in which spectrum would be needed;

2 the appropriate sharing and compatibility[1] studies, taking into account the protection of services to which the frequency band is allocated on a primary basis for the following frequency bands:

– [102-109.5 GHz, 151.5-164 GHz, 167-174.8 GHz, 209-226 GHz and 252-275 GHz],

invites administrations

to participate actively in the studies and provide the information required for the studies listed under *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference* by submitting contributions to ITU-R,

invites the 2031 world radiocommunication conference

to consider, based on the results of studies, the identification of frequency bands for the terrestrial component of IMT; the frequency bands to be considered being limited to part or all of the frequency bands listed in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference* 2.

[1] Including studies with respect to services in adjacent bands, as appropriate.

RESOLUTION 256 (WRC-23)

Sharing and compatibility studies and development of technical conditions for the use of International Mobile Telecommunications (IMT) in the frequency bands 4 400-4 800 MHz, 7 125-8 400 MHz (or parts thereof), and 14.8-15.35 GHz for the terrestrial component of IMT

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that International Mobile Telecommunications (IMT) is intended to provide telecommunication services on a worldwide scale, regardless of location and type of network or terminal;

b) that the continuous development of IMT and other mobile broadband systems contribute to global economic and social development by providing diverse usage scenarios and a wide range of applications;

c) that ultra-low latency and very high bit-rate applications of IMT will require contiguous blocks of spectrum for use by administrations wishing to implement IMT;

d) that there continues to be an increase in the data-traffic demand for mobile communications beyond 2030 to satisfy numerous connections and user experience, especially in areas of high user density;

e) that the ITU Radiocommunication Sector (ITU-R) is working on the development of IMT-2030 and beyond;

f) that the appropriate choices of contiguous frequency bands to provide coverage, capacity and performance are necessary and are important to the cost-effective implementation of future systems, taking into account the radio-wave propagation characteristics and implementation complexity and cost factors;

g) that harmonized worldwide/regional frequency bands and frequency arrangements for IMT are highly desirable in order to achieve global roaming and the benefits of economies of scale;

h) that the implementation of IMT may differ among administrations in different frequency bands identified for IMT;

i) the need to protect existing services and to allow for their continued development when considering frequency bands for possible additional allocations to any service;

j) that continuation of studies regarding additional spectrum identification for IMT is needed in order to provide proper conditions for use of IMT, which provides sharing and compatibility with other incumbent applications, and then to give flexibility for administrations to select the frequency bands among those bands identified for IMT;

noting

a) that relevant information relating to terrestrial IMT technology and previous sharing studies are contained in Recommendations ITU-R M.2083, ITU-R M.2150, ITU-R M.2160, ITU-R M.2101 and ITU-R M.2116 and Reports ITU-R M.2410, ITU-R M.2320, ITU-R M.2516, ITU-R M.2370 and ITU-R M.2376;

b) that Resolution ITU-R 65 addresses the principles for the process of development of IMT-2020 and IMT-2030;

c) that IMT encompasses IMT-2000, IMT-Advanced, IMT-2020 and IMT-2030 collectively, as described in Resolution ITU-R 56;

d) that Question ITU-R 77/5 considers the needs of developing countries in the development and implementation of IMT;

e) that Question ITU-R 229/5 seeks to address the further development of IMT;

f) that Question ITU-R 262/5 addresses the study of usage of IMT systems for specific applications;

g) that relevant ITU-R Recommendations provide information on propagation models that may be relevant to the studies,

recognizing

a) that there is a lead time between the allocation of frequency bands by WRCs and the deployment of systems in those bands, and that timely availability of wide and contiguous blocks of spectrum is therefore important to support the development of IMT;

b) that, in order to ensure the future development of IMT, it is important to ensure the timely identification of additional spectrum;

c) that any identification of frequency bands for IMT should take into account the use of the frequency band(s) and adjacent frequency bands by other services and the evolving needs of these services;

d) that administrations may have different spectrum requirements for IMT depending on national conditions and particular circumstances;

e) that the frequency bands 4 400-4 800 MHz, 7 125-8 400 MHz (or parts thereof), and 14.8-15.35 GHz are also allocated to the radiocommunication services on a primary basis and that those allocations are used by a variety of incumbent systems in many administrations;

f) that No. **5.457D** identifies the frequency band 6 425-7 025 MHz for IMT for certain countries of Region 3, and that some other countries in Region 3 could propose adding their names to this footnote in accordance with Resolution **26 (Rev.WRC-23)**,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

1 the appropriate studies of technical, operational and regulatory issues pertaining to the possible use of the terrestrial component of IMT in the frequency bands listed in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* 2, taking into account:

– evolving needs to meet emerging demand for IMT;

– technical and operational characteristics of terrestrial IMT systems that would operate in these specific frequency bands, including the evolution of IMT through advances in technology and spectrally efficient techniques;

– the deployment scenarios envisaged for IMT systems and the related requirements of balanced coverage and capacity;

– the needs of developing countries; and

– the time-frame in which spectrum would be needed;

2 sharing and compatibility studies, with a view to ensuring the protection of services to which the frequency band is allocated on a primary basis, including protection of stations operating in international waters or airspace which cannot be registered in the MIFR, without imposing additional regulatory or technical constraints on those services, and also on services in adjacent bands, for the frequency bands:

– 4 400-4 800 MHz;

– 7 125-8 400 MHz; and

– 14.8-15.35 GHz,

invites administrations

to participate actively in the studies and provide the information required for the studies listed under *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* by submitting contributions to ITU-R,

invites the 2027 world radiocommunication conference

to consider, based on results of studies, the identification of frequency band(s):

– 4 400-4 800 MHz, or parts thereof, in Region 1 and Region 3;

– 7 125-8 400 MHz, or parts thereof, in Region 2 and Region 3;

– 7 125-7 250 MHz and 7 750-8 400 MHz, or parts thereof, in Region 1;

– 14.8-15.35 GHz,

for the terrestrial component of IMT.

RESOLUTION 331 (REV.WRC-12)

Operation of the Global Maritime Distress and Safety System

The World Radiocommunication Conference (Geneva, 2012),

noting

that all ships subject to the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended, are required to be fitted for the Global Maritime Distress and Safety System (GMDSS),

noting further

a) that a number of administrations have taken steps to implement the GMDSS also for classes of vessels not subject to SOLAS, 1974, as amended;

b) that an increasing number of vessels not subject to SOLAS, 1974, as amended, are making use of the techniques and frequencies of the GMDSS prescribed in Chapter **VII**;

c) that Chapter **VII** provides for maintaining interoperability between ships fitted for GMDSS and ships not yet fully equipped for GMDSS;

d) that the International Maritime Organization (IMO) is of the view that SOLAS ships, while at sea, should be required to keep a listening watch on VHF channel 16, for the foreseeable future, with a view to providing:

– a distress alerting and communication channel for non-SOLAS ships; and

– bridge-to-bridge communications;

e) that IMO has urged administrations to require all seagoing vessels under national legislation, and encourage all vessels voluntarily carrying VHF radio equipment to be fitted with facilities for transmitting and receiving distress alerts by digital selective calling (DSC) on VHF channel 70;

f) that separate provisions in the existing Radio Regulations allow VHF channel 16 and 2 182 kHz to be used for general calling by radiotelephony;

g) that several administrations have established Vessel Traffic Service (VTS) systems and require their vessels to keep watch on local VTS channels;

h) that ships that are required by SOLAS to carry a radio station have been equipped with DSC, and many vessels subject to national carriage requirements are also being equipped with DSC, but the majority of vessels that carry a radio station on a voluntary basis might not yet have DSC equipment;

i) that many administrations have established distress and safety service based on DSC watchkeeping, but the majority of port stations, pilot stations and other operational coast stations might not yet have been equipped with DSC facilities;

j) that ships not required by international agreement to carry GMDSS equipment can do so for safety purposes,

recognizing

a) that stations in the maritime mobile service are increasingly making use of the frequencies and techniques of GMDSS;

b) that there may be a need to maintain existing shore-based distress and safety services for reception of distress, urgency and safety calling by voice on VHF channel 16 for some years after this Conference so that ships whose ability to participate in GMDSS is limited to VHF channel 16 will be able to attract attention and obtain assistance from these services,

resolves

1 to urge all administrations to assist in enhancing safety at sea by:

– encouraging, where appropriate, establishment of shore-based facilities for GMDSS, either on an individual basis or in cooperation with other relevant parties in the area;

– encouraging the implementation of GMDSS techniques and frequencies on non-SOLAS vessels including national ships;

– encouraging all vessels carrying maritime VHF equipment to be fitted with DSC on VHF channel 70 as soon as possible, taking into account the relevant decisions of IMO;

– encouraging vessels to limit their use of VHF channel 16 and the frequency 2 182 kHz for calling to the minimum necessary, noting the provisions of No. **52.239**;

2 that coast stations that form part of shore-based arrangements for reception of distress calling by radiotelephony on VHF channel 16 should maintain an efficient watch on VHF channel 16. Such watch shall be indicated in the List of Coast Stations and Special Service Stations;

3 that administrations may release their coast stations from the listening watch on VHF channel 16 in respect of distress, urgency and safety calling by voice, in accordance with relevant decisions of IMO and ITU on aural watch-keeping requirements on channel 16, taking into account the GMDSS radio systems available in the area concerned;

when doing so, administrations should:

– inform IMO of their decisions and submit to IMO details on the area concerned;

– inform the Secretary-General of the necessary details for inclusion in the List of Coast Stations and Special Service Stations,

resolves further

that the Secretary-General should ensure that such arrangements and details regarding the area concerned be indicated in relevant maritime publications,

invites ITU-R

to monitor the development of and changes to the GMDSS, and to continue to develop techniques and systems relevant for the GMDSS,

instructs the Secretary-General

to bring this Resolution to the attention of IMO, the International Civil Aviation Organization (ICAO) and the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA).

RESOLUTION 339 (REV.WRC-07)

Coordination of NAVTEX services

The World Radiocommunication Conference (Geneva, 2007),

considering

a) that the International Maritime Organization (IMO) has established a Coordinating Panel on NAVTEX to, *inter alia*, coordinate the operational aspects of NAVTEX services, such as allocation of transmitter identification character (B1) and time schedules, in the planning stages for transmissions on the frequencies 490 kHz, 518 kHz or 4 209.5 kHz;

b) that coordination in the frequencies 490 kHz, 518 kHz and 4 209.5 kHz is essentially operational;

c) that the frequency band around 518 kHz is also allocated to the aeronautical radionavigation service on a primary basis,

resolves

to invite administrations to apply the procedures established by IMO, taking into account the IMO NAVTEX Manual, for coordinating the use of the frequencies 490 kHz, 518 kHz and 4 209.5 kHz,

instructs the Secretary-General

to invite IMO to provide ITU with information on a regular basis on operational coordination for NAVTEX services on the frequencies 490 kHz, 518 kHz and 4 209.5 kHz,

instructs the Director of the Radiocommunication Bureau

to publish this information in the *List of Coast Stations and Special Service Stations* (List IV) (see No. **20.7**).

RESOLUTION 343 (REV.WRC-12)

Maritime certification for personnel of ship stations and ship earth stations for which a radio installation is not compulsory

The World Radiocommunication Conference (Geneva, 2012),

considering

a) that WRC-97 considered the question of certification for personnel of ship stations and ship earth stations within the Global Maritime Distress and Safety System (GMDSS);

b) that GMDSS was fully implemented on 1 February 1999 by vessels subject to an international agreement;

c) that vessels not subject to an international agreement have adopted GMDSS systems and techniques;

d) that use of GMDSS equipment should be accompanied by appropriate training and certification;

e) that the Radio Regulations stipulate that the service of every ship radio station working on frequencies assigned for international use shall be performed by operators holding a certificate;

f) that WRC-07 suppressed Appendix **13** to the Radio Regulations, which specified distress communications and operator's certificates by radiotelephones, and that, in order to incorporate provisions for non-GMDSS certificates, WRC-12 has further modified Article **47**,

noting

that a number of administrations currently issue radio operator certificates specially designed for the non-compulsory sector,

resolves

that administrations wishing to implement special certification for the non-compulsory sector should implement the certificates contained in the Annex to this Resolution,

invites ITU-R

to develop a Recommendation describing these certificates,

instructs the Secretary-General

to bring this Resolution to the attention of the International Maritime Organization (IMO).

ANNEX TO RESOLUTION 343 (REV.WRC-12)

Examination syllabus for radio operator's certificates appropriate to vessels using the frequencies and techniques of the Global Maritime Distress and Safety System on a non-compulsory basis

Introduction

The introduction of the Global Maritime Distress and Safety System (GMDSS) in February 1992 made it necessary to harmonize the examination requirements for certificates for professional radio operators. Harmonized examination procedures for the general operator's Certificate and restricted operator's Certificate, based on the syllabuses described in Article **47**, have already been introduced for maritime radio operators performing radiocommunication duties on board vessels subject to the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended. The GMDSS was fully implemented on 1 February 1999 for vessels subject to SOLAS, 1974, as amended.

For vessels not subject to SOLAS, 1974, as amended, and which install radiocommunication equipment on a voluntary basis, there are significant advantages to also using the GMDSS. However, it was foreseen by some administrations that such vessels would use some, but not all, of the frequencies and techniques of the GMDSS and that radio personnel on board such vessels would not need the same level of certification as radio personnel on board vessels which use all of the frequencies and techniques of the GMDSS on a compulsory basis. A syllabus has been developed which provides the flexibility for a depth of study, level of knowledge, and length of course appropriate to meet the certification requirements of radio personnel on board vessels which use some of the frequencies and techniques of the GMDSS on a non-compulsory basis. The syllabus also provides for certification in the use of satellite equipment where appropriate.

This Annex describes the syllabus developed to meet the certification requirements referred to above, and which are implemented in a number of countries under the title "Long Range Certificate" and "Short Range Certificate". The Short Range Certificate should at least contain those elements of the syllabus which are relevant to sea area A1.

Examination syllabus

The examination should consist of theoretical and practical tests and should include at least:

A **General knowledge of radiocommunications in the maritime mobile service**

A.1 The general principles and basic features of the maritime mobile service.

B **Detailed practical knowledge and ability to use radio equipment**

B.1 The VHF radio installation. Use of VHF equipment in practice.

B.2 The MF/HF radio installation. Use of MF/HF equipment in practice.

B.3 Purpose and use of digital selective calling facilities and techniques.

C **Operational procedures of the GMDSS and detailed practical operation of GMDSS subsystems and equipment**

C.1 Basic introduction to GMDSS procedures.

C.2 Distress, urgency and safety communication procedures in the GMDSS.

C.3 Distress, urgency and safety communication procedures by radiotelephony in the old distress and safety system.

C.4 Protection of distress frequencies.

C.5 Maritime safety information (MSI) systems in the GMDSS.

C.6 Alerting and locating signals in the GMDSS.

C.7 Procedures for cancelling an inadvertent false alert transmission.

D **Operational procedures and regulations for radiotelephone communications**

D.1 Ability to exchange communications relevant to the safety of life at sea.

D.2 Regulations, obligatory procedures and practices.

D.3 Practical and theoretical knowledge of radiotelephone procedures.

D.4 Use of the international phonetic alphabet and, where appropriate, parts of the IMO Standard Marine Communication Phrases.

E **Optional examination module for the maritime mobile-satellite service for vessels not subject to a compulsory fit**

E.1 The general principles and basic features of the maritime mobile-satellite service.

E.2 Operational procedures and detailed practical operation of ship earth stations in the GMDSS.

RESOLUTION 344 (REV.WRC-19)

Management of the maritime identity numbering resource

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

noting

a) that the installation of digital selective calling (DSC) equipment and some Inmarsat ship earth station equipment on ships participating in the Global Maritime Distress and Safety System (GMDSS) on a mandatory or voluntary basis requires the assignment of a unique nine-digit maritime mobile service identity (MMSI);

b) that such equipment offers the possibility to connect with public telecommunication networks;

c) that only mobile-satellite systems have been able to resolve the various billing, routing, charging and signalling requirements needed to provide full two-way automatic connectivity between ships and the international public correspondence service;

d) that the automatic identification system (AIS) and its related systems require MMSI or other maritime identities;

e) that radios capable of DSC and intended to be used on non-SOLAS ships require maritime identities;

f) that the first three digits of a ship station MMSI form the maritime identification digits (MID), which denote the ship's administration,

considering

a) that DSC distress alerts require valid identities recognizable by search and rescue authorities in order to ensure a timely response;

b) that AIS and its related systems require valid identities recognizable by other ships and authorities for safety of navigation and search and rescue operations;

c) that Recommendation ITU-R M.585 contains guidance for the assignment and use of maritime identities, such as MMSIs and other maritime identities,

recognizing

a) that even domestic ships which install the present generation of ship earth stations will require the assignment of MMSI numbers from those numbers originally intended for ships communicating worldwide, further depleting the resource;

b) that mobile-satellite systems offering access to public telecommunication networks and participating in the GMDSS employ a free-form numbering system that need not include any part of the MMSI;

c) that future growth of AIS and its related systems will require further resources of MMSI and other maritime identities,

noting further

a) that the ITU Radiocommunication Sector (ITU-R) is solely responsible for managing the MMSI and MID numbering resources;

b) that ITU-R can monitor the status of the MMSI resource, through regular reviews of the spare capacity available within the MIDs already in use, and the availability of spare MIDs, taking account of regional variations;

c) that ITU-R, as a part of the review of MMSI numbering resources, adopted a revision of Recommendation ITU-R M.585 in 2019, removing a provision within the MMSI numbering scheme that set aside three trailing zeros for some categories of mobile-satellite service systems participating in the GMDSS to facilitate the shore-to-ship routing of calls; the provision is no longer necessary and its removal has allowed for the release of reserved MMSI numbering resources,

resolves to instruct the Director of the Radiocommunication Bureau

1 to manage allotment and distribution of the MID resource within the MMSI and other maritime identity numbering formats, taking into account:

– Sections II, V and VI of Article **19**;

– regional variations in MMSI use;

– spare capacity within the MID resource; and

– the assignment, management and conservation of maritime identities contained in the most recent version of Recommendation ITU-R M.585, in particular as regards the reuse of MMSIs;

2 to report to each world radiocommunication conference on the use and status of the MMSI resource, noting in particular the anticipated reserve capacity and any indications of rapid exhaustion of the resource,

invites the ITU Radiocommunication Sector

to keep under review the Recommendations for assigning MMSIs and other maritime identities, with a view to:

– improving the management of the MID, MMSI and other maritime identity resources; and

– identifying alternative resources if there is an indication of rapid exhaustion of these resources,

instructs the Secretary-General

to communicate this Resolution to the International Maritime Organization.

RESOLUTION 349 (REV.WRC-23)

Operational procedures for cancelling false distress alerts in the global maritime distress and safety system

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the 1974 International Convention for the Safety of Life at Sea (SOLAS), as amended, prescribes that ships subject to that Convention shall be fitted with global maritime distress and safety system (GMDSS) equipment as appropriate;

b) that non-SOLAS vessels are also being equipped with GMDSS equipment;

c) that the transmission and relay of false distress alerts is a significant problem within the GMDSS,

noting

that the International Maritime Organization (IMO) refers to this operational procedure for cancelling false distress alerts in its documentation,

resolves

1 to urge administrations to take all necessary measures to avoid false distress alerts and to minimize the unnecessary burden on rescue organizations which occurs;

2 to urge administrations to encourage the correct use of GMDSS equipment, with particular attention to appropriate training;

3 to urge administrations to implement the operational procedures contained in the Annex to this Resolution;

4 that administrations should take any consequential appropriate action in this respect,

instructs the Secretary-General

to bring this Resolution to the attention of IMO.

ANNEX TO RESOLUTION 349 (REV.WRC-23)

Cancelling of false distress alerts

If a distress alert is inadvertently transmitted, the following steps shall be taken to cancel the distress alert.

1 VHF digital selective calling

1) Follow the instructions on the radio screen, if applicable, or

   Switch off and switch on after 10 seconds, and follow the instructions on the radio screen, if applicable;

2) If the digital selective-calling (DSC) equipment is capable of cancellation, start the distress self-cancel operation in accordance with the most recent version of Recommendation ITU-R M.493;

3) Set to channel 16; and

4) Transmit a broadcast message to "All Stations" giving the ship's name, call sign and maritime mobile service identity (MMSI), and cancel the false distress alert.

   Example of message:

   – the words "ALL STATIONS", spoken three times;

   – the words "THIS IS";

   – the name of the vessel, spoken three times;

   – the call sign or other identification;

   – the MMSI;

   – the words "PLEASE CANCEL MY DISTRESS ALERT OF" followed by the time in UTC.

2 MF digital selective calling

1) Follow the instructions on the radio screen, if applicable, or

   Switch off and switch on after 10 seconds, and follow the instructions on the radio screen, if applicable;

2) If the DSC equipment is capable of cancellation, start the distress self-cancel operation in accordance with the most recent version of Recommendation ITU-R M.493;

3) Tune for radiotelephony transmission on 2 182 kHz; and

4) Transmit a broadcast message to "All Stations" giving the ship's name, call sign and MMSI, and cancel the false alert;

   For example of message see section 1.

3 HF digital selective calling

1) Follow the instructions on the radio screen, if applicable; or

   Switch off and switch on after 10 seconds, and follow the instructions on the radio screen, if applicable;

2) If the DSC equipment is capable of cancellation, start the distress self-cancel operation in accordance with the most recent version of Recommendation ITU-R M.493;

3) Tune for radiotelephony on the distress and safety frequency in each frequency band in which a false distress alert was transmitted (see Appendix **15**); and

4) Transmit a broadcast message to "All Stations" giving the ship's name, call sign and MMSI, and cancel the false alert on the distress and safety frequency in each frequency band in which the false distress alert was transmitted;

   For example of message see section 1.

4 Ship earth station

Notify the appropriate rescue coordination centre that the alert is cancelled by sending a distress priority message. Provide ship name, call sign and ship earth station identity with the cancelled alert message.

Example of message by telegraphy:

– NAME, CALL SIGN, IDENTITY NUMBER, POSITION;

– Cancel my distress;

– Alert of DATE, TIME UTC;

– =Master+.

Example of message by radiotelephony:

– the words "ALL STATIONS", spoken three times;

– the words "THIS IS";

– the name of the vessel, spoken three times;

– the call sign or other identification;

– the identity number/MMSI;

– the words "PLEASE CANCEL MY DISTRESS ALERT OF" followed by the time in UTC.

5 Satellite emergency position indicating radiobeacon (EPIRB)

If for any reason a satellite emergency position indicating radiobeacon (EPIRB) is activated inadvertently or accidentally, immediately stop the inadvertent transmission and contact the appropriate rescue coordination centre through a coast station or land earth station and cancel the distress alert.

6 General

Notwithstanding the above, ships may use additional appropriate means available to them to inform the appropriate authorities that a false distress alert has been transmitted and should be cancelled.

No action will normally be taken against any ship or mariner for reporting and cancelling a false distress alert. However, in view of the serious consequences of false alerts, and the strict ban on their transmission, authorities may take actions in cases of repeated violation.

RESOLUTION 352 (WRC-03)

Use of the carrier frequencies 12 290 kHz and 16 420 kHz for safety-related calling to and from rescue coordination centres

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that this Conference modified No. **52.221A** to allow safety-related calling to and from rescue coordination centres on the carrier frequencies 12 290 kHz and 16 420 kHz;

b) that this limited safety-related calling function on these carrier frequencies will enhance the capability of those search and rescue organizations which maintain watch on these distress and safety frequencies to call vessels not utilizing the Global Maritime Distress and Safety System (GMDSS),

noting

a) that regulation IV/4.8 of the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended, requires that SOLAS ships, while at sea, be capable of transmitting and receiving general radiocommunications to and from shore-based radio systems or networks;

b) that general communications may include safety-related communications necessary for the safe operation of vessels,

further noting

that safety-related communications require adequate, effective and immediate access and protection,

recognizing

a) that the International Maritime Organization (IMO) notes that distress, urgency and safety radiocommunications include, but are not limited to:

– transmissions of maritime safety information;

– distress calls and traffic;

– acknowledgment and relaying of distress calls;

– search and rescue coordination communications;

– ship movement service communications;

– communications related to the safe operation of ships;

– communications related to navigation;

– meteorological warnings;

– meteorological observations;

– ship position reports; and

– medical emergencies (e.g. MEDICO/MEDIVAC);

b) that distress, urgency and safety communications are defined in Articles **32** and **33**,

resolves

1 that the carrier frequencies 12 290 kHz and 16 420 kHz be used only for distress, urgency and safety communications, and safety-related calling limited to that to and from rescue coordination centres;

2 that safety-related calling be initiated only after determination that other communications are not present on these frequencies;

3 that safety-related calling be minimized and not cause interference to distress, urgency and safety communications,

invites administrations

to encourage the coast and ship stations under their jurisdiction to use digital selective calling techniques,

instructs the Secretary-General

to bring this Resolution to the attention of the IMO.

RESOLUTION 354 (REV.WRC-23)

Distress and safety radiotelephony procedures for 2 182 kHz

The World Radiocommunication Conference (Dubai, 2023),

noting

a) that all ships subject to the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended, are required to be fitted for the global maritime distress and safety system (GMDSS);

b) that some vessels not subject to SOLAS, 1974, as amended, may not be making use of the techniques and frequencies of GMDSS prescribed in Chapter **VII** and may wish to continue using radiotelephony procedures for distress and safety communications on 2 182 kHz until such time as they are able to participate in the GMDSS;

c) that some administrations may have a need to maintain shore-based radiotelephony distress and safety services on 2 182 kHz so that vessels not subject to SOLAS, 1974, as amended, and not yet using the techniques and frequencies of GMDSS will be able to obtain assistance from these services until such time as they are able to participate in GMDSS,

considering

that there needs to be some recognized guidance for the use of radiotelephony on 2 182 kHz for distress and safety communications,

resolves

1 that ships, when in distress or when engaged in urgency or safety-related communications on 2 182 kHz, use the radiotelephony procedures contained in the Annex to this Resolution;

2 that coast stations, in order to maintain communication with non-GMDSS ships that are in distress or engaged in urgency or safety related communications on 2 182 kHz, use the radiotelephony procedures contained in the Annex to this Resolution.

ANNEX TO RESOLUTION 354 (REV.WRC-23)

Distress and safety radiotelephony procedures for 2 182 kHz*

PART A1 − GENERAL

§ 1 The frequencies and techniques specified in this Resolution may be used in the maritime mobile service for stations[1] not required by national or international regulation to fit GMDSS equipment and for communications between those stations and aircraft. However, stations of the maritime mobile service, when additionally fitted with any of the equipment used by stations operating in conformity with the provisions specified in Chapter **VII**, should, when using that equipment, comply with the appropriate provisions of that Chapter.

§ 2 1) No provision of this Resolution prevents the use by a mobile station or mobile earth station in distress of any means at its disposal to attract attention, make known its position, and obtain help.

2) No provision of this Resolution prevents the use by stations on board aircraft or ships engaged in search and rescue operations, in exceptional circumstances, of any means at their disposal to assist a mobile station or mobile earth station in distress.

3) No provision of this Resolution prevents the use by a land station or coast earth station, in exceptional circumstances, of any means at its disposal to assist a mobile station or mobile earth station in distress (see also No. **4.16**).

§ 3 In cases of distress, urgency or safety, communications by radiotelephony should be made slowly and distinctly, each word being clearly pronounced to facilitate transcription.

§ 4 The abbreviations and signals of Recommendation ITU-R M.1172 and the Phonetic Alphabet and Figure Code in Appendix **14** should be used where applicable[2].

§ 5 Distress, urgency and safety communications may also be made using digital selective calling and satellite techniques, in accordance with the provisions specified in Chapter **VII** and relevant ITU-R Recommendations.

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* Distress and safety communications include distress, urgency and safety calls and messages.

[1] These stations may include rescue coordination centres. The term "Rescue Coordination Centre" as defined in the International Convention on Maritime Search and Rescue (1979) refers to a unit responsible for promoting the efficient organization of search and rescue services and for coordinating the conduct of search and rescue operations within a search and rescue region.

[2] The use of the Standard Marine Communication Phrases (SMCP) and, where language difficulties exist, the International Code of Signals, both published by the International Maritime Organization, is also recommended. It should be noted that the pronunciations for figures in Appendix **14** and IMO SMCP are different.

§ 6 Mobile stations[3] of the maritime mobile service may communicate for safety purposes with stations of the aeronautical mobile service. Such communications shall normally be made on the frequencies authorized, and under the conditions specified, in Section I of Part A2 (see also § 2 1)).

§ 7 Mobile stations of the aeronautical mobile service may communicate for distress and safety purposes with stations of the maritime mobile service in conformity with the provisions of this Resolution.

§ 8 Any aircraft required by national or international regulations to communicate for distress, urgency or safety purposes with stations of the maritime mobile service shall be capable of transmitting and receiving class J3E emissions when using the carrier frequency 2 182 kHz or the carrier frequency 4 125 kHz.

PART A2 − FREQUENCIES FOR DISTRESS AND SAFETY

Section I − Availability of frequencies

A − 2 182 kHz

§ 1 1) The carrier frequency 2 182 kHz is an international distress frequency for radiotelephony; it may be used by ship, aircraft and survival craft stations when requesting assistance from the maritime services. It is used for distress calls and distress traffic, for the urgency signal and urgency messages and for the safety signal. Safety messages should be transmitted, when practicable, on a working frequency, after a preliminary announcement on 2 182 kHz. The class of emission to be used for radiotelephony on the frequency 2 182 kHz shall be J3E. Distress traffic on 2 182 kHz following the reception of a distress call using digital selective calling should take into account that some shipping in the vicinity may not be able to receive this traffic.

2) If a distress message on the carrier frequency 2 182 kHz has not been acknowledged, the distress call and message may be transmitted again on a carrier frequency of 4 125 kHz or 6 215 kHz, as appropriate.

3) However, ship stations and aircraft which cannot transmit either on the carrier frequency 2 182 kHz or on the carrier frequencies 4 125 kHz or 6 215 kHz may use any other available frequency on which attention might be attracted.

4) Coast stations using the carrier frequency 2 182 kHz for distress purposes and to send navigational warnings may transmit an audible alarm signal[4] of short duration for the purpose of attracting attention to the message which follows.

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[3] Mobile stations communicating with the stations of the aeronautical mobile (R) service in bands allocated to the aeronautical mobile (R) service shall conform to the provisions of the Regulations which relate to that service and, as appropriate, any special arrangements between the governments concerned by which the aeronautical mobile (R) service is regulated.

[4] Alarm signals may consist of transmissions of sinusoidal audio frequency tones 1 300 Hz, 2 200 Hz, or both. Different tone generation patterns may be used to signal the type of message which follows, and an alarm signal ending in a 10-second continuous tone could be used to identify a transmission by a coast station.

B – 4 125 kHz

§ 2 1) The carrier frequency 4 125 kHz is used to supplement the carrier frequency 2 182 kHz for distress and safety purposes and for call and reply. This frequency is also used for distress and safety traffic by radiotelephony.

2) The carrier frequency 4 125 kHz may be used by aircraft to communicate with stations of the maritime mobile service for distress and safety purposes, including search and rescue.

C – 6 215 kHz

§ 3 The carrier frequency 6 215 kHz is used to supplement the carrier frequency 2 182 kHz for distress and safety purposes and for call and reply. This frequency is also used for distress and safety traffic by radiotelephony.

Section II – Protection of distress and safety frequencies

A – General

§ 4 Test transmissions on any of the distress and safety frequencies described above shall be kept to a minimum and, wherever practicable, be carried out on artificial antennas or with reduced power.

§ 5 Before transmitting on any of the frequencies identified for distress and safety communications, a station shall listen on the frequency concerned to make sure that no distress transmission is being sent (see Recommendation ITU-R M.1171). This does not apply to stations in distress.

B – 2 182 kHz

§ 6 1) Except for transmissions authorized on the carrier frequency 2 182 kHz and on the frequencies 2 174.5 kHz, 2 177 kHz, 2 187.5 kHz and 2 189.5 kHz, all transmissions on the frequencies between 2 173.5 kHz and 2 190.5 kHz are forbidden (see also No. **5.110** for 2 174.5 kHz, Nos. **52.130** to **52.136** for 2 177 kHz and 2 189.5 kHz and Appendix **15** for 2 182 kHz and 2 187.5 kHz).

2) To facilitate the reception of distress calls, all transmissions on 2 182 kHz should be kept to a minimum.

Section III – Watch on distress frequencies

A – 2 182 kHz

§ 7 1) Coast stations may maintain a watch on the carrier frequency 2 182 kHz if so directed by their Administration. Such assignments should be indicated in the List of Coast Stations and Special Service Stations.

2) Ship stations not fitted with equipment compatible with the GMDSS are encouraged to keep the maximum watch practicable on the carrier frequency 2 182 kHz.

B − 4 125 kHz, 6 215 kHz

§ 8 Coast stations may maintain additional watch, as permitted, on the carrier frequencies 4 125 kHz and 6 215 kHz. Such assignments should be indicated in the List of Coast Stations and Special Service Stations.

PART A3 − DISTRESS COMMUNICATIONS

Section I − General

§ 1 The general provisions for distress communications are found in Section I of Article **32** (see Nos. **32.1**, **32.3**, and **32.4**).

Section II − Distress signal, call and message

§ 2 The radiotelephone distress signal, call and message are described in Section II of Article **32** (see Nos. **32.13BA**, **32.9**, **32.13B**, **32.13C**, and **32.13D**).

Section III − Procedures

§ 3 After the transmission by radiotelephony of its distress message, the mobile station may be requested to transmit suitable signals, followed by its call sign or other identification, to permit direction-finding stations to determine its position. This request may be repeated at frequent intervals if necessary.

§ 4 1) The distress message, preceded by the distress call, shall be repeated at intervals until an answer is received.

2) The intervals shall be sufficiently long to allow time for replying stations, in their preparations, to start their sending apparatus.

§ 5 When the mobile station in distress receives no answer to a distress message sent on the distress frequency, the message may be repeated on any other available frequency on which attention might be attracted.

Section IV − Transmission of a distress relay message by a station not itself in distress

§ 6 The radiotelephone procedures for the transmission of a distress relay message by a station not itself in distress are found in Section II of Article **32** (see Nos. **32.16** to **32.19A** and **32.19D** to **32.19F**).

Section V − Receipt and acknowledgement of a distress message

§ 7 The procedures relating to the receipt and acknowledgement of a distress message are found in Section II of Article **32** (see Nos. **32.23**, **32.26**, **32.28**, **32.29**, **32.30** and **32.35**).

Section VI − Distress traffic

§ 8 The radiotelephone procedures relating to the distress traffic are found in Section III of Article **32** (see Nos. **32.39** to **32.42**, **32.45** to **32.47**, **32.49** to **32.52** and **32.54** to **32.59**).

§ 9 1) Every mobile station acknowledging receipt of a distress message shall, on the order of the person responsible for the ship, aircraft or other vehicle, transmit the following information in the order shown as soon as possible:

– its name;

– its position;

– the speed at which it is proceeding towards, and the approximate time it will take to reach, the mobile station in distress;

– additionally, if the position of the ship in distress appears doubtful, ship stations should also transmit, when available, the true bearing of the ship in distress.

2) Before transmitting the message specified in § 9 1), the station shall ensure that it will not interfere with the emissions of other stations better situated to render immediate assistance to the station in distress.

PART A4 − URGENCY AND SAFETY COMMUNICATIONS

Section I − Urgency communications

§ 1 The radiotelephone procedures for urgency communications are found in Sections I and II of Article **33** (see Nos. **33.1** to **33.7** and **33.8**, **33.8B** to **33.9A** and **33.11** to **33.16**).

Section II − Safety communications

§ 2 The radiotelephone procedures for safety communications are found in Sections I and IV of Article **33** (see Nos. **33.31**, **33.31C**, **33.32**, **33.34** to **33.35** and **33.38B**).

RESOLUTION 356 (REV.WRC-19)

ITU maritime service information registration

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

noting

a) that the provisions of No. **20.16** of Article **20** require administrations to notify the Radiocommunication Bureau (BR) of any changes in the operational information contained in the List of Coast Stations and Special Service Stations (List IV) and the List of Ship Stations and Maritime Mobile Service Identity Assignments (List V);

b) that WRC-07 modified Article **19** to provide for the assignment of a maritime mobile service identity (MMSI) to search and rescue aircraft, automatic identification system (AIS) aids to navigation, and craft associated with a parent ship;

c) that the provisions of No. **20.15**, however, give BR authority to change the content and form of this information in consultation with administrations;

d) that the International Maritime Organization (IMO) has already identified, in Resolution A.887(21) adopted on 25 November 1999, information to be included in search and rescue databases, including:

– vessel identification number (IMO number or national registration number);

– maritime mobile service identity (MMSI);

– radio call sign;

– name, address and telephone number and, if applicable, telefax number of emergency contact person ashore;

– alternative 24-hour emergency telephone number;

– capacity for persons on board (passengers and crew),

resolves to instruct the Director of the Radiocommunication Bureau

to maintain online information systems to allow rescue coordination centres to have immediate access to this information on a 24-hour per day, 7-day per week basis,

invites the ITU Radiocommunication Sector

to consult on a regular basis with administrations, IMO, the International Civil Aviation Organization (ICAO), the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) and the International Hydrographic Organization (IHO) to identify elements for incorporation in ITU online information systems,

instructs the Secretary-General

to communicate this Resolution to IMO, ICAO, IALA and IHO.

RESOLUTION 363 (REV.WRC-23)

Improving the utilization of the VHF maritime mobile band

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the ITU Radiocommunication Sector (ITU-R) is conducting ongoing studies on improving efficiency in the use of the VHF maritime mobile band, including the use of digital technologies to respond to the emerging demands for new maritime uses and to ease congestion;

b) that transitional arrangements from analogue voice to digital voice VHF radios may take a long time and needs effective transitional solutions;

c) that use of existing maritime mobile service (MMS) allocations, where practicable, for ship and port security and enhanced maritime safety would be preferable, particularly where international interoperability is required;

d) that any changes made in Appendix **18** should not prejudice the future use of these frequencies or the capabilities of systems or new applications required for use by the MMS;

e) that ensuring resilient positioning, navigation and timing (PNT) data is particularly important for safe navigation at sea;

f) that ranging mode (R-Mode), which uses VHF data exchange system (VDES), is a maritime radionavigation system that provides independent resilient terrestrial PNT data,

recognizing

a) that Appendix **18** identifies frequencies to be used for distress and safety communications and other maritime communications on an international basis;

b) that some frequencies in the bands used by the MMS in Appendix **18** are allocated to the fixed and mobile services on a co-primary basis;

c) that a need exists to protect existing and planned in-band and adjacent-band services with no additional regulatory or technical constraints on these co-primary incumbent services when considering any potential modifications to MMS channelling arrangements;

d) that it is desirable to enhance maritime safety and ship and port security via spectrum-dependent systems;

e) that ITU and relevant international organizations have initiated related studies on the use of digital technologies for maritime safety and ship and port security;

f) that studies will be required to provide a basis for considering possible regulatory provisions to improve maritime safety and ship and port security, which may need access to spectrum for experimental use;

g) that administrations' and some relevant international organizations' efforts to continue the development of R-Mode to support the implementation of e-navigation may require a review of the Radio Regulations,

noting

a) that WRC-12, WRC-15 and WRC-19 reviewed Appendix **18** to improve use and efficiency for data communication using digital systems, e.g. for the introduction of VDES;

b) that maritime on-board communication systems have implemented digital technologies for voice communication as described in Recommendation ITU-R M.1174 to improve efficient use of the frequency band 450-470 MHz;

c) that digital systems have been implemented in the land mobile service,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference

1 studies on sharing and compatibility with incumbent services that are allocated on a primary basis in the same and adjacent frequency bands and studies on spectrum needs, transitional arrangements and possible changes to the VHF maritime mobile band, in order to advance digital voice and data technologies in the MMS, taking into account *recognizing b)* and *c)*;

2 compatibility studies, limited to frequencies identified in Appendix **18** for VDES, for a new allocation of the maritime radio navigation service under Article **5** and within the existing MMS to implement R-Mode,

invites administrations

to participate actively in the studies as described in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference* and provide the information required for the studies by submitting contributions to ITU-R,

invites the 2031 world radiocommunication conference

1 to consider, based on the results of studies, and within the Radio Regulations, excluding new allocations under Article **5**, possible regulatory changes to advance digital voice and data technologies in the MMS within the VHF maritime mobile band;

2 to consider, based on the results of studies, possible revisions to the Radio Regulations, including new allocations under Article **5**, limited to frequencies identified in Appendix **18** for VDES, for implementation of R-Mode as a new maritime radionavigation service,

invites relevant international organizations

to participate actively in the studies by providing requirements and information that should be taken into account in ITU-R studies,

instructs the Secretary-General

to bring this Resolution to the attention of the International Maritime Organization, International Association of Marine Aids to Navigation and Lighthouse Authorities, Comité International Radio-Maritime and other concerned international and regional organizations.

RESOLUTION 364 (WRC-23)

Coordination of services provided by the NAVDAT system

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the International Maritime Organization (IMO) coordinates the operational aspects of services provided by the NAVDAT system, such as allocation of transmitter identification and time schedules, in the planning stages for transmissions on the frequencies 500 kHz and/or 4 226 kHz and other frequencies which are specified in No. **5.79** and Appendix **15**;

b) that coordination in the frequencies 500 kHz and/or 4 226 kHz, and other frequencies which are specified in No. **5.79** and Appendix **15**, is essentially operational,

resolves

to invite administrations to apply the procedures established by IMO, taking into account the IMO NAVDAT manual, for coordinating the use of the frequencies 500 kHz and/or 4 226 kHz, and other frequencies which are specified in No. **5.79** and Appendix **15**,

instructs the Secretary-General

to invite IMO to provide ITU with information on a regular basis on operational coordination for services provided by the NAVDAT system on the frequencies 500 kHz and/or 4 226 kHz, and other frequencies which are specified in No. **5.79** and Appendix **15**,

instructs the Director of the Radiocommunication Bureau

to publish this information in the *List of Coast Stations and Special Service Stations* (List IV) (see No. **20.7**).

RESOLUTION 365 (WRC-23)

Provisional application of the Radio Regulations for the introduction of new geostationary satellite networks into the global maritime distress and safety system

The World Radiocommunication Conference (Dubai, 2023),

considering

a) the growing demand for global maritime distress and safety system (GMDSS) communications capabilities to enhance maritime safety;

b) that the Maritime Safety Committee (MSC) of the International Maritime Organization (IMO), in its resolution MSC.529(106), recognized a new geostationary (GSO) mobile satellite communication system[1] for the use of a regional messaging system in the GMDSS limited to the service area within 75°E to 135°E longitude and 10°N to 55°N latitude, hereinafter referred to as "the GSO Networks"; and that it is necessary for the coordination process to be completed before the GSO system commences GMDSS services;

c) that this conference considered a revised radio regulatory framework for reflecting the frequencies for GMDSS on a provisional basis in Appendix **15** and Articles **5** and **33** of the Radio Regulations,

considering further

a) that the GSO Networks currently operate using frequency assignments recorded in the Master International Frequency Register under No. **11.41** (see Annex 1);

b) that the primary mobile-satellite service (MSS) allocations in the frequency bands 1 614.4225-1 618.725 MHz or 1 616.3-1 620.38 MHz and 2 483.59-2 499.91 MHz are also used by non-GSO MSS systems and radiodetermination-satellite service (RDSS) systems operating in the same recognized service area, and that further coordination is required with these notified satellite systems and networks as identified in accordance with No. **9.27**;

c) the potential impact of coordination outcomes and technological advancements on the identification of frequencies for GMDSS safety services by the GSO Networks,

[1] The system described here refers to BeiDou Message Service System as recognized by IMO for use in GMDSS.

noting

a) that regulatory provisions for the frequency coordination and notification of any satellite network and system are contained in Articles **9** and **11**;

b) that several other satellite systems have satisfied the provisions of Articles **9** and **11** and operate in the same frequency bands;

c) the ongoing coordination being conducted by the GSO Networks and relevant non-GSO systems, in accordance with Article **9** and relevant Rules of Procedure;

d) that it is necessary for the notifying administration of the GSO Networks to address issues with respect to related assignments identified under No. **9.27** before the commencement of the GMDSS service (i.e. to achieve compatibility between relevant systems and resolve identified harmful interference issues),

recognizing

a) that the GSO Networks need to be coordinated under Nos. **9.7** and **9.11A**;

b) that the GSO Networks shall not cause harmful interference to, or claim protection from, the frequency assignments which are the basis of unfavourable findings until frequency coordination and notification is completed;

c) that non-GSO systems with an earlier date of protection and operating in the same frequency bands as the GSO Networks are experiencing harmful interference as reported in ITU2023-63161 (received on 17.08.2023), USA2023-63567 (received on 14.09.2023), F2023-63644 (received on 25.09.2023), USA2023-64675 (received on 15.11.2023), F2023-64822 (received on 23.11.2023), and F2023-64912 (received on 30.11.2023),

recognizing further

a) that successful completion of coordination with all necessary satellite systems ensures reliable operation of a GMDSS service;

b) that systems in the GMDSS should be protected from harmful interference to ensure safety of life at sea,

resolves

1 that the provisions of this Resolution apply only to the GSO Networks as recognized for use in the GMDSS system identified in *considering b)*;

2 that any identified harmful interference shall be eliminated;

3 that the GSO Networks shall successfully complete coordination of their frequency assignments with the relevant non-GSO systems in *considering further b)* in accordance with Articles **9** and **11** prior to the commencement of GMDSS services;

4 that the coordination of frequency assignments used for GMDSS services by the GSO Networks shall only be considered as completed after the corresponding remarks and indication relating to assignments for which an unfavourable finding had led to its recording under No. **11.41** are removed according to No. **11.41B**;

5 that a review of the frequency bands in Nos. **5.368**, **5.372A**, Article **33** and Appendix **15** in the Earth-to-space direction for GMDSS shall be conducted at the first world radiocommunication conference following the completion of coordination as referenced in *resolves* 3 to determine the relevant frequency band;

6 that the regulatory provisions referred to in *considering c)* shall enter into force as of the date of successful completion and fulfilment of *resolves* 1 to 5 above,

urges the administrations responsible for the respective satellite filings

1 to make the utmost effort to eliminate any harmful interference and engage in frequency coordination with other administrations concerned, in order to complete coordination before WRC-27;

2 to submit reports on the resolution of any identified harmful interference and on frequency coordination progress to the Radiocommunication Bureau before WRC-27;

3 to cooperate to address any potential issues related to the coordination of RDSS in the frequency band 2 483.5-2 500 MHz,

instructs the Director of the Radiocommunication Bureau

1 to report to WRC-27 the status of the implementation of this Resolution and any potential difficulties;

2 to follow, to the extent practical, the progress of frequency coordination between the administrations involved and to take appropriate measures within the mandate of the Bureau in order to assist in the implementation of this Resolution;

3 to publish ITU circular letters to confirm that frequency coordination has completed between all relevant administrations in accordance with *resolves* 3,

instructs the Secretary-General

to bring this Resolution to the attention of the IMO and other relevant international and regional organizations.

ANNEX 1 TO RESOLUTION 365 (WRC-23)

List of geostationary satellite network filings associated with the GSO networks

Orbital position	Satellite network	Special section (the service link of BDMSS)
58.75° E	COMPASS-58.75E	CR/C/798 MOD-1 CR/C/798 MOD-2 Part II-S
80° E	CHINASAT-31	AR11/C/2674 Part II-S
	COMPASS-80E	CR/C/799 MOD-5 Part II-S
110.5° E	CHINASAT-33	AR11/C/2676 Part II-S
	COMPASS-110.5E	CR/C/800 MOD-1 CR/C/800 MOD-2 Part II-S
140° E	CHINASAT-32	AR11/C/2675 Part II-S
	COMPASS-140E	CR/C/801 MOD-1 CR/C/801 MOD-2 Part II-S
160° E	COMPASS-160E	CR/C/1526 MOD-1 CR/C/1526 MOD-2 Part II-S

RESOLUTION 366 (WRC-23)

Improving the utilization and channelization of maritime radiocommunication in the MF and HF bands, including potential revisions to Article 52 and Appendix 17

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the ITU Radiocommunication Sector (ITU-R) has finalized studies to remove narrowband direct-printing (NBDP) frequencies for distress and safety communications from Article **5** and Appendices **15** and **17**;

b) that the International Maritime Organization (IMO) decided to remove NBDP for distress and safety communications from the Global Maritime Distress and Safety System (GMDSS) in MF and HF bands;

c) that ITU-R has finalized studies on the implementation of the automatic connection system (ACS) using digital selective calling (DSC) in MF and HF maritime mobile frequency bands;

d) that the implementation of the ACS will ensure simple and reliable access to the required radio links for ship stations;

e) that IMO has implemented the ACS in performance standards for shipborne MF and MF/HF radio installations for GMDSS,

recognizing

a) that Article **52** identifies frequencies and channelling arrangements in the MF band in some Regions;

b) that Appendix **17** identifies frequencies and channelling arrangements in the HF bands for the maritime mobile service (MMS);

c) that some HF bands lack channels in Appendix **17** for inter-ship operation;

d) that the implementation of the ACS may require revision of Article **52** and Appendix **17** channel plans for more working channels on an international basis,

noting

a) that this conference reviewed MF and HF bands in Article **5** and Appendices **15** and **17** to remove NBDP frequencies for distress and safety communications;

b) that this conference reviewed MF and HF bands in Article **5** and Appendix **17** to introduce the ACS;

c) that there is no global inter-ship channel in the MF band, and some HF bands lack channels for inter-ship operation in Appendix **17**,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference

studies on possible revisions to the Article **52** and Appendix **17** channel plans to identify additional working channels on an international basis to improve the use of maritime radiocommunication in the MF and HF bands,

invites the 2031 world radiocommunication conference

to consider, based on the results of studies, possible revisions to the Article **52** and Appendix **17** channel plans in the maritime mobile MF and HF bands to improve use and efficiency,

invites administrations

to participate actively in the studies described in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference* and provide the information required for the studies by submitting contributions to ITU-R,

invites relevant international organizations

to participate actively in the studies by providing requirements and information that should be taken into account in ITU-R studies,

instructs the Secretary-General

to bring this Resolution to the attention of IMO and other international and regional organizations concerned.

RESOLUTION 405

Relating to the use of frequencies of the aeronautical mobile (R) service[1]

The World Administrative Radio Conference (Geneva, 1979),

considering

a) that WARC-Aer2 adopted and developed a new Frequency Allotment Plan for the use of HF channels for the aeronautical mobile (R) service (Appendix **27**);

b) that air operations are subject to continuous changes;

c) that these changes require attention by the administrations concerned; but

d) that, in seeking to satisfy new communication requirements, no decision should be taken that will prevent or handicap the coordinated utilization of those high frequency aeronautical mobile (R) band allotments as prescribed in the Plan;

e) that the families of frequencies allotted to the major world air route areas (MWARAs), regional and domestic air route areas (RDARAs) and sub-areas and VOLMET areas have been chosen considering propagation conditions which allow for the selection of the most suitable frequencies for the distances involved;

f) that specific steps should be taken to ensure that the correct order of frequency is used;

g) that it is essential to distribute the communication traffic load as uniformly as possible over the frequencies available;

h) that frequencies have been allotted for worldwide use,

resolves

that administrations, individually or in collaboration, take the necessary steps:

1 to make as great a use as possible of higher frequencies in order to lessen the load on the HF aeronautical mobile (R) bands;

2 to make as great a use as possible of antennas of appropriate directivity and efficiency in order to minimize the possibilities of mutual interference within an area or between areas;

3 to coordinate the use of families of frequencies necessary for a given route segment in accordance with the technical principles in Appendix **27** and in the light of the propagation data available, to ensure that the most appropriate frequencies are used with an aircraft at a given distance from the aeronautical station providing service over the route segment concerned;

4 to improve operating techniques and procedures and to use equipment which will make it possible to attain the highest possible efficiency in handling air-ground HF communications;

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[1] WRC-97 made editorial amendments to this Resolution.

5 to collect precise data on the operation of their HF communication systems, particularly data having a bearing on technical and operating standards, so as to facilitate re-examination of the Plan;

6 to establish, through regional arrangements, the best method of providing the communications required for any new long-distance international or regional air operation which is not or cannot be accommodated within the system of MWARA and RDARA, in such a manner as not to cause harmful interference to the utilization of frequencies as prescribed in the Plan.

RESOLUTION 406 (WRC-23)

Use of the frequency band 117.975-137 MHz by the aeronautical mobile-satellite (R) service

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the optimization of air traffic management (ATM) over oceanic and remote areas necessitates appropriate aeronautical surveillance and communication means, in order to meet the required communication performance for reduced separation minima;

b) that the allocation of the frequency band 117.975-137 MHz to the aeronautical mobile-satellite (R) service (AMS(R)S) is intended for the relay via satellite of VHF communications under the aeronautical mobile (R) service (AM(R)S), in order to complement terrestrial communication infrastructures when aircraft are operating in oceanic and remote areas;

c) that the AM(R)S VHF channels have become congested in some areas and AMS(R)S systems need to operate in such a manner as not to constrain AM(R)S VHF systems, without modification to aircraft equipment,

noting

a) that there are Standards and Recommended Practices (SARPs) developed by the International Civil Aviation Organization (ICAO) detailing frequency assignment planning criteria for AM(R)S VHF communication systems;

b) that frequency assignment planning between stations operated under the AM(R)S allocation in the frequency band 117.975-137 MHz is performed by competent organizations under ICAO provisions;

c) that the development of compatibility criteria between AMS(R)S systems proposed for operations under *considering b)* and ICAO-standardized aeronautical systems in the frequency band 117.975-137 MHz is the responsibility of ICAO;

d) that feeder links of AMS(R)S systems are not planned to be operated in the frequency band 117.975-137 MHz,

recognizing

a) that the frequency band 117.975-137 MHz is allocated on a primary basis to the AM(R)S and is used by air-ground, air-air and ground-air systems operated in accordance with ICAO SARPs, providing critical voice and data communications for ATM on a global basis;

b) that Annex 10 to the Convention on International Civil Aviation contains SARPs for safety aeronautical radionavigation and radiocommunication systems used by international civil aviation,

resolves

1 that the notifying administration for the AMS(R)S satellite system authorizing the use of the frequency band 117.975-137 MHz by that system shall take into account relevant ICAO frequency assignment planning procedures in relation to *noting b)*;

2 that, taking into account *resolves* 1, the frequency band 117.975-137 MHz may also be used by AMS(R)S experimental systems during the period of time that the relevant SARPs are being developed and before operational deployment;

3 that the interference from out-of-band emissions of the AMS(R)S space station operating in the frequency band 117.975-137 MHz to adjacent channels of the AM(R)S airborne receiving stations shall not be more than the interference from out-of-band emissions of AM(R)S aircraft stations;

4 that, in accordance with ICAO frequency assignment planning procedures, the identification or selection of channels for use by the AMS(R)S shall:

– take into account the operational deployment of stations operating in the AM(R)S and, when available, the aeronautical mobile (OR) service (AM(OR)S);

– not adversely affect the potential future modifications of AM(R)S channel planning when required;

5 that, in assigning frequencies to stations in the AM(OR)S, the administration needs to take into account the frequencies assigned to the AMS(R)S for which coordination under Nos. **9.14** and **9.15** has been agreed to between both administrations involved in the coordination process;

6 that space stations operating in the frequency band 117.975-137 MHz in the AMS(R)S shall not have out-of-band emissions into the frequency band 137-138 MHz that exceed a power flux-density of −170 dB(W/(m² · 14 kHz)) at the Earth's surface;

7 that, in the frequency band 136.8-137 MHz, AMS(R)S space station receivers shall be designed to be resilient to the interference environment resulting from satellite systems operating in the frequency band 137-138 MHz; the power level(s) contained in the Annex to this Resolution and associated percentage(s) of time are to be taken into account in the development of relevant ICAO SARPs,

instructs the Secretary-General

to bring this Resolution to the attention of ICAO and the International Maritime Organization,

invites the International Civil Aviation Organization

to take into account this Resolution in the course of developing SARPs for the AMS(R)S and planning the AM(R)S and AMS(R)S in the frequency band 117.975-137 MHz.

ANNEX TO RESOLUTION 406 (WRC-23)

The following table provides the power levels for several percentages of time for the AMS(R)S space station channel centre frequency between 136.8 and 136.975 MHz:

Power level (dBW/25 kHz)		**AMS(R)S space station channel centre frequency (MHz)**							
		136.8	**136.825**	**136.85**	**136.875**	**136.9**	**136.925**	**136.95**	**136.975**
% of time	50	−207	−205	−203	−201	−195.75	−190.5	−185.25	−180
	10	−184	−182	−180	−178	−172.75	−167.5	−162.25	−157
	1	−175	−173	−171	−169	−163.75	−158.5	−153.25	−148
	0.1	−167	−165	−163	−161	−155.75	−150.5	−145.25	−140
	0.01	−161	−159	−157	−155	−149.75	−144.5	−139.25	−134
	0.001	−155	−153	−151	−149	−143.75	−138.5	−133.25	−128
	0.0001	−152	−150	−148	−146	−140.75	−135.5	−130.25	−125

RESOLUTION 411 (WRC-23)

Consideration of appropriate regulatory actions to update Appendix 26 in support of modernization of high-frequency spectrum use in the aeronautical mobile (OR) service

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that digital aeronautical high-frequency (HF) systems need to coexist with existing aeronautical analogue voice and data HF systems without causing harmful interference;

b) that characteristics of HF propagation enable long distance communication for aircraft;

c) that aeronautical analogue voice and narrowband digital HF systems are some of the current means of communication with aircraft in remote and oceanic areas;

d) that there exist modern HF systems that can enhance the HF communication capability of aircraft,

recognizing

a) that the modernization of aeronautical HF communications will not require any changes to Article **5**;

b) that the frequencies 3 023 kHz and 5 680 kHz are designated for search and rescue in Appendix **15**;

c) that for the purpose of this Resolution, the term "wideband" in HF communications may refer to a combination of emissions wider than 3 kHz channels;

d) that wideband operation can be achieved by single- or multi-carrier emissions;

e) that wideband operation may be achieved by contiguous or non-contiguous channel aggregation for multi-carrier emissions;

f) that the use of existing frequency and area allotments in the frequency bands allocated to the aeronautical mobile (OR) service between 3 025 kHz and 18 030 kHz is governed by the provisions of Appendix **26**,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

1 studies on the introduction of new technologies that enhance performance, including, but not limited to, new classes of emission, wideband systems (see *recognizing c)*, *d)* and *e)*), etc., to the aeronautical mobile (OR) service systems in the frequency ranges considered in Appendix **26**;

2 in order to undertake *resolves to invite ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* 1, the definition of the relevant technical and operational characteristics and conduct sharing and compatibility studies with existing aeronautical mobile (OR) service systems and with other incumbent services that are allocated on a primary basis in the same or adjacent frequency bands;

3 based on ITU Radiocommunication Sector (ITU-R) studies, the identification of any potential modifications to Appendix **26**, without modifying the existing area allotments in *recognizing f)*, and while taking into account that the current use of the narrowband systems shall remain unchanged and shall not be impacted nor precluded by the revision of Appendix **26**,

invites administrations

to participate actively in the studies and provide the information required for the studies listed in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* by submitting contributions to ITU-R,

invites the 2027 world radiocommunication conference

to consider necessary changes, as appropriate, to Appendix **26**, on the basis of the studies conducted under *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* above.

RESOLUTION 413 (REV.WRC-23)

Use of the frequency band 108-117.975 MHz by the aeronautical mobile (R) service

The World Radiocommunication Conference (Dubai, 2023),

considering

a) the current allocation of the frequency band 108-117.975 MHz to the aeronautical radionavigation service (ARNS);

b) the current requirements of FM broadcasting systems operating in the frequency band 87-108 MHz;

c) that digital sound broadcasting systems are capable of operating in the frequency band at about 87-108 MHz as described in Recommendation ITU-R BS.1114;

d) the need for the aeronautical community to provide additional services by enhancing navigation systems through a radiocommunication data link;

e) the need for the broadcasting community to provide digital terrestrial sound broadcasting services;

f) that this allocation was made by WRC-07 in the knowledge that studies are ongoing with respect to the technical characteristics, sharing criteria and sharing capabilities;

g) the need for the aeronautical community to provide additional services for radiocommunications, relating to safety and regularity of flight, in the band 112-117.975 MHz;

h) that WRC-07 modified the allocation of the band 112-117.975 MHz to the aeronautical mobile (R) service (AM(R)S) in order to make available this frequency band for new AM(R)S systems, and in doing so enabled further technical developments, investments and deployment;

i) that the frequency band 117.975-137 MHz currently allocated to the AM(R)S is reaching saturation in certain areas of the world;

j) that this new allocation is intended to support the introduction of applications and concepts in air traffic management which are data intensive, and which could support data links that carry safety-critical aeronautical data;

k) that additional information is needed about the new technologies which will be used, the amount of spectrum required, the characteristics and sharing capabilities/conditions, and that therefore studies are urgently required on which AM(R)S systems will be used, the amount of spectrum required, the characteristics and the conditions for sharing with ARNS systems,

recognizing

a) that precedence must be given to the ARNS operating in the frequency band 108-117.975 MHz;

b) that, in accordance with Annex 10 to the Convention on International Civil Aviation, all aeronautical systems must meet standards and recommended practices (SARPs) requirements;

c) that within ITU-R, compatibility criteria between FM broadcasting systems operating in the frequency band 87-108 MHz and the ARNS operating in the frequency band 108-117.975 MHz already exist, as indicated in the most recent version of Recommendation ITU-R SM.1009;

d) that all compatibility issues between FM broadcasting systems and International Civil Aviation Organization (ICAO) standard ground-based systems for the transmission of radionavigation-satellite differential correction signals have been addressed,

noting

a) that aeronautical systems are converging towards a radiocommunication data link environment to support aeronautical navigation and surveillance functions, which need to be accommodated in existing radio spectrum;

b) that some administrations are planning to introduce digital sound broadcasting systems in the frequency band at about 87-108 MHz;

c) that no compatibility criteria currently exist between FM broadcasting systems operating in the frequency band 87-108 MHz and the planned additional aeronautical systems in the adjacent band 108-117.975 MHz using aircraft transmission;

d) that no compatibility criteria currently exist between digital sound broadcasting systems capable of operating in the frequency band at about 87-108 MHz and aeronautical services in the band 108-117.975 MHz,

resolves

1 that any aeronautical mobile (R) service systems operating in the band 108-117.975 MHz shall not cause harmful interference to, nor claim protection from ARNS systems operating in accordance with international aeronautical standards;

2 that any AM(R)S systems planned to operate in the frequency band 108-117.975 MHz shall, as a minimum, meet the FM broadcasting immunity requirements contained in Annex 10 to the Convention on International Civil Aviation for existing aeronautical radionavigation systems operating in this frequency band;

3 that AM(R)S systems operating in the band 108-117.975 MHz shall place no additional constraints on the broadcasting service or cause harmful interference to stations operating in the bands allocated to the broadcasting service in the frequency band 87-108 MHz and No. **5.43** does not apply to systems identified in *recognizing d)*;

4 that frequencies below 112 MHz shall not be used for AM(R)S systems excluding the ICAO systems identified in *recognizing d)*;

5 that any AM(R)S operating in the frequency band 108-117.975 MHz shall meet SARPs requirements published in Annex 10 to the Convention on International Civil Aviation,

invites the ITU Radiocommunication Sector

to study any compatibility issues between the broadcasting service and AM(R)S in the frequency band 108-117.975 MHz that may arise from the introduction of appropriate digital sound broadcasting systems, described in the most recent version of Recommendation ITU-R BS.1114, and to develop new or revised ITU-R Recommendations as appropriate,

instructs the Secretary-General

to bring this Resolution to the attention of ICAO.

RESOLUTION 416 (WRC-07)

Use of the bands 4 400-4 940 MHz and 5 925-6 700 MHz by an aeronautical mobile telemetry application in the mobile service

The World Radiocommunication Conference (Geneva, 2007),

considering

a) that there is a need to provide global spectrum to the mobile service for wideband aeronautical mobile telemetry (AMT) systems;

b) that studies have been conducted within ITU-R concerning the sharing and compatibility of AMT for flight testing with other services in the bands 4 400-4 940 MHz and 5 925-6 700 MHz;

c) that based on the results of these studies, in the bands 4 400-4 940 MHz and 5 925-6 700 MHz, technical and operational measures applied to AMT for flight testing purposes facilitate sharing with other services and applications in these bands;

d) that spectrum efficiency is enhanced in situations where new applications can be implemented compatibly in bands that are heavily occupied;

e) that there is extensive deployment of fixed-satellite service (FSS) earth stations in the band 5 925-6 425 MHz and to a lesser extent in the band 6 425-6 700 MHz;

f) that there is extensive deployment of fixed service stations in the bands 4 400-4 940 MHz and 5 925-6 700 MHz;

g) that in certain locations, availability of spectrum will be limited due to its extensive use by the various services while in other locations, this may not be the case;

h) that there are various techniques which can enhance sharing between co-primary services such as frequency or geographic separation;

i) that WRC-07 has adopted Nos. **5.440A** and **5.457C**,

recognizing

a) that the bands 4 400-4 500 MHz and 4 800-4 940 MHz are allocated to the fixed and mobile services on a primary basis;

b) that the band 4 500-4 800 MHz is allocated to the fixed, fixed-satellite (space-to-Earth), and mobile services on a co-primary basis;

c) that the band 4 800-4 990 MHz is allocated to the radio astronomy service on a secondary basis worldwide and that No. **5.149** applies;

d) that the band 4 825-4 835 MHz referred to in *recognizing c)* is allocated on a primary basis to radio astronomy in Argentina, Australia and Canada (see No. **5.443**);

e) that No. **5.442** applies to AMT for flight testing operations in the band 4 825-4 835 MHz;

f) that the band 5 925-6 700 MHz is allocated to the fixed, fixed-satellite (Earth-to-space), and mobile services on a co-primary basis;

g) that the use of the band 4 500-4 800 MHz (space-to-Earth) by the FSS shall be in accordance with the provisions of Appendix **30B (Rev.WRC-07)** (see No. **5.441**);

h) that provisions for the coordination of terrestrial and space services exist in the Radio Regulations,

resolves

1 that, in the bands 4 400-4 940 MHz and 5 925-6 700 MHz, administrations authorizing AMT for flight test purposes per Nos **5.440A**, **5.442** and **5.457C** shall utilize the criteria set forth below:

– emissions limited to transmission from aircraft stations only, see No. **1.83**;

– in these bands, AMT in the aeronautical mobile service is not considered an application of a safety service as per No. **1.59**;

– the peak e.i.r.p. density of a telemetry transmitter antenna shall not exceed −2.2 dB(W/MHz);

– transmissions limited to designated flight test areas, where flight test areas are airspace designated by administrations for flight testing;

– if operation of AMT aircraft stations is planned within 500 km of the territory of an administration in which the band 4 825-4 835 MHz is allocated to radio astronomy on a primary basis (see No. **5.443**), consult with that administration to determine whether any special measures are needed to prevent interference to their radio astronomy observations;

– in the bands 4 400-4 940 MHz and 5 925-6 700 MHz, bilateral coordination of transmitting AMT aircraft stations with respect to receiving fixed or mobile stations must be effected if the AMT aircraft station will operate within 450 km of the receiving fixed or mobile stations of another administration. The following procedure should be used to establish whether a fixed or mobile service receiver within 450 km of the flight test area will receive an acceptable level of interference:

  – determine if the receiving fixed or mobile station's antenna main-beam axis, out to a distance of 450 km, passes within 12 km of the designated area used by transmitting AMT aircraft stations, where this distance is measured orthogonally from the main-beam axis projection on the Earth's surface to the nearest boundary of the projection of the flight test area on the Earth's surface;

  – if the main-beam axis does not intersect the flight test area or any point within the 12 km offset, the interference could be accepted. Otherwise, further bilateral coordination discussions would be needed;

2 that administrations authorizing AMT per Nos **5.440A**, **5.442** and **5.457C** in the bands 4 400-4 940 MHz and 5 925-6 700 MHz require the use of technical and/or operational measures on AMT where appropriate to facilitate sharing with other services and applications in these bands.

RESOLUTION 417 (REV.WRC-15)

Use of the frequency band 960-1 164 MHz by the aeronautical mobile (R) service

The World Radiocommunication Conference (Geneva, 2015),

considering

a) that WRC-07 allocated the frequency band 960-1 164 MHz to the aeronautical mobile (R) service (AM(R)S) in order to make available this frequency band for AM(R)S systems, and in doing so enabled further technical developments, investments and deployment;

b) that the frequency band 960-1 164 MHz is currently allocated to the aeronautical radionavigation service (ARNS);

c) that new technologies are being developed to support communications and air navigation, including airborne and ground surveillance applications;

d) that the allocation of the frequency band 960-1 164 MHz to the aeronautical mobile (R) service is intended to support the introduction of applications and concepts in air traffic management which are data intensive and which could support data links that carry safety critical aeronautical data;

e) that in Armenia, Azerbaijan, Belarus, Bulgaria, China, the Russian Federation, Kazakhstan, Mongolia, Uzbekistan, Kyrgyzstan, Tajikistan and Ukraine, the frequency band 960-1 164 MHz is also used by systems in the ARNS for which standards and recommended practices (SARPs) have not been developed nor published by the International Civil Aviation Organization (ICAO);

f) that, furthermore, the frequency band 960-1 164 MHz is also used by a non-ICAO system operating in the ARNS that has characteristics similar to those of ICAO standard distance measuring equipment,

recognizing

a) that Annex 10 to the Convention on International Civil Aviation contains SARPs for aeronautical radionavigation and radiocommunication systems used by international civil aviation;

b) that all compatibility issues between the ICAO Standard Universal Access Transceiver (UAT) operating under the AM(R)S allocation and other systems which operate in the same frequency range, excluding the system identified in *considering e)*, have been addressed;

c) that in the frequency band 1 024-1 164 MHz the sharing conditions are more complex than in the frequency band 960-1 024 MHz,

noting

a) that the development of compatibility criteria between AM(R)S systems proposed for operations in the frequency band 960-1 164 MHz and ICAO-standardized aeronautical systems in this frequency band is the responsibility of ICAO;

b) that the development of compatibility criteria between AM(R)S systems operating in the frequency band 960-1 164 MHz and radionavigation-satellite service (RNSS) receivers on the same aircraft is the responsibility of ICAO;

c) that practical operational measures should be developed to facilitate the coordination between AM(R)S systems and non-ICAO ARNS systems,

resolves

1 that any AM(R)S system operating in the frequency band 960-1 164 MHz shall meet SARPs requirements published in Annex 10 to the Convention on International Civil Aviation;

2 that, with the exception of the system described in *recognizing b)*, any operation of AM(R)S systems in the frequency band 960-1 164 MHz with aircraft stations operating within 934 km or/and ground stations operating within 465 km from the border of the territory of Armenia, Azerbaijan, Belarus, Bulgaria, China, the Russian Federation, Kazakhstan, Mongolia, Uzbekistan, Kyrgyzstan, Tajikistan and Ukraine is subject to coordination with the concerned administrations of the countries listed above for the protection of aeronautical radionavigation systems (see *considering e)*) operating in the same frequency band in these countries. An administration not responding within a four-month period after receiving a request to seek agreement shall be regarded as unaffected;

3 the system described in *recognizing b)* shall not cause harmful interference to, or claim protection from, the systems described in *considering e)*;

4 that administrations authorizing AM(R)S systems in the frequency band 960-1 164 MHz shall ensure compatibility with systems indicated under *considering f)* whose characteristics are described in Annex 1 of Recommendation ITU-R M.2013-0;

5 that such compatibility between any AM(R)S systems in the frequency band 960-1 164 MHz and systems in *considering f)* is a matter to be dealt with in ICAO;

6 that administrations intending to implement AM(R)S in the frequency band 960-1 164 MHz, in order not to cause harmful interference to the RNSS in the frequency band 1 164-1 215 MHz, shall utilize the criteria set forth below:

– any ground station operating under the AM(R)S allocation in the frequency band 960-1 164 MHz shall limit its maximum equivalent isotropically radiated power (e.i.r.p.) to the values presented in the following table:

Emissions in the frequency band 960-1 164 MHz (Maximum allowable e.i.r.p. in the frequency band 960-1 164 MHz as a function of the carrier central frequency) for non-pulsed AM(R)S ground station transmissions				**Emissions in the frequency band 1 164-1 215 MHz**	
AM(R)S centre frequency < 1 091 MHz	AM(R)S centre frequency 1 091-1 119 MHz	AM(R)S centre frequency 1 119-1 135 MHz	AM(R)S centre frequency 1 135-1 164 MHz	1 164-1 197.6 MHz	1 197.6-1 215 MHz
51.6 dBW	Linearly decreasing from 51.6 to 23.6 dBW	Linearly decreasing from 23.6 to −2.4 dBW	Linearly decreasing from −2.4 to −68.4 dBW	−90.8 dBW in any 1 MHz of the frequency band 1 164-1 197.6 MHz	−90.8 dBW in any 1 MHz of the frequency band 1 197.6-1 215 MHz

– any airborne station operating under the AM(R)S allocation in the frequency band 960-1 164 MHz shall limit its maximum e.i.r.p. to the values presented in the following table:

Emissions in the frequency band 960-1 164 MHz (Maximum allowable e.i.r.p. in the frequency band 960-1 164 MHz as a function of the carrier central frequency) for non-pulsed AM(R)S airborne station transmissions				**Emissions in the frequency band 1 164-1 215 MHz**	
AM(R)S centre frequency < 1 091 MHz	AM(R)S centre frequency 1 091-1 119 MHz	AM(R)S centre frequency 1 119-1 135 MHz	AM(R)S centre frequency 1 135-1 164 MHz	1 164-1 197.6 MHz	1 197.6-1 215 MHz
55.3 dBW	Linearly decreasing from 55.3 to 27.3 dBW	Linearly decreasing from 27.3 to −1.3 dBW	Linearly decreasing from −1.3 to −64.7 dBW	−84 dBW in any 1 MHz of the frequency band 1 164-1 197.6 MHz	−92.4 dBW in any 1 MHz of the frequency band 1 197.6-1 215 MHz

7 that future AM(R)S systems operating in the frequency band 960-1 164 MHz with pulsed emissions shall demonstrate that they limit AM(R)S ground and airborne station emission characteristics in order to provide protection to RNSS systems equivalent to the protection provided by non-pulsed emission AM(R)S ground and airborne stations operating in the 960-1 164 MHz frequency band at the maximum e.i.r.p. levels in *resolves* 6 above,

instructs the Secretary-General

to bring this Resolution to the attention of ICAO.

RESOLUTION 418 (REV.WRC-19)

Use of the frequency band 5 091-5 250 MHz by the aeronautical mobile service for telemetry applications

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that there is a need to provide global spectrum to the mobile service for wideband aeronautical telemetry systems;

b) that the operation of aircraft stations is subject to national and international rules and regulations;

c) that the frequency band 5 030-5 150 MHz is allocated to the aeronautical radionavigation service on a primary basis;

d) that the allocation of the frequency band 5 091-5 250 MHz to the fixed-satellite service (FSS) (Earth-to-space) is limited to feeder links of non-geostationary-satellite systems in the mobile-satellite service;

e) that the frequency band 5 091-5 150 MHz is also allocated to the aeronautical mobile-satellite (R) service on a primary basis, subject to agreement obtained under No. **9.21**;

f) that WRC-07 allocated the frequency band 5 091-5 150 MHz to the aeronautical mobile service (AMS) on a primary basis subject to No. **5.444B**;

g) that the frequency band 5 150-5 250 MHz is also allocated to the mobile, except aeronautical mobile, service on a primary basis;

h) that WRC-07 additionally allocated the frequency band 5 150-5 250 MHz to the AMS on a primary basis, subject to No. **5.446C**;

i) that aeronautical mobile telemetry (AMT) in the AMS is not considered an application of a safety service as defined in No. **1.59**,

noting

a) that results of studies show the feasibility of using the frequency band 5 091-5 250 MHz for the AMS on a primary basis, limited to transmissions of telemetry for flight testing, under certain conditions and arrangements as provided in Recommendation ITU-R M.2122;

b) that the identification by ITU Radiocommunication Sector (ITU-R) of technical and operational requirements for aircraft stations operating in the frequency band 5 091-5 250 MHz should prevent unacceptable interference to other services;

c) that the frequency band 5 091-5 150 MHz is to be used for the operation of international standard microwave landing system (MLS) for precision approach and landing;

d) that MLS can be protected through the implementation of an adequate separation distance between an AMS transmitter to support telemetry and MLS receivers;

e) that ITU-R studies have generated methods, described in Report ITU-R M.2118, for ensuring compatibility and sharing between the AMS and the FSS operating in the frequency band 5 091-5 250 MHz, which result in interference of no more than 1% $\Delta T_{satellite}/T_{satellite}$ from AMT aircraft station transmissions to FSS spacecraft receivers;

f) that a method to facilitate sharing between MLS and the AMS is contained in Recommendation ITU-R M.1829;

g) that Recommendation ITU-R M.1828 provides the technical and operational requirements for aircraft stations of the AMS, limited to transmissions of telemetry for flight testing;

h) that ITU-R compatibility studies have been performed for AMT, limited to flight testing, such application being for the testing of aircraft during non-commercial flights for the purpose of development, evaluation and/or certification of aircraft in airspace designated by administrations for this purpose,

recognizing

a) that priority is to be given to MLS in accordance with No. **5.444** in the frequency band 5 030-5 091 MHz;

b) that studies have been performed within ITU-R concerning the sharing and compatibility of AMT for flight testing with other services in the frequency band 5 091-5 250 MHz;

c) that Resolution **748 (Rev.WRC-19)** also provides guidance on the use of the frequency band 5 091-5 150 MHz by the AMS,

resolves

1 that administrations choosing to implement AMT shall limit AMT applications to those identified in *noting h)* in the frequency band 5 091-5 250 MHz, and shall utilize the criteria set forth in the Annex to this Resolution;

2 that the power flux-density limits in §§ 3 and 4 of the Annex to this Resolution which protect terrestrial services may be exceeded on the territory of any country whose administration has so agreed.

ANNEX TO RESOLUTION 418 (REV.WRC-19)

1 In implementing aeronautical mobile telemetry (AMT), administrations shall utilize the following criteria:

– limit transmissions to those from aircraft stations only (see No. **1.83**);

– the operation of aeronautical telemetry systems within the frequency band 5 091-5 150 MHz shall be coordinated with administrations operating microwave landing systems (MLS) and whose territory is located within a distance D of the AMT flight area, where D is determined by the following equation:

$$D = 43 + 10^{(127.55 - 20 \log(f) + E)/20}$$

where:

D : separation distance (km) triggering the coordination

f : minimum frequency (MHz) used by the AMT system

E : peak equivalent isotropically radiated power density (dBW in 150 kHz) of the aircraft transmitter.

2 For the protection of the fixed-satellite service (FSS), a telemetry aircraft station in the frequency band 5 091-5 250 MHz shall be operated in such a manner that one aircraft station transmitter power flux-density (pfd) be limited to −198.9 dB(W/(m^2 · Hz)) at the FSS satellite orbit for spacecraft using Earth coverage receive antennas. Such pfd limit per aircraft transmitter has been derived under the assumptions that the FSS satellite orbit is at 1 414 km altitude and that a total of 21 co-frequency AMT transmitters operate concurrently within the field of view of the FSS satellite. In case of fewer than 21 AMT co-frequency transmitters operating simultaneously in view of the satellite, the transmitter power can be adjusted so as not to exceed an aggregate pfd at the satellite of −185.7 dB(W/(m^2 · Hz)), which corresponds to a $\Delta T_{satellite}/T_{satellite}$ of 1%.

3 For the protection of the mobile service in the frequency band 5 150-5 250 MHz, the maximum pfd produced at the surface of the Earth by emissions from an aircraft station of an aeronautical mobile service (AMS) system, limited to transmissions of telemetry for flight testing, shall not exceed: −79.4 dB(W/(m^2 · 20 MHz)) − G_r (θ).

G_r(θ) represents the mobile service receiver antenna gain versus elevation angle θ and is defined as follows:

Wireless access system elevation antenna pattern

Elevation angle, θ (degrees)	**Gain G_r(θ) (dBi)**
45 < θ ≤ 90	−4
35 < θ ≤ 45	−3
0 < θ ≤ 35	0
−15 < θ ≤ 0	−1
−30 < θ ≤ −15	−4
−60 < θ ≤ −30	−6
−90 < θ ≤ −60	−5

4 For the protection of the aeronautical mobile (R) service (AM(R)S) in the frequency band 5 091-5 150 MHz, the maximum pfd produced at the surface of the Earth, where AM(R)S may be deployed in accordance with No. **5.444B**, by emissions from an aircraft station of an AMS system, limited to transmissions of telemetry for flight testing, shall not exceed: −89.4 dB(W/(m^2 · 20 MHz)) − G_r (θ).

$G_r(\theta)$ represents the mobile -service receiver antenna gain versus elevation angle θ and is defined as follows:

$$G_r(\theta) = \max\left[G_1(\theta),\ G_2(\theta)\right]$$

$$G_1(\theta) = 6 - 12\left(\frac{\theta}{27}\right)^2$$

$$G_2(\theta) = -6 + 10\log\left[\left(\max\left\{\frac{|\theta|}{27}.1\right\}\right)^{-1.5} + 0.7\right]$$

where:

$G(\theta)$: gain relative to an isotropic antenna (dBi)

(θ) : absolute value of the elevation angle relative to the angle of maximum gain (degrees).

RESOLUTION 422 (WRC-12)

Development of methodology to calculate aeronautical mobile-satellite (R) service spectrum requirements within the frequency bands 1 545-1 555 MHz (space-to-Earth) and 1 646.5-1 656.5 MHz (Earth-to-space)

The World Radiocommunication Conference (Geneva, 2012),

considering

a) that coordination between satellite networks is required on a bilateral basis in accordance with the Radio Regulations, and that, in the frequency bands 1 525-1 559 MHz (space-to-Earth) and 1 626.5-1 660.5 MHz (Earth-to-space), coordination is partially assisted by regional multilateral meetings;

b) that, in these frequency bands, geostationary mobile-satellite system operators currently use a capacity-planning approach at multilateral coordination meetings, with the guidance and support of their administrations, to periodically coordinate access to the spectrum needed to accommodate their requirements, including aeronautical mobile-satellite (R) service (AMS(R)S) spectrum requirements;

c) that within ITU-R, there is no agreed methodology for calculating AMS(R)S spectrum requirements related to the priority categories 1 to 6 of Article **44**;

d) that within ITU-R, some administrations have expressed a desire to develop an agreed methodology for calculating AMS(R)S spectrum requirements on an ongoing basis for purposes of bilateral and multilateral mobile-satellite service (MSS) coordinations conducted pursuant to Article **9** of the Radio Regulations;

e) that, since spectrum resources are limited, there is a need to use them in the most efficient manner within and amongst various MSS networks,

recognizing

a) that WRC-97 allocated the frequency bands 1 525-1 559 MHz (space-to-Earth) and 1 626.5-1 660.5 MHz (Earth-to-space) to the MSS to facilitate the assignment of spectrum to multiple MSS networks in a flexible and efficient manner;

b) that WRC-97 adopted No. **5.357A** giving priority to accommodating spectrum requirements for, and protecting from unacceptable interference, the AMS(R)S providing transmission of messages with priority categories 1 to 6 in Article **44** in the frequency bands 1 545-1 555 MHz and 1 646.5-1 656.5 MHz,

noting

that AMS(R)S systems are an essential element of the International Civil Aviation Organization (ICAO) standardized communications infrastructure used in air traffic management for the provision of safety and regularity of flight in civil aviation,

resolves to invite ITU-R

to conduct studies on, and develop in one or more ITU-R Recommendations, a methodology, including clear definitions of input parameters and assumptions to be used, to calculate spectrum requirements within the frequency bands 1 545-1 555 MHz (space-to-Earth) and 1 646.5-1 656.5 MHz (Earth-to-space) for AMS(R)S communications related to the priority categories 1 to 6 of Article **44**, and to take into account *considering b)* in conducting these studies,

invites

ICAO, the International Air Transport Association (IATA), administrations and other concerned organizations to participate in the studies identified in *resolves* above,

instructs the Secretary-General

to bring this Resolution to the attention of ICAO.

RESOLUTION 424 (REV.WRC-23)

Use of Wireless Avionics Intra-Communications in the frequency band 4 200-4 400 MHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that aircraft are designed to enhance their efficiency, reliability and safety, as well as to be more environmentally friendly;

b) that Wireless Avionics Intra-Communications (WAIC) systems provide radiocommunications between two or more aircraft stations integrated into or installed on a single aircraft, supporting the safe operation of the aircraft;

c) that WAIC systems do not provide radiocommunications between an aircraft and the ground, another aircraft or a satellite;

d) that WAIC systems operate in a manner that ensures the safe operation of an aircraft;

e) that WAIC systems operate during all phases of flight, including on the ground;

f) that aircraft equipped with WAIC systems operate globally;

g) that WAIC systems operating inside an aircraft receive the benefits of fuselage attenuation to facilitate sharing with other services;

h) that Recommendation ITU-R M.2067 provides technical characteristics and operational objectives for WAIC systems,

recognizing

that Annex 10 to the International Civil Aviation Organization (ICAO) Convention on International Civil Aviation contains Standards and Recommended Practices (SARPs) for safety aeronautical radionavigation and radiocommunication systems used by international civil aviation,

resolves

1 that WAIC is defined as radiocommunication between two or more aircraft stations located on board a single aircraft, supporting the safe operation of the aircraft;

2 that WAIC systems operating in the frequency band 4 200-4 400 MHz shall not cause harmful interference to, nor claim protection from, systems of the aeronautical radionavigation service operating in this frequency band;

3 that WAIC systems operating in the frequency band 4 200-4 400 MHz shall comply with the Standards and Recommended Practices published in Annex 10 to the Convention on International Civil Aviation;

4 that No. **43.1** shall not apply for WAIC systems,

instructs the Secretary-General

to bring this Resolution to the attention of ICAO,

invites the International Civil Aviation Organization

to take into account the most recent version of Recommendation ITU-R M.2085 in the course of development of SARPs for WAIC systems.

RESOLUTION 425 (REV.WRC-19)

Use of the frequency band 1 087.7-1 092.3 MHz by the aeronautical mobile-satellite (R) service (Earth-to-space) to facilitate global flight tracking for civil aviation

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that Resolution 185 (Busan, 2014) of the Plenipotentiary Conference instructed WRC-15, pursuant to No. 119 of the ITU Convention, to include in its agenda, as a matter of urgency, the consideration of global flight tracking, including, if appropriate, and consistent with ITU practices, various aspects of the matter, taking into account ITU Radiocommunication Sector (ITU-R) studies;

b) that the frequency band 960-1 164 MHz is allocated to the aeronautical radionavigation service and the aeronautical mobile (R) service;

c) that the frequency band 960-1 164 MHz is used by International Civil Aviation Organization (ICAO) standardized and non-ICAO systems, thus creating a complex interference environment;

d) that Automatic Dependent Surveillance-Broadcast (ADS-B) is defined by ICAO, and involves aircraft transmission of data such as identification and position;

e) that the frequency band 1 087.7-1 092.3 MHz is currently utilized for terrestrial transmission and reception of ADS-B signals in accordance with ICAO standards, involving transmissions from aircraft to terrestrial stations on the ground within line-of-sight;

f) that WRC-15 allocated the frequency band 1 087.7-1 092.3 MHz to the aeronautical mobile-satellite (R) service (AMS(R)S) in the Earth-to-space direction, limited to the space station reception of ADS-B emissions from aircraft transmitters that operate in accordance with recognized international aeronautical standards;

g) that the allocation of the frequency band 1 087.7-1 092.3 MHz to the AMS(R)S is to extend reception of currently transmitted ADS-B signals beyond terrestrial line-of-sight, to facilitate reporting the position of ADS-B equipped aircraft located anywhere in the world;

h) that, taking into account *considering c)*, use of the frequency band 1 087.7-1 092.3 MHz requires some administrations to control all users to ensure proper operation of all terrestrial systems,

recognizing

a) that ICAO develops standards and recommended practices (SARPs) for systems enabling position determination and tracking of aircraft;

b) that Annex 10 to the Convention on International Civil Aviation contains SARPs for terrestrial ADS-B usage of the frequency band 1 087.7-1 092.3 MHz,

noting

a) that the development of performance criteria for space station reception of ADS-B operating under the provisions of No. **5.328AA**, including whether such criteria would require modifications to ICAO standard ADS-B equipment, is the responsibility of ICAO;

b) that Report ITU-R M.2396 provides information on use of mobile-satellite systems for flight tracking, including through reception of ADS-B in the frequency band 1 087.7-1 092.3 MHz,

resolves

1 that the use of the frequency band 1 087.7-1 092.3 MHz by AMS(R)S systems shall be in accordance with recognized international aeronautical standards;

2 that AMS(R)S systems (Earth-to-space) in the frequency band 1 087.7-1 092.3 MHz shall be designed so that they can operate in the interference environment as described in *considering c)*;

3 that, taking into account *resolves* 2, AMS(R)S use of the frequency band 1 087.7-1 092.3 MHz shall not constrain administrations which have responsibilities as referred to in *considering h)*,

instructs the Secretary-General

to bring this Resolution to the attention of ICAO.

RESOLUTION 506 (REV.WRC-97)

Use by space stations in the broadcasting-satellite service operating in the 12 GHz frequency bands allocated to the broadcasting-satellite service of the geostationary-satellite orbit and no other

The World Radiocommunication Conference (Geneva, 1997),

considering

a) that a Plan designating frequency assignments in the above-mentioned frequency bands and positions in the geostationary-satellite orbit was adopted by WARC SAT-77 for Regions 1 and 3;

b) that a similar Plan for Region 2 was adopted by the Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2 (Geneva, 1983);

c) that the Plans referred to in *considering a)* and *b)* above were consolidated in Appendix **30** at WARC Orb-85;

d) that the Plans in Appendices **30** and **30A** for Regions 1 and 3 have been modified by this Conference;

e) that the operation of the broadcasting-satellite service in the frequency bands concerned in orbits other than the geostationary-satellite orbit might be incompatible with the Plans referred to in *considering a)*, *b)* and *d)* above,

resolves

that administrations shall ensure that their space stations in the broadcasting-satellite service in these frequency bands are operated in the geostationary-satellite orbit and no other.

RESOLUTION 507 (REV.WRC-19)

Establishment of agreements and associated plans for the broadcasting-satellite service[1]

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that it is important to make the best possible use of the geostationary-satellite orbit (GSO) and of the frequency bands allocated to the broadcasting-satellite service (BSS);

b) that the great number of receiving installations using such directional antennas as could be set up for a BSS may be an obstacle to changing the location of space stations in that service on the GSO, as of the date of their being brought into use;

c) that satellite broadcasts may create harmful interference over a large area of the Earth's surface;

d) that the other services with allocations in the same frequency band need to use the frequency band before the BSS is set up,

resolves

1 that stations in the BSS shall be established and operated in accordance with agreements and associated plans adopted by world (WRCs) or regional (RRCs) radiocommunication conferences, as the case may be, in which all the administrations concerned and the administrations whose services are liable to be affected may participate;

2 that, during the period before the entry into force of such agreements and associated plans, the administrations and the Radiocommunication Bureau shall apply the procedure contained in Articles **9** to **14**,

invites the ITU Council

to keep under review the question of WRCs, and/or RRCs, as required, with a view to fixing suitable dates, places and agendas.

[1] This Resolution does not apply to the frequency band 21.4-22 GHz.

RESOLUTION 517 (REV.WRC-19)

Introduction of digitally modulated emissions in the high-frequency bands between 3 200 kHz and 26 100 kHz allocated to the broadcasting service

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that digital techniques are being introduced into many existing services;

b) that digital techniques allow more effective utilization of the frequency spectrum than double-sideband (DSB) techniques;

c) that digital techniques enable reception quality to be improved;

d) the relevant parts of Appendix **11** concerning the digital system specification in the high-frequency (HF) broadcasting services;

e) that the ITU Radiocommunication Sector (ITU-R), in its Recommendation ITU-R BS.1514, has recommended system characteristics for digital sound broadcasts in the broadcasting frequency bands below 30 MHz;

f) that digital modulation techniques are expected to provide the means to achieve the optimum balance between sound quality, circuit reliability and bandwidth;

g) that digitally modulated emissions can, in general, provide more efficient coverage than amplitude-modulated transmissions by using fewer simultaneous frequencies and less power;

h) that it may be economically attractive, using current technology, to convert modern conventional DSB broadcasting systems to digital operation in accordance with *considering d)*;

i) that some DSB transmitters have been used with digital modulation techniques without transmitter modifications;

j) that ITU-R is carrying out further studies on the development of broadcasting using digitally modulated emissions in the frequency bands allocated to the broadcasting service below 30 MHz;

k) that a long period could be needed for the introduction of digital broadcasting, taking into account the cost impact of replacement of transmitters and receivers,

resolves

1 that the early introduction of digitally modulated emissions as recommended by ITU-R in the HF bands between 3 200 kHz and 26 100 kHz allocated to the broadcasting service is to be encouraged;

2 that digitally modulated emissions shall comply with the characteristics specified in the relevant parts of Appendix **11**;

3 that whenever an administration replaces a DSB emission by an emission using digital modulation techniques, it shall ensure that the level of interference is not greater than that caused by the original DSB emission, and shall use the RF protection values specified in Resolution **543 (Rev.WRC-19)**;

4 that the continued use of DSB emissions may be reviewed by a future competent world radiocommunication conference (WRCs) based on administrations' experience with the introduction of digital HF broadcasting services,

instructs the Director of the Radiocommunication Bureau

to compile and provide to the future competent WRC referred to in *resolves* 4 the latest available complete statistics on the worldwide distribution of digital HF broadcasting receivers and transmitters,

invites the ITU Radiocommunication Sector

to continue its studies on digital techniques in HF broadcasting with a view to assisting in the development of this technology for future use,

invites administrations

to encourage the inclusion in all new HF broadcasting transmitters put into service after 1 January 2004 of the capability to offer digital modulation,

further invites administrations

1 to assist the Director of the Radiocommunication Bureau by providing the relevant statistical data and to participate in ITU-R studies on matters relating to the development and introduction of digitally modulated emissions in the HF bands between 3 200 kHz and 26 100 kHz allocated to the broadcasting service;

2 to bring to the notice of transmitter and receiver manufacturers the recent results of relevant ITU-R studies on spectrum-efficient modulation techniques suitable for use at HF as well as the information referred to in *considering d)* and *e)*, and encourage the availability of affordable low-cost digital receivers.

RESOLUTION 526 (REV.WRC-12)

Future adoption of procedures to ensure flexibility in the use of the frequency band allocated to the broadcasting-satellite service (BSS) for wide RF-band high-definition television (HDTV) and to the associated feeder links

The World Radiocommunication Conference (Geneva, 2012),

considering

a) that WARC-92 has added an allocation to the BSS in the band 17.3-17.8 GHz in Region 2 for use by wide RF-band HDTV;

b) that in the longer term regulatory provisions designed to ensure flexible and equitable use of the BSS (HDTV) and associated feeder-link allocations will be necessary,

resolves to invite ITU-R

to study the development of future regulatory provisions for BSS (HDTV) to ensure flexibility in the use of the band 17.3-17.8 GHz in Region 2, having regard to the interests of all countries and the state of technical development of this new service,

instructs the Secretary-General

to bring this Resolution to the attention of the Council with a view to placing an appropriate item on the agenda of a future world radiocommunication conference.

RESOLUTION 528 (REV.WRC-19)

Introduction of broadcasting-satellite service (sound) systems and complementary terrestrial broadcasting in the frequency bands allocated to these services within the frequency range 1-3 GHz

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that WARC-92 made frequency allocations to the broadcasting-satellite service (BSS) (sound) and complementary terrestrial broadcasting;

b) that it is necessary to ensure that the introduction of the BSS (sound) and complementary terrestrial broadcasting proceeds in a flexible and equitable manner;

c) that efficient use of the spectrum will be enhanced by a worldwide allocation;

d) that a worldwide allocation may cause difficulties to some countries in relation to their existing services;

e) that future planning may limit the effect on other services,

resolves

1 that a competent conference should be convened for the planning of the BSS (sound) in the frequency bands allocated to this service in the frequency range 1-3 GHz and the development of procedures for the coordinated use of complementary terrestrial broadcasting;

2 that that conference should review criteria for sharing with other services;

3 that, in the interim period, broadcasting-satellite systems may only be introduced within the upper 25 MHz of the appropriate frequency band in accordance with the procedures contained in Articles **9** to **14**, as appropriate; the complementary terrestrial service may be introduced during this interim period subject to coordination with administrations whose services may be affected;

4 that the calculation methods and the interference criteria to be employed in evaluating the interference should be based upon relevant ITU-R Recommendations agreed by the administrations concerned as a result of Resolution **703 (Rev.WRC-07)** or otherwise,

invites the ITU Radiocommunication Sector

to conduct the necessary studies prior to the conference,

instructs the Secretary-General

to bring this Resolution to the attention of the ITU Council to consider including in the agenda of a radiocommunication conference the matters addressed above.

RESOLUTION 535 (REV.WRC-23)

Information needed for the application of Article 12 of the Radio Regulations

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that WRC-97 adopted Article **12** as a simple and flexible seasonal planning procedure for high-frequency broadcasting (HFBC) based on coordination;

b) that, for the purpose of the application of Article **12**, the Radiocommunication Bureau developed the software of which administrations were informed through circular letters,

resolves to instruct the Director of the Radiocommunication Bureau

to consider improvements to the established arrangements for the preparation, publication and dissemination of the information relating to the application of Article **12**, in consultation with administrations and regional coordination groups,

invites administrations

to submit their schedules in a common electronic format,

instructs the Secretary-General

to consider provision of the necessary funding to enable developing countries to participate fully in the application of Article **12** and relevant radiocommunication seminars.

ANNEX TO RESOLUTION 535 (REV.WRC-23)

This Annex responds to the need for information in the application of Article **12**; the flowchart in Description 2 provides an overview of the Procedure.

Software modules

Data capture of requirements

A new module will be required that permits the capture of all data elements detailed in Description 3. This module should also contain validation routines that prevent inconsistent data being captured and sent to the Radiocommunication Bureau for processing.

Propagation calculation

This new module should calculate the field strength and other necessary data at all relevant test points as described in Descriptions 1 and 4.

It should also include an option that allows administrations to select the optimum frequency bands for their requirements.

The output format of the data and the medium should be such as to allow easy publication and distribution of the results to all administrations.

The results of these calculations should be displayable in a graphical format.

Compatibility analysis

This module should use the output of the propagation calculation to provide a technical analysis of a requirement both alone and in the presence of other requirements as in Description 4. This analysis would be used in the coordination process.

The values for the parameters given in Description 4 should be user selectable, but in the absence of other values the recommended default values should be used.

The results of this analysis should be capable of being displayed in a graphical format for a defined service area as in Description 4.

Data query

This module should enable the user to perform typical data query functions.

DESCRIPTION 1

Selection of suitable frequency band(s)

General

In order to assist broadcasters and administrations in the preparation of their HF broadcasting requirements, the Bureau will prepare and distribute suitable computer software. This should be easy to use and the output should be easy to understand.

User input data

The user should be able to enter:

– the name of the transmitting station (for reference purposes);

– the geographic coordinates of the transmitting station;

– the transmitter power;

– the frequency bands which are available for use;

– hours of transmission;

– sunspot number;

– months during which a service is required;

– the available antenna types, together with the relevant directions of maximum radiation;

– the required coverage area specified as a set of CIRAF zones and quadrants (or by means of relevant geographic information).

It is desirable that the software should be able to store the above information, once it has been entered correctly, and provide the user with an easy means of recalling any previously entered information.

Methodology and data

The software should use:

– Recommendation ITU-R BS.705 for the calculation of antenna patterns;

– Recommendation ITU-R P.533 for the prediction of wanted field-strength values;

– Recommendation ITU-R P.842 for the calculation of reliability values.

The set of 911 test points (agreed at WARC HFBC-87) should be used, supplemented where necessary with test points based on a geographic grid.

The software should calculate the field-strength values and the fading margins at each test point inside the required service area for each of the frequency bands declared to be available, taking account of the relevant transmitting antenna characteristics for each frequency band. The desired RF signal-to-noise ratio should be user selectable with a default value of 34 dB in the case of double sideband (DSB) or as provided in the most recent version of Recommendation ITU-R BS.1615, as appropriate, in the case of digital emissions.

The dates for which calculations are made should be user selectable, the default values being:

– 0.5 month after the start of the season;

– mid-point of the season;

– 0.5 month before the end of the season.

The times for which calculations are made should be user selectable, the default values being:

– 30 min past the hour in which the requirement starts;

– 30 min past each successive hour until the hour in which the requirement stops.

Software output data

For rapid assessment of suitable frequency bands, the software should calculate:

– the basic service reliability for each available frequency band and for the relevant test points from the set of 911 test points;

– the basic area reliability for each available frequency band and for the relevant test points from the set of 911 test points.

In order to provide information about the geographic distribution of wanted signal values within the required service area, additional results should be available from the software:

– a listing should be available giving, for each of the available frequency bands, the basic circuit reliability (BCR) for each of the test points (from the set of 911 test points) inside the required service area.

In some cases, a graphical display of the BCR values throughout the required service area may be desirable. These values should be calculated at test points at 2° intervals of latitude and longitude throughout the required service area.

The BCR values should be displayed graphically as a set of coloured or hatched "pixels" scaled in steps of 10%. It should be noted that:

– reliability values relate to the use of a single frequency band;

– reliability values are a function of the desired RF signal-to-noise ratio (user selectable);

– the field-strength values should be calculated by the supplied software on the user's own computer hardware. The software supplied should calculate the relevant reliability values based on these field-strength values and the user-supplied desired RF signal-to-noise values.

DESCRIPTION 2

Time sequence for the Procedure

In the sequence outlined below, the start date for a given schedule period is defined as D and the end date for the same schedule period is defined as E.

Date	Action
D − 4 months	Closing date for administrations to send their schedules[1] to the Radiocommunication Bureau (Bureau), preferably by electronic means. Schedule data will be made available via TIES as soon as it has been processed.
D − 2 months	Bureau to send to administrations a consolidated schedule (the first Tentative Schedule) together with a complete compatibility analysis[2].
D − 6 weeks	Closing date for receipt of amendments from administrations to correct errors and other changes resulting from the coordination process to ensure that this information appears in the second Tentative Schedule for D − 1 month.
D − 1 month	Bureau to send to administrations a consolidated schedule (the second Tentative Schedule) together with a complete compatibility analysis[2].
D − 2 weeks	Closing date for receipt of amendments from administrations to correct errors and other changes resulting from the coordination process to ensure that this information appears in the Schedule for date D.
D	Bureau to issue the High Frequency Broadcasting Schedule and compatibility analysis.

[1] See Description 3.

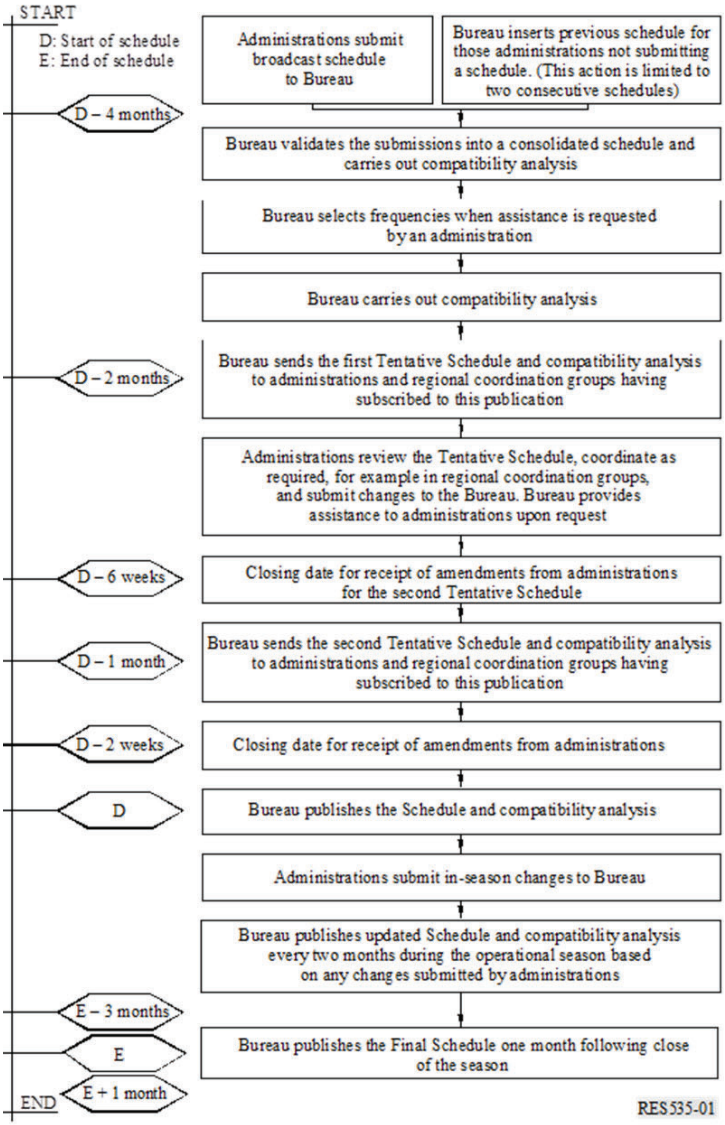
[2] See Description 4. The schedules and the results of the analyses should be available on CD-ROM and in TIES.

Date	Action
D to E − 3 months	Administrations to correct errors and coordinate in-season changes of requirements, sending information to the Bureau as it becomes available. Bureau to issue updates of the Schedule and compatibility analysis at intervals of two months.
E	Closing date for receipt of final operational schedules from administrations to Bureau. No input is needed if there have been no changes to the information previously sent.
E + 1 month	Bureau to send to administrations the final consolidated schedule (the Final Schedule) together with a compatibility analysis.

Figure 1 shows, in flow chart form, the time sequence for the Procedure.

FIGURE 1

Time sequence for the Procedure



DESCRIPTION 3

Specification of input data for a requirement

The fields needed for a given requirement and their specifications are:

– frequency in kHz, up to 5-digit integer;

– start time, as 4-digit integer;

– stop time, as 4-digit integer;

– target service area, as a set of up to 12 CIRAF zones and quadrants up to a maximum of 30 characters;

– site code, a 3-character code from a list of codes, or a site name and its geographic coordinates;

– power in kW, up to 4-digit integer;

– azimuth of maximum radiation;

– slew angle, up to 2-digit integer representing the difference between the azimuth of maximum radiation and the direction of unslewed radiation;

– antenna code, up to 3-digit integer from a list of values, or a full antenna description, as given in Recommendation ITU-R BS.705;

– days of operation;

– start date, in the case that the requirement starts after the start of the schedule;

– stop date, in the case that the requirement stops before the end of the schedule;

– modulation choice, to specify if the requirement is to use DSB, single-side band (SSB) or digital emission (for the latter, see Recommendation ITU-R BS.1514). This field may be used to identify any other type of modulation when this has been defined for use by HFBC in an ITU-R Recommendation;

– administration code;

– broadcasting organization code;

– identification number;

– identification of synchronization with other requirements.

DESCRIPTION 4

Compatibility analysis

General

In order to assess the performance of each requirement in the presence of noise and of the potential interference from other requirements using the same or adjacent channels, it is necessary to calculate the relevant reliability values. To this end, the Bureau will prepare suitable software, taking account of user requirements in terms of desired signal-to-noise and signal-to-interference ratios.

Input data

The schedule for a given season − this may be either an initial consolidated schedule (to permit assessment of those requirements which need coordination) or the High Frequency Broadcasting Schedule (to permit assessment of the likely performance of requirements during the relevant season).

Methodology and data

The software should use:

– Recommendation ITU-R BS.705 for the calculation of antenna patterns;

– Recommendation ITU-R P.533 for the prediction of the wanted field-strength values at each test point for each wanted requirement;

– Recommendation ITU-R P.533 for the prediction of the potentially interfering field-strength values from all other co-channel or adjacent channel requirements at each test point for each wanted requirement;

– Recommendation ITU-R BS.560 for adjacent channel RF protection ratios;

– Recommendation ITU-R P.842 for the calculation of reliability values.

The set of 911 test points (agreed at WARC HFBC-87) should be used, supplemented where necessary with test points based on a geographic grid.

The software should calculate the wanted and unwanted field-strength values and the fading margins at each test point inside the required service area.

The desired RF signal-to-noise and RF protection ratios should be user selectable, the default values being 34 dB and 17 dB (DSB-to-DSB co-channel case), respectively. In the case of digital emissions, the desired RF signal-to-noise ratios are as provided in the most recent version of Recommendation ITU-R BS.1615. The default values of RF protection ratio to be used by the Bureau for its compatibility analyses are given in Section 1 of the Annex to Resolution **543 (Rev.WRC-19)**.

The dates for which a compatibility analysis is made should be user selectable, the default values being:

– 0.5 month after the start of the season;

– mid-point of the season;

– 0.5 month before the end of the season.

These default values should be used by the Bureau for its compatibility analyses.

The times for which a compatibility analysis is made should be user selectable, the default values being:

– 30 min past the hour in which the requirement starts;

– 30 min past each successive hour until the hour in which the requirement ends.

These default values should be used by the Bureau for its compatibility analyses.

Software output data

For rapid assessment of the performance of a requirement, the software should calculate:

– the overall service reliability for the relevant test points from the set of 911 test points;

– the overall area reliability for the relevant test points from the set of 911 test points.

In order to provide information about the geographic distribution of wanted and unwanted signal values for a given requirement, additional results should be available from the software:

– a listing should be available giving the overall circuit reliability for each of the relevant test points from the set of 911 test points.

In some cases, a graphical display of the coverage achieved throughout a required service area may be desirable. These values will need to be calculated by the user (with the supplied software and on the user's own computer hardware) at test points at 2° intervals of latitude and longitude throughout the required service area. The values should be displayed graphically as a set of coloured or hatched pixels in steps of 10%. It should be noted that:

– reliability values relate to the use of a single frequency;

– reliability values are a function of the desired RF signal-to-noise and RF protection ratios (both user selectable);

– the field-strength values for the test points (from the set of 911 test points) inside the required service area should be calculated by the Bureau. The software supplied should calculate the relevant reliability values based on these pre-calculated field-strength values and the user-supplied desired signal-to-noise and signal-to-interference values;

– the field-strength values for the test points at 2° intervals should be calculated using the supplied software on the user's own computer hardware. The software supplied should calculate the relevant reliability values based on these field-strength values and the user-supplied desired signal-to-noise and signal-to-interference values.

RESOLUTION 536 (WRC-97)

Operation of broadcasting satellites serving other countries

The World Radiocommunication Conference (Geneva, 1997),

considering

a) the institutional nature of the ITU which is founded on an agreement between its Member States;

b) the treaty status of the Plans in Appendices **30** and **30A**;

c) that these Plans were established on the basis of planning principles which included, *inter alia*, that the Plans should be based mainly on national coverage;

d) the increasing number of applications under Article 4 of Appendices **30** and **30A** for modifications to the Plans, leading to many multinational systems;

e) that No. **23.13** requires that "In devising the characteristics of a space station in the broadcasting-satellite service, all technical means available shall be used to reduce, to the maximum, the radiation over the territory of other countries unless an agreement has been previously reached with such countries",

recognizing

a) that current technology provides opportunities to implement broadcasting-satellite systems with service areas that exceed national coverage;

b) that several such systems have been implemented and others are being planned;

c) that successful Appendices **30** and **30A** Article 4 coordination of such systems does not in any way imply licensing authorization to provide a service within the territory of a Member States,

resolves

that, in addition to observing No. **23.13**, and before providing satellite broadcasting services to other administrations, administrations originating the services should obtain the agreement of those other administrations.

RESOLUTION 539 (REV.WRC-19)

Use of the frequency band 2 605-2 655 MHz in certain Region 3 countries by non-geostationary-satellite systems in the broadcasting-satellite service (sound)

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that the frequency band 2 535-2 655 MHz is allocated under No. **5.418** to the broadcasting-satellite service (BSS) (sound) in certain Region 3 countries;

b) that the provisions of Resolution **528 (Rev.WRC-19)** currently limit the use of this frequency band by systems in the BSS (sound) to the upper 25 MHz of the frequency band;

c) that, prior to WRC-2000, there were no coordination procedures applicable to non-geostationary (non-GSO) BSS (sound) systems in this frequency band in relation to other non-GSO or GSO networks;

d) that satellite technology has now advanced to the stage where non-GSO systems in the BSS (sound) are technically and economically feasible when operated with high elevation angles and that there are practical designs available to ensure that the radiation of the non-GSO satellite in the BSS (sound) outside the main beam is kept at low levels;

e) that satellite systems in the BSS as described in *considering d)* can be used for the delivery of high-quality, spectrally efficient BSS (sound) to portable and mobile terminals;

f) that non-GSO systems in the BSS (sound) in the frequency band 2 630-2 655 MHz in Region 3 have been notified to ITU and are expected to be brought into use in the near future;

g) that, prior to WRC-2000, the protection of existing terrestrial services was addressed through the coordination procedures of No. **9.11**;

h) that the provision cited in *considering g)* may be inadequate to ensure the future deployment of terrestrial services in this frequency band;

i) that a regulatory procedure is required in order to meet the dual objectives of providing adequate long-term protection to existing and planned terrestrial services while not placing undue constraints on the development and implementation of non-GSO BSS (sound) systems;

j) that there are non-GSO systems being planned for operation in the BSS (sound) in the frequency band 2 605-2 655 MHz in Region 3 that have highly elliptical orbits;

k) that the ITU Radiocommunication Sector (ITU-R) has undertaken studies of the likely aggregate interference from a number of co-frequency broadcasting-satellite systems sharing with the terrestrial services on a co-primary basis;

l) that ITU-R has undertaken studies that assumed there is only one satellite active at any time in a non-GSO system operating in a highly elliptical orbit,

invites

1 administrations planning to operate non-GSO BSS (sound) systems in accordance with this Resolution to take measures to design the system to minimize interference to terrestrial services outside the non-GSO BSS (sound) service area, for example as in *considering d)* above;

2 administrations whose territory is geographically close to the territory of an administration planning to operate a non-GSO BSS (sound) system in accordance with this Resolution, and for which there is a correspondingly high elevation angle to the active satellite, to take measures to facilitate the operation of non-GSO BSS (sound) systems,

resolves

1 that any BSS (sound) system using non-GSO orbits brought into operation in the frequency band 2 605-2 655 MHz in Region 3 shall be operated such that the minimum elevation angle over the service area is not less than 55°, for the purposes of sharing with terrestrial services;

2 that, before an administration notifies to the Radiocommunication Bureau (BR) or brings into use a frequency assignment for a BSS (sound) system using non-GSO satellites in the frequency band 2 630-2 655 MHz for which complete Appendix **4** coordination information or notification information has been received after 2 June 2000, and in the frequency band 2 605-2 630 MHz for which complete Appendix **4** coordination information or notification information has been received after 4 July 2003, the following regulatory arrangements shall apply:

The following mask of power flux-density (pfd) values at the Earth's surface produced by emissions from a space station for all conditions and for all methods of modulation shall be used as the basis of the regulatory procedures of this Resolution:

-130	dB(W/(m^2 · MHz))	for $0° \le \theta \le 5°$
$-130 + 0.4\,(\theta - 5)$	dB(W/(m^2 · MHz))	for $5° < \theta \le 25°$
-122	dB(W/(m^2 · MHz))	for $25° < \theta \le 45°$
$-122 + 0.2\,(\theta - 45)$	dB(W/(m^2 · MHz))	for $45° < \theta \le 65°$
$-118 + 0.09\,(\theta - 65)$	dB(W/(m^2 · MHz))	for $65° < \theta \le 76°$
-117	dB(W/(m^2 · MHz))	for $76° < \theta \le 90°$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees.

These values relate to the pfd and angles of arrival which would be obtained under free-space propagation conditions.

Furthermore:

– for angles of arrival of less than 76° in the pfd mask above, if the limits are exceeded, the notifying administration shall obtain explicit agreement from any administration identified by BR in its examination below;

– for angles of arrival from 76° to 90° in the pfd mask above, the coordination procedure with respect to those administrations identified by BR in its examination below will be that of No. **9.11**;

3 that systems in the BSS (sound) using non-GSO satellites shall be limited to national services unless agreement has been reached to include the territories of other administrations in the service area;

4 that, within the context of this Resolution, an administration listed in No. **5.418** shall not have simultaneously two overlapping frequency assignments, one under that provision, and the other one under No. **5.416**;

5 that, as from 5 July 2003, BR and administrations shall apply the provisions of Articles **9** and **11** taking into account Nos. **5.418**, **5.418A**, **5.418B**, **5.418C** and this Resolution, as revised by WRC-03,

instructs the Radiocommunication Bureau

1 when applying *resolves* 2, to use the pfd mask in *resolves* 2; and

– for angles of arrival of less than 76°, identify the affected administrations which have a primary allocation to terrestrial services in the same frequency band and on whose territory the pfd is exceeded, and inform both the notifying and the affected administrations; at the notification stage, the lack of any necessary agreement is considered as non-conformity with No. **11.31**;

– for angles of arrival from 76° to 90°, identify the affected administrations which have a primary allocation to terrestrial services in the same frequency band and on whose territory the pfd is exceeded; and inform both the notifying and the affected administrations; at the notification stage, each notice shall be examined in the application of No. **11.32** and, if appropriate, under No. **11.32A** with respect to the probability of harmful interference that may be caused to assignments for which coordination could not be successfully completed;

2 as from 5 July 2003, to apply *resolves* 5 in its examination of requests for coordination and notifications for any BSS (sound) systems using non-GSO satellites in the frequency band 2 630-2 655 MHz for which complete Appendix **4** coordination information or notification information has been received after 2 June 2000.

RESOLUTION 543 (REV.WRC-19)

Provisional RF protection ratio values for analogue and digitally modulated emissions in the high-frequency broadcasting service

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that this conference has resolved to encourage the introduction of digitally modulated emissions in the high-frequency (HF) broadcasting bands allocated to the broadcasting service and has revised Resolution **517** accordingly;

b) that the current use of the spectrum is based on the use of double-sideband (DSB) emissions;

c) that Appendix **11** gives details of the system parameters and the emission characteristics of the digitally modulated emissions;

d) that the ITU Radiocommunication Sector (ITU-R) is carrying out further studies on the development of HF broadcasting using digitally modulated emissions in the frequency bands allocated to the broadcasting service below 30 MHz;

e) that RF co-channel and adjacent channel protection ratios are among the fundamental parameters when determining compatibility;

f) that the currently available values of RF protection ratios may need to be updated in the light of future ITU-R studies;

g) that Annex 1 to Recommendation ITU-R BS.1514 describes a digital system suitable for broadcasting in the frequency bands below 30 MHz;

h) that there is a need to compile and maintain statistics on administrations' capability to introduce digital modulation systems for their HF broadcasting services,

resolves

1 that digital modulation in accordance with Resolution **517 (Rev.WRC-19)** may be used in any of the HF bands allocated to the broadcasting service; this accommodation has to be made with the appropriate amounts of protection given to both analogue and digital emissions as described in the Annex to this Resolution;

2 that the protection ratio values described in the Annex be used in the coordination process under Article **12** on a provisional basis;

3 to invite a future competent conference to revise these provisional protection ratio values, as appropriate,

invites the ITU Radiocommunication Sector

to continue studies on digital techniques in HF broadcasting with the purpose of revising the RF protection ratio values for analogue and digitally modulated emissions in the HF broadcasting service as described in the Annex to this Resolution.

ANNEX TO RESOLUTION 543 (REV.WRC-19)

Section 1 − Standard RF protection ratio values

RF protection ratio values to be used for seasonal planning under the provisions of Article **12** are contained in Table 1 in this Section.

The values are consistent with those in Recommendation ITU-R BS.1615.

The characteristics of the digital emission are based on the 64-QAM modulation system, protection level No. **1**, robustness mode B, spectrum occupancy type 3 (as contained in Recommendation ITU-R BS.1514), which will be used extensively for HF sky-wave broadcasting in 10 kHz channels.

The characteristics of the analogue emission are based on double-sideband modulation as summarized in Part A of Appendix **11**, with 53% modulation depth.

TABLE 1

Relative RF protection ratios (dB) associated with digitally modulated emissions in the HF bands allocated to the broadcasting service

Wanted signal	**Unwanted signal**	**Frequency separation $f_{unwanted} - f_{wanted}$ (kHz)**								
		−20	**−15**	**−10**	**−5**	**0**	**5**	**10**	**15**	**20**
Amplitude modulation	Digital	−47	−42	−32	3	6	3	−32	−42	−47
Digital	Amplitude modulation	−54	−48	−40	−3	0	−3	−40	−48	−54
Digital	Digital	−53	−47	−38	−3	0	−3	−38	−47	−53

In the case of an amplitude modulation (AM) signal interfered with by a digital signal, the protection ratios are determined by adding 17 dB (audio-frequency protection ratio) to the relative RF protection ratios in Table 1.

In the case of a digital signal interfered with by an AM signal, the protection ratios are determined by adding 7 dB (signal-to-interference ratio for a bit error ratio (BER) of 10^{-4}) to the relative RF protection ratios in Table 1.

In the case of a digital signal interfered with by a digital signal, the protection ratios are determined by adding 16 dB (signal-to-interference ratio for a BER of 10^{-4}) to the RF relative protection ratios in Table 1.

Section 2 − Correction values of RF protection ratios

Correction values of RF protection ratios for different wanted signal conditions such as AM modulation depths, AM quality grades and digital modulation modes are provided in this Section.

1 AM modulation depth

RF protection ratios for a wanted AM signal interfered with by a digital signal depend on the AM modulation depth. A modulation depth of 53% is used as a default value in this Annex. If a different modulation depth is used, a correction value for RF protection ratio is required. Table 2 provides correction values for typical modulation depths.

TABLE 2

Correction values (dB) to be used for other AM modulation depths in respect of wanted AM signal

Modulation depth (%)	30	38	53	*m*
Correction value (dB)	5	3	0	20 log (53/*m*)

2 AM audio quality

RF protection ratios for a wanted AM signal interfered with by a digital signal depend on the required audio quality grade. If another quality grade is used, correction values of RF protection ratios as in Table 3 shall be added.

TABLE 3

Correction values (dB) to be used for other audio quality grades in respect of wanted AM signal

Audio quality grade	3	3.5	4
Correction value (dB)	0	7	12

3 Digital modulation scheme, protection level number and robustness mode

RF protection ratios for a wanted digital signal interfered with by an analogue or digital signal depend on the digital modulation scheme and mode. If any combination different from the default value in Section 1 is used, correction values of RF protection ratios as in Table 4 shall be added.

TABLE 4

Correction values (dB) to be used for other combinations of digital modulation scheme, protection level number and robustness mode in respect of wanted digital signal

Modulation scheme	Protection level number	Robustness mode		
		B	C	D
16-QAM	0	−7	−6	−6
	1	−5	−4	−4
64-QAM	0	−1	−1	0
	1	0	0	1

NOTE − 10 kHz nominal bandwidth.

Protection levels Nos. 2 and 3 and robustness mode A are not recommended for use in HF and are therefore not described here.

Section 3 − Explanatory examples

a) In Table 1, first row <AM interfered with by Digital>: with the AF protection ratio = 17 dB, all values of relative protection ratios entered in that row of the Table must be increased by 17 dB in order to determine the absolute value of the RF protection ratio (RF PR). As examples:

– For co-channel interference (0 kHz separation) the RF PR would be 6 + 17 = 23 dB.

– For adjacent channel interference (±10 kHz separation) the RF PR would be −32 + 17 = −15 dB.

– For the case of modulation depth = 38% and audio quality grade = 4, a correction factor of 15 dB (= 3 + 12) is added to the RF PR values described above.

b) In Table 1, second row <Digital interfered with by AM>: all values of relative protection ratios entered in that row of the Table must be increased by 7 dB in order to determine the absolute value of the RF PR. As examples:

– For co-channel interference (0 kHz separation) the RF PR would be 0 + 7 = 7 dB.

– For adjacent channel interference (±10 kHz separation) the RF PR would be −40 + 7 = −33 dB.

c) In Table 1, third row <Digital interfered with by Digital>: all values of relative protection ratios entered in that row of the Table must be increased by 16 dB in order to determine the absolute value of the RF protection ratio. As examples:

– For co-channel interference (0 kHz separation) the RF PR would be 0 + 16 = 16 dB.

– For adjacent channel interference (±10 kHz separation) the RF PR would be −38 + 16 = −22 dB.

RESOLUTION 548 (REV.WRC-12)

Application of the grouping concept in Appendices 30 and 30A in Regions 1 and 3[1]

The World Radiocommunication Conference (Geneva, 2012),

considering

a) that the grouping concept as it is applied in Appendices **30** and **30A** with respect to Regions 1 and 3 was considered by WRC-03;

b) that the protection of assignments in the Plan and the List in Appendices **30** and **30A** is based upon an equivalent protection margin criterion;

c) that concerns have been raised that the use of the grouping concept by one administration may reduce access to spectrum resources by others;

d) that coordination of one network[2] in a group shall not lead to a reduction of coordination requirements for other networks in the same group;

e) that WRC-2000 accepted grouping in the Regions 1 and 3 List for some networks which are separated by up to 0.2° in the geostationary arc according to their respective nominal orbital locations,

noting

a) that the 2002 Conference Preparatory Meeting considered a proposed solution in which there is a limit to the number of assignments in a group or number of groups in one orbital location;

b) that the Radio Regulations Board has developed Rules of Procedure with respect to the application of the grouping concept,

resolves

1 that a grouping of networks with an overall separation of not more than 0.4° in the geostationary arc, in accordance with their respective nominal orbital locations, is regarded as a grouping at the same orbital location;

2 that the limitations referred to in *resolves* 4 do not apply to grouping of networks before the inclusion of the assignments in the List;

3 that the limitations in *resolves* 4 do not apply to grouping within one network;

---

[1] It is noted that the application of the grouping concept in Region 2 does not require any change. Therefore, the Radiocommunication Bureau shall continue to apply the grouping concept in Region 2 as it has applied it prior to WRC-03.

[2] In the application of this Resolution, a network is understood as being a submission by one administration, or one administration acting on behalf of a group of administrations, to the Bureau of a set of assignments, received on the same date, with the same name for the satellite network and at the same orbital location.

4 that under Appendices **30** and **30A** in Regions 1 and 3 the following principles with respect to the application of the grouping concept between networks at the same orbital location shall apply:

a) these limitations apply for networks with overlapping frequency bands;

b) for networks for which a submission is received by the Bureau under § 4.1.3 of Appendix **30** or **30A** after 4 July 2003, not more than three networks within the same overlapping frequency bandwidth can be in a group in the List;

c) for networks for which a submission was received by the Bureau under § 4.1.3 of Appendix **30** or **30A** before 5 July 2003, not more than five networks within the same overlapping frequency bandwidth can be in a group in the List;

d) if the number of networks in a group in the List reaches the maximum limit specified above, no new networks can be entered into the List in this group without removal of another overlapping part of a network from the List;

5 that, as from 5 July 2003, in the processing and publication by the Bureau of submissions relating to Regions 1 and 3 under Article 4 of Appendix **30** or **30A** received after 2 June 2000 and the identification of affected administrations in accordance with § 4.1.5, each network in a group is examined separately, without taking into account the other networks in the group[3].

[3] In applying § 4.1.11, the application of the new methodology in this *resolves* to networks received before 3 June 2000 shall not result in additional coordination requirements for those networks.

RESOLUTION 550 (REV.WRC-19)

Information relating to the high-frequency broadcasting service

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that this conference reviewed the case for relieving congestion in certain of the high-frequency (HF) bands allocated to the broadcasting service;

b) that this conference decided to maintain the present Table of Frequency Allocations in the HF bands, in view of the rapid development and use of the frequency bands by all services;

c) that, as part of a general transition away from analogue transmission systems, digital modulation is being introduced into the HF broadcasting bands;

d) that, in common with the other services using the HF bands, the broadcasting service has an ongoing need to review the effectiveness of its use of spectrum,

noting

that Resolution **517 (Rev.WRC-19)** deals with the introduction of digitally modulated emissions in the HF bands allocated to the broadcasting service,

noting further

that the ITU Radiocommunication Sector (ITU-R) has prepared a wide-ranging report, namely Report ITU-R BS.2105, on information relating to the HF broadcasting service,

resolves to invite the ITU Radiocommunication Sector

to continue studies on HF broadcasting, taking into account:

– technical and operational factors;

– digital transmissions, including how the introduction of these emissions will affect HF broadcasting requirements and operations,

invites administrations and Sector Members

to participate actively in the aforementioned studies by submitting contributions to ITU-R.

RESOLUTION 552 (REV.WRC-23)

Long-term access to and development in the frequency band 21.4-22 GHz in Regions 1 and 3

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that WARC-92 allocated the frequency band 21.4-22 GHz in Regions 1 and 3 to the broadcasting-satellite service (BSS) to be implemented after 1 April 2007;

b) that the use of the frequency band since 1992 was subject to an interim procedure in accordance with Resolution **525 (WARC-92**, **Rev.WRC-03** and **Rev.WRC-07**)[*, 1];

c) that Article 44 of the ITU Constitution sets out the basic principles for the use of the radio-frequency spectrum and the geostationary-satellite (GSO) and other satellite orbits, taking into account the needs of developing countries;

d) that a due diligence process was first adopted by WRC-97 with a view to providing, as early as possible, information on the industrial project behind a satellite network submitted to ITU;

e) that providing information required under this due diligence process was a prerequisite to qualifying for a two-year extension of the regulatory period to bring into use a satellite network in non-planned bands;

f) that WRC-03 decided to remove the two-year extension by setting the regulatory period to bring into use a satellite network in non-planned bands at seven years;

g) that data concerning the manufacturer, launch service provider and launch date of a satellite will be more accurate and useful if submitted after the launch of the satellite,

resolves

1 that this Resolution applies to GSO networks in the BSS in the frequency band 21.4-22 GHz;

2 that, for frequency assignments to satellite networks as described in *resolves* 1 for which confirmation of the date of bringing into use under the provisions of Article **11** was not received by the Radiocommunication Bureau before 18 February 2012 or which were suspended under No. **11.49** at that date, the procedure contained in Annex 1 to this Resolution shall be applied at the time of first bringing into use or when resuming use after a suspension, as appropriate;

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[*] *Note by the Secretariat*: This Resolution was abrogated by WRC-12.

[1] Reference to Resolution **525 (WARC-92**, **Rev.WRC-03** and **Rev.WRC-07)** is provided as background information.

3 that, for frequency assignments to satellite networks as described in *resolves* 1 for which confirmation of the date of bringing into use under the provisions of Article **11** was received by the Bureau before 18 February 2012, the provisions of §§ 5 to 8 of Annex 1 to this Resolution shall be applied, as appropriate,

further resolves

that the procedures in this Resolution are in addition to the provisions under Articles **9** and **11**,

instructs the Director of the Radiocommunication Bureau

to include in his report to future competent world radiocommunication conferences the results of the implementation of this Resolution.

ANNEX 1 TO RESOLUTION 552 (REV.WRC-23)

1 Within 30 days after the actual commencement, or resumption, of use of the frequency assignments to a satellite network subject to these procedures, the notifying administration shall send to the Radiocommunication Bureau (BR) the information specified in Annex 2 to this Resolution.

2 The information to be submitted in accordance with § 1 above shall be signed by an authorized official of the notifying administration.

3 If the spacecraft is used for the first time under this Resolution, the due diligence information to be submitted in accordance with § 1 above could be supplemented by a copy of the contract with the launch service provider.

4 On receipt of the information under § 1 above, BR shall promptly examine its completeness. If the information is found to be complete, BR shall publish the complete information in a special section of its International Frequency Information Circular (BR IFIC) within two months. If the information is found to be incomplete, BR shall request the notifying administration to submit the missing information within 30 days.

5 The information submitted in accordance with § 1 above shall be updated and resubmitted to BR by the notifying administration not later than 30 days after the end of life or the relocation of the spacecraft associated with the submission under § 1 above. In the case of end of life of a spacecraft, the corresponding ITU ID number associated with such a spacecraft shall no longer be used.

6 On receipt of the information under § 5 above, BR shall promptly examine its completeness. If the information is found to be complete, BR shall publish the complete information in a special section of the BR IFIC within two months. If the information is found to be incomplete, BR shall request the notifying administration to submit the missing information within 30 days.

7 If the complete information specified in § 1 and 5 above is not received by BR within the time-limits specified in § 1, 4, 5 and 6 above, BR shall immediately inform the notifying administration and take appropriate measures under § 8, if required.

8 Within 30 days after the end of the seven-year period following the date of receipt by BR of the relevant complete information under No. **9.30**, and after the end of the three-year period following the date of suspension under No. **11.49**, if the complete information under this Resolution is not yet received by BR, the corresponding frequency assignments shall be cancelled by BR, which subsequently informs the administration accordingly.

ANNEX 2 TO RESOLUTION 552 (REV.WRC-23)

Information to be submitted

1 Identity of the satellite network

a) Identity of the satellite network

b) Name of the notifying administration

c) Orbital characteristics

d) Reference to the request for coordination

e) Reference to the notification, when available

f) Frequency band(s) included in the relevant special sections of the satellite network

g) First date of bringing into use[2]

h) Regulatory status

– Satellite network under operation (only data listed in § 2 shall be provided) or

– Satellite network suspended (only data listed in § 3 shall be provided)

2 Identity of the spacecraft[3] (if satellite network filing is under operation)

a) ITU ID number or

b) Spacecraft manufacturer

– Name of the spacecraft manufacturer

– Date of execution of the contract

– Delivery date

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[2] This information has already been provided by the administration under the provisions of Article **11** and will be inserted by BR.

[3] If data about the spacecraft are submitted for the first time under this Resolution, items “Spacecraft manufacturer”, “Launch service provider” and “Frequency band(s) present on board the spacecraft” shall be provided. Otherwise, if data about the spacecraft were already submitted under this Resolution, the ID number (based on the ITU filing number) given by BR to this spacecraft at that time shall be indicated.

c) Launch service provider

– Name of the launch vehicle provider

– Date of execution of the contract

– Name of the launch vehicle

– Name and location of the launch facility

– Launch date

d) Frequency band(s) present on board the spacecraft (i.e. frequency bands for each transponder that are able to be transmitted by a transponder located on board the spacecraft within the frequency band 21.4-22 GHz)

3 Suspension information (if satellite network filing is suspended)

a) Date of suspension[4]

b) Reason for suspension:

– Spacecraft moved to another orbital position, or

– In-orbit failure of the spacecraft, or

– Spacecraft de-orbited,

– Other reasons (to be specified).

[4] This information has already been provided by the administration under the provisions of Article **11** and will be inserted by BR.

RESOLUTION 553 (REV.WRC-23)

Additional regulatory measures for broadcasting-satellite networks in the frequency band 21.4-22 GHz in Regions 1 and 3 for the enhancement of equitable access to this frequency band

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that WARC-92 allocated the frequency band 21.4-22 GHz in Regions 1 and 3 to the broadcasting-satellite service (BSS) to be implemented after 1 April 2007;

b) that the use of the frequency band since 1992 was subject to an interim procedure in accordance with Resolution **525 (WARC-92**, **Rev.WRC-03** and **Rev.WRC-07)**[*];

c) that the frequency band 21.4-22 GHz in Regions 1 and 3 for the BSS was subject to Resolution **507 (Rev.WRC-12)**[**],

considering further

a) that *a priori* planning for BSS networks in the frequency band 21.4-22 GHz in Regions 1 and 3 is not necessary and should be avoided as it freezes access according to technological assumptions at the time of planning and then prevents flexible use taking account of real world demand and technical developments;

b) that WRC-12 established definitive arrangements for the use of the frequency band 21.4-22 GHz;

c) that Articles 12 and 44 of the ITU Constitution lay down the basic principles for the use of the radio-frequency spectrum and the geostationary-satellite and other satellite orbits, taking into account the needs of developing countries;

d) that those principles have been included in the Radio Regulations;

e) that all countries have equal rights in the use of both the radio frequencies allocated to various space radiocommunication services and geostationary-satellite orbit and other satellite orbits for these services;

f) that, accordingly, a country or a group of countries having frequency assignments for the BSS in the frequency band 21.4-22 GHz need to take all practical measures to facilitate the use of new space systems by other countries or groups of countries;

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[*] *Note by the Secretariat*: This Resolution was abrogated by WRC-12.

[**] *Note by the Secretariat:* This Resolution was revised by WRC-15 and WRC-19.

g) that, according to No. **23.13**, in devising the characteristics of a space station in the BSS, all technical means available shall be used to reduce, to the maximum, the radiation over the territory of other countries unless an agreement has been previously reached with such countries,

recognizing

a) that the "first-come, first-served" concept can restrict and sometimes prevents access to and use of certain frequency bands and orbital positions;

b) the relative disadvantage for developing countries in coordination negotiations due to various reasons such as a lack of resources and expertise;

c) the perceived differences in consistency of application of the Radio Regulations,

recognizing further

a) that WRC-12 received information provided by the Bureau or the various submissions received by the Bureau which include assignments in the BSS for Regions 1 or 3 in the frequency band 21.4-22 GHz up until December 2011 and that the table below summarizes the data provided by the Bureau and shows the variations for the number of networks at the various stages;

	Advance publication information	**Coordination request**	**Notification submission**	**Networks in MIFR**	**Resolution 49**	**Confirmed brought into use**
October 2008	605	115	21	2	18	
September 2009	599	158	24	9	22	18
March 2010	558	199	22	11	20	19
June 2010	664	229	22	12	23	19
January 2011	703	242	20	7	18	14
December 2011	890	291	13	8*	16	10*

* Clarification is awaited for one network. One network is suspended under No. **11.49**.

b) that the number of submissions made by some administrations as contained in the above table in this frequency band is large, which may not be realistic and may be difficult to implement within the regulatory time-limit under Article **11**;

c) that the number of submissions as shown in *recognizing further a)* above, is complicating coordination of BSS systems already submitted or planned to be submitted by other administrations,

resolves

that, as of 18 February 2012, the special procedure outlined in the Attachment to this Resolution for processing of coordination requests for BSS frequency assignments in Regions 1 and 3 in the frequency band 21.4-22 GHz shall be applied in respect of submissions of administrations meeting the specified requirements in the Attachment.

ATTACHMENT TO RESOLUTION 553 (REV.WRC-23)

Special procedure to be applied for an assignment for a broadcasting-satellite service system in the frequency band 21.4-22 GHz in Regions 1 and 3

1 The special procedure described in this attachment can only be applied to one network at a time (except as described in § 4 below) by an administration or an administration acting on behalf of a group of named administrations when, for the frequency band 21.4-22 GHz, none of those administrations have:

– a network in the Master International Frequency Register (MIFR), notified under Article **11**; or

– more than one network successfully examined under No. **9.34** and published under No. **9.38** at the same orbital position as the one of the network subject to this special procedure; or

– a network successfully examined under No. **9.34** and published under No. **9.38** at an orbital position different from the one of the network subject to this special procedure.

In the case of countries complying with § 4 below, the special procedure described in this Attachment can also be applied[1] by an administration when the administration has networks in the MIFR, notified under Article **11**, or more than one network successfully examined under No. **9.34** and published under No. **9.38** at the same orbital position as the one of the network subject to this special procedure, or a network successfully examined under No. **9.34** and published under No. **9.38** at an orbital position different from the one of the network subject to this special procedure for the frequency band 21.4-22 GHz, but which, combined, do not include its entire territory in the service area. Each one of the administrations in a group will lose its right to apply this special procedure individually or as a member of another group.

2 In the case that an administration that has already made a submission under this special procedure, either individually or as a part of a group (except as described in § 4 below), at a later stage submits a new submission, this new submission cannot benefit from this special procedure except where the network associated with the previous submission under this special procedure has not been notified prior to the regulatory deadline.

[1] The number of submissions shall not exceed the number of orbital locations for national assignments in the Appendix **30** Plan, reduced by the number of orbit locations of that administration for networks in the MIFR, submissions notified under Article **11** and submissions successfully examined under No. **9.34** and published under No. **9.38**.

3 In order to benefit from the application of this special procedure, the submitting administration may either withdraw or modify its submission previously sent to the Bureau under the normal procedure and successfully examined under No. **9.34** and published under No. **9.38**. In the case of modification, such modification shall remain within the envelope characteristics of the previous submission in order to retain the original date of receipt. If the previous assignment includes several frequency bands, the modification can be applied to the frequency band 21.4-22 GHz to be separated as an independent submission under the special procedure.

4 In order to meet the concerns of some countries with a large territory or dispersed territories that cannot be covered from one orbital location, under this procedure the requirement of such countries having large territory would be met by allowing them to apply this special procedure for submissions to cover their territories from an absolute minimum number of orbital locations[2] that enable them to cover the entire territory in question.

5 Administrations seeking to apply this special procedure shall submit their request to the Bureau, with the following information:

a) the geographical coordinates of not more than 20 points for determining the minimal ellipse[3] to cover its/their national territory[4];

b) the height above sea level of each of its points;

c) any special requirement which is to be taken into account, to the extent practicable.

6 In submitting their request under § 5 above, administrations may seek the assistance of the Bureau to suggest candidate orbital locations for a submission.

7 Upon receipt of the complete information (mentioned in § 5 above) from an administration seeking the assistance of the Bureau under § 6, the Bureau shall expeditiously generate the minimum coverage ellipse and candidate orbital locations (if requested by the administration) for a prospective submission. The Bureau shall send this information to the requesting administration.

8 Before an administration notifies to the Bureau or brings into use a frequency assignment subject to this special procedure, it shall effect coordination with other administrations as required in § 11 below.

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[2] The number of orbital locations shall not exceed the number of orbital locations for national assignments in the Appendix **30** Plan.

[3] In some cases, use of composite beams may be necessary to provide required coverage while reducing undesired coverage of adjacent geographical areas.

[4] Countries requiring more than one orbital location to cover their national territory (see § 4 above) shall submit points for different orbital locations such that the polygons drawn between the points do not overlap with those from other orbital locations of the same administration.

9 Upon receipt of the information under § 7 above, administrations seeking assistance in applying this special procedure shall submit a request for coordination together with the appropriate information listed in Appendix **4**.

10 Administrations not seeking the assistance of the Bureau may submit a request for coordination together with the appropriate information listed in Appendix **4** at the same time as submitting the information under § 5 above.

11 On receipt of the complete information sent under § 9 or § 10 above, the Bureau shall, ahead of submissions not yet processed under No. **9.34**, promptly:

a) examine the information with respect to conformity with Annex 1 to this Attachment and §§ 1 to 4 above;

b) examine the information with respect to its conformity with No. **11.31**;

c) identify, in accordance with Annex 2 to this Attachment, any administration with which coordination may need to be effected[5];

d) include their names in the publication under *e)* below;

e) publish[6], as appropriate, the complete information in its International Frequency Information Circular (BR IFIC) within four months. Where the Bureau is not in a position to comply with the time-limit referred to above, it shall periodically so inform the administrations, giving the reasons therefor;

f) inform the administrations concerned of its actions and communicate the results of its calculations, drawing attention to the relevant BR IFIC.

12 If the information is found to be incomplete, the Bureau shall immediately seek from the administration concerned any clarification required and information not provided.

13 The provisions in this Resolution are in addition to the provisions of Articles **9** and **11**.

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[5] The Bureau shall also identify the specific satellite networks with which coordination needs to be effected.

[6] If the payments are not received in accordance with the provisions of Council Decision 482, as amended, on the implementation of cost recovery for satellite network filings, the Bureau shall cancel the publication, after informing the administration concerned. The Bureau shall inform all administrations of such action and that the network specified in the publication in question no longer has to be taken into consideration by the Bureau and other administrations. The Bureau shall send a reminder to the notifying administration not later than two months prior to the deadline for the payment in accordance with the above-mentioned Council Decision 482 unless the payment has already been received. (WRC-12)

ANNEX 1

TO

ATTACHMENT TO RESOLUTION 553 (REV.WRC-23)

Technical parameters to be used for submissions for Regions 1 and 3 broadcasting-satellite service networks under the special procedure of this Resolution

a) The receiving earth station antenna diameter should be in the range 45-120 cm. The radiation pattern of the receiving terminal antenna should comply with Recommendation ITU-R BO.1900.

b) The noise temperature of the receiving earth station should be in the range 145-200 K.

c) The transmitting equivalent isotropically radiated power (e.i.r.p.) of the space station shall be in the range from 43.2 dBW/MHz to 58.2 dBW/MHz[7].

d) The service area shall be limited by the national borders of the country and the minimum coverage ellipse generated by the Bureau.

e) In the case of an administration with a large territory or dispersed territories, requiring more than one orbit location to cover the territory of their country, the polygons drawn between the points submitted under § 5 above for each submitted orbital location shall not overlap each other and shall not overlap with service areas of networks of this administration successfully examined under No. **9.34** and published under No. **9.38**.

f) The minimum coverage ellipse, generated from not more than 20 points with associated geographical coordinates[8].

g) The reference pattern of the transmitting space station shall be in compliance with Figure 1 below.

h) The maximum pointing error of the transmitting space station antenna shall be 0.1° in any direction.

i) The maximum rotational error of the transmitting space station antenna shall be ±1°.

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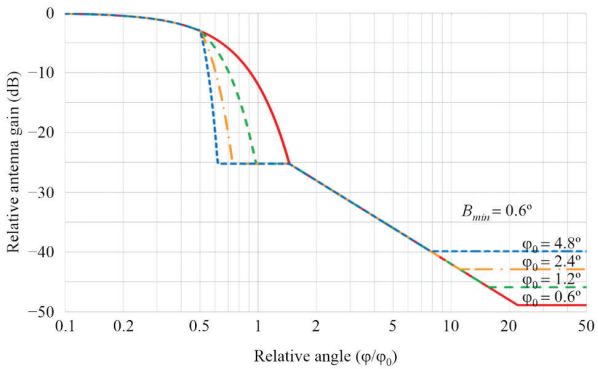
[7] The maximum pfd produced at high elevation angles at the Earth's surface under free-space conditions shall not exceed −105 dB(W/(m^2 · MHz)).

[8] In some cases use of composite beams may be necessary to provide required coverage while reducing undesired coverage of adjacent geographical areas.

FIGURE 1* (WRC-12)

Reference patterns for satellite antennas with fast roll-off in the main beam



$$G_{max} = 44.45 - 10 \log (\varphi_{01} \cdot \varphi_{02}) \quad \text{dBi} \quad \text{(WRC-12)}$$

Curve A: dB relative to main beam gain

$-12\,(\varphi/\varphi_0)^2$	for $0 \le (\varphi/\varphi_0) \le 0.5$
$-12\left[\dfrac{(\varphi/\varphi_0)-x}{B_{min}/\varphi_0}\right]^2$	for $0.5 < (\varphi/\varphi_0) \le \left(\dfrac{1.45B_{min}}{\varphi_0}+x\right)$
-25.23	for $\left(\dfrac{1.45\,B_{min}}{\varphi_0}+x\right) < (\varphi/\varphi_0) \le 1.45$
$-(22 + 20 \log (\varphi/\varphi_0))$	for $(\varphi/\varphi_0) > 1.45$

after intersection with Curve B: Curve B.

Curve B: Minus the on-axis gain (Curve B represents examples of four antennas having different values of φ_0 as labelled in Fig. 1. The on-axis gains of these antennas are approximately 39.9, 42.9, 45.9 and 48.9 dBi, respectively) (WRC-12)

where:

φ: off-axis angle (degrees)

φ_0: cross-sectional half-power beamwidth in the direction of interest (degrees)

φ_{01}, φ_{02}: major and minor axis half-power beamwidth, respectively, of elliptical beam (degrees) (WRC-12)

$$x = 0.5\left(1 - \frac{B_{min}}{\varphi_0}\right)$$

where:

$B_{min} = 0.6°$

* Figure 1 represents patterns for some values of φ_0. (WRC-12)

ANNEX 2

TO

ATTACHMENT TO RESOLUTION 553 (REV.WRC-23)

Technical criteria to determine coordination requirements for submissions under the special procedure to be applied for an assignment for a broadcasting-satellite service system in the frequency band 21.4-22 GHz in Regions 1 and 3

Coordination of assignments for a broadcasting-satellite service (BSS) space station with respect to other BSS networks is not required if the power flux-density (pfd) produced under assumed free space propagation conditions does not exceed the threshold values shown below, anywhere within the service area of the potentially affected assignment:

a) this mask shall be applied for frequency assignments subject to this Resolution with regard to frequency assignments not subject to this Resolution for which:

– notification is not submitted under Article **11**; and

– complete information under Resolution **552 (Rev.WRC-23)** is not received by the Bureau,

at the date of receipt of complete information under § 9 and 10 of the Attachment to this Resolution,

-146.88	dB(W/(m^2 · MHz))	for	$0° \leq \theta < 0.6°$
$-150.2 + 9.3\ \theta^2$	dB(W/(m^2 · MHz))	for	$0.6° \leq \theta < 1.05°$
$-140.5 + 27.2 \log \theta$	dB(W/(m^2 · MHz))	for	$1.05° \leq \theta < 2.65°$
$-138.1 + 1.3\ \theta^2$	dB(W/(m^2 · MHz))	for	$2.65° \leq \theta < 4.35°$
$-130.2 + 26.1 \log \theta$	dB(W/(m^2 · MHz))	for	$4.35° \leq \theta < 9.1°$
-105	dB(W/(m^2 · MHz))	for	$9.1° \leq \theta$

where θ is the minimum nominal geocentric orbital separation, in degrees, between the wanted and interfering space stations, taking into account the respective east-west station-keeping accuracies;

b) this mask shall be applied for frequency assignment subject to this Resolution with regard to:

– frequency assignments subject to this Resolution; or

– frequency assignments not subject to this Resolution for which:

  – notification is submitted under Article **11**; or

  – complete information under Resolution **552 (Rev.WRC-23)** is received by the Bureau,

at the date of receipt of complete information under § 9 and 10 of the Attachment to this Resolution,

-149.88	dB(W/(m^2 · MHz))	for	$0° \leq \theta < 0.6°$
$-153.2 + 9.3\ \theta^2$	dB(W/(m^2 · MHz))	for	$0.6° \leq \theta < 1.05°$
$-143.5 + 27.2 \log \theta$	dB(W/(m^2 · MHz))	for	$1.05° \leq \theta < 2.65°$
$-141.1 + 1.3\ \theta^2$	dB(W/(m^2 · MHz))	for	$2.65° \leq \theta < 4.35°$
$-133.2 + 26.1 \log \theta$	dB(W/(m^2 · MHz))	for	$4.35° \leq \theta < 12°$
-105	dB(W/(m^2 · MHz))	for	$12° \leq \theta$

where θ is the minimum nominal geocentric orbital separation, in degrees, between the wanted and interfering space stations, taking into account the respective east-west station-keeping accuracies.

RESOLUTION 554 (WRC-12)

Application of pfd masks to coordination under No. 9.7 for broadcasting-satellite service networks in the band 21.4-22 GHz in Regions 1 and 3

The World Radiocommunication Conference (Geneva, 2012),

considering

a) that more precise criteria to apply No. **9.7** have the potential to reduce undue protection requirements for assignments in respect of incoming assignments in their vicinity;

b) that reduction of undue protection requirements will facilitate coordination of submissions of new networks;

c) that the use of pfd thresholds to identify coordination requirements will encourage use of more homogeneous technical parameters and support efficient spectrum usage,

resolves

1 that coordination of assignments for a broadcasting-satellite service (BSS) space station in Regions 1 and 3 in the 21.4-22 GHz band with respect to other BSS networks is not required if the pfd produced under assumed free space propagation conditions, does not exceed the threshold values shown below, anywhere within the service area of the potentially affected assignment:

-149.88	dB(W/(m^2 · MHz))	for	$0° \leq \theta < 0.6°$
$-153.2 + 9.3\ \theta^2$	dB(W/(m^2 · MHz))	for	$0.6° \leq \theta < 1.05°$
$-143.5 + 27.2 \log \theta$	dB(W/(m^2 · MHz))	for	$1.05° \leq \theta < 2.65°$
$-141.1 + 1.3\ \theta^2$	dB(W/(m^2 · MHz))	for	$2.65° \leq \theta < 4.35°$
$-133.2 + 26.1 \log \theta$	dB(W/(m^2 · MHz))	for	$4.35° \leq \theta < 12°$
-105	dB(W/(m^2 · MHz))	for	$12° \leq \theta$

where θ is the minimum nominal geocentric orbital separation, in degrees, between the wanted and interfering space stations, taking into account the respective East-West station-keeping accuracies;

2 that when the Bureau, under No. **11.32**, conducts its examination of notifications of satellite networks in respect of compliance with the coordination procedures, it shall base its findings on the coordination requirements set by No. **9.7** in Table **5-1** of Appendix **5** as revised by WRC-12 for those networks received under No. **9.30** before 18 February 2012.

RESOLUTION 558 (WRC-19)

Protection of implemented broadcasting-satellite service networks in the orbital arc of the geostationary-satellite orbit between 37.2° W and 10° E in the frequency band 11.7-12.2 GHz

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that the provisions applying to the broadcasting-satellite service (BSS) in the frequency bands 11.7-12.5 GHz in Region 1, 12.2-12.7 GHz in Region 2 and 11.7-12.2 GHz in Region 3 are contained in Appendix **30**;

b) that systems in the fixed-satellite service (FSS) and the BSS share the frequency band 11.7-12.2 GHz;

c) that this conference suppressed the limitation in Section 3 of Annex 7 to Appendix **30 (Rev.WRC-15)** which determined allowable portions of the orbital arc between 37.2° W and 10° E for new or modified assignments in the frequency band 11.7-12.2 GHz in the Regions 1 and 3 List;

d) that Section 1 of Annex 1 to Appendix **30** provides criteria used for determining coordination requirements for frequency assignments of the Regions 1 and 3 Plan and List;

e) that power flux-density mask values in Section 1 of Annex 1 to Appendix **30** are based on the parameters adopted by WRC-2000, based on a minimum earth station receiving antenna diameter of 60 cm;

f) that the use of this frequency band by the BSS is subject to the coordination procedure of Article 4 of Appendix **30**,

noting

a) that the ITU Radiocommunication Sector has carried out a significant amount of studies in preparation for conferences on BSS planning, and has developed a number of Reports and Recommendations;

b) that, within the orbital arc of the geostationary-satellite orbit (GSO) between 37.2° W and 10° E, prior to this conference there were limitations on the use of some orbital positions for any proposed new or modified assignment in the Regions 1 and 3 List of additional uses in the frequency band 11.7-12.2 GHz;

c) that some networks with an earth station receiving antenna diameter smaller than 60 cm were successfully implemented within the orbital arc mentioned in *noting b)*, in view of protection due to the presence of limitations on the use of orbital positions in this orbital arc;

d) that, with the deletion of orbital position limitations, the protection of satellite assignments mentioned in *noting c)* shall be ensured;

e) that the GSO between 37.2° W and 10° E is widely used by Region 1 BSS and Region 2 FSS networks;

f) that equitable access to and efficient use of the 12 GHz frequency range should be encouraged,

resolves

1 that this Resolution is applicable only to implemented[1] networks with an earth station receiving antenna diameter smaller than 60 cm (40 cm and 45 cm) as outlined in Annex 1 to this Resolution;

2 that frequency assignments associated with an earth station receiving antenna diameter of 40 cm or 45 cm in the networks mentioned in *resolves* 1 above are considered by the Radiocommunication Bureau (BR) as being affected by a proposed new or modified assignment in the List filed at the GSO orbital positions mentioned in Annex 1 to this Resolution, only if the following conditions specified in Annex 1 to Appendix **30** are met:

– the minimum orbital spacing between the wanted and interfering space stations, under worst-case station-keeping conditions, is less than 9°;

– the reference equivalent downlink protection margin corresponding to at least one of the test points of that wanted assignment, including the cumulative effect of any previous modification to the List or any previous agreement, falls more than 0.45 dB below 0 dB, or, if already negative, more than 0.45 dB below that reference equivalent protection margin value;

3 that, for cases when a proposed new assignment in the List is filed within the GSO orbital arc between 37.2° W and 10° E in orbital arc segments that differ from those in Annex 1 to this Resolution, appropriate provisions of Annex 1 to Appendix **30** to determine the need for coordination continue to be applied with respect to relevant frequency assignments of the satellite networks mentioned in *resolves* 1.

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[1] For the avoidance of doubt, the "implemented" networks referred to are related to Regions 1 and 3 BSS networks in the orbital arc 37.2° W and 10° E:

– for which complete Appendix **4** information had been received by BR under § 4.1.3 of Appendix **30 (Rev.WRC-15)** prior to 28 November 2015, and

– for which complete Appendix **4** information had been received by BR under § 4.1.12 of Appendix **30 (Rev.WRC-15)** prior to 23 November 2019, and

– for which the complete due diligence information, in accordance with Annex 2 to Resolution **49 (Rev.WRC-15)**, had been received by BR prior to 23 November 2019, and

– for which complete Appendix **4** information had been received by BR under § 5.1.2 of Appendix **30 (Rev.WRC-15)** prior to 23 November 2019, and

– brought into use, and for which the date of bringing into use has been confirmed to BR before 23 November 2019.

ANNEX 1 TO RESOLUTION 558 (WRC-19)

Satellite networks in the frequency band 11.7-12.2 GHz and orbital arc segments for which this Resolution is applicable

Satellite networks for which this Resolution applies					Orbital arc segments where the conditions specified in *resolves* 2 of this Resolution apply
Orbital position	**Earth station antenna diameter, cm**	**Satellite network**	**Date of receipt of Part A submission**	**Notice ID Part II**	
30.0° W	45	HISPASAT-1	08.02.2000	99500256	34.92° W ≤ θ < 33.5° W; 32.5° W < θ ≤ 31.78° W; 28.22° W ≤ θ < 26.0° W.
		HISPASAT-37A	19.11.2014	117560019	
4.8° E	40	SIRIUS-N-BSS	17.11.2014	118560003	0° < θ ≤ 2.93° E; 6.67° E ≤ θ < 9.0° E; 9° E < θ ≤ 10° E.

Where θ is the orbital position within the orbital segment defined in the table above.

RESOLUTION 559 (WRC-19)

Additional temporary regulatory measures following the deletion of part of Annex 7 to Appendix 30 (Rev.WRC-15) by WRC-19

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that some national assignments, especially those of developing countries in the Regions 1 and 3 Plan, have equivalent downlink protection margin (EPM) values in Appendix **30 (Rev.WRC-15)** equal to or below −10 dB;

b) that implementation of a national assignment in the Regions 1 and 3 Plan with an EPM equal to or below −10 dB would be difficult;

c) that any modification of orbital position and other parameters of a national assignment in the Appendix **30** Plan would require a corresponding modification of the orbital position and other parameters in the Appendix **30A** feeder-link Plan,

recognizing

a) that Article 44 of the ITU Constitution stipulates that: "In using frequency bands for radio services, Member States shall bear in mind that radio frequencies and any associated orbits, including the geostationary-satellite orbit, are limited natural resources and that they must be used rationally, efficiently and economically, in conformity with the provisions of the Radio Regulations, so that countries or groups of countries may have equitable access to those orbits and frequencies taking account the special needs of the developing countries and the geographical situation of particular countries";

b) that Resolution 71 (Rev. Dubai, 2018) of the ITU Plenipotentiary Conference includes the ITU strategic plan for 2020-2023, which contains, as one of the strategic objectives of the ITU Radiocommunication Sector: "Meet, in a rational, equitable, efficient, economical and timely way, the ITU membership's requirements for radio-frequency spectrum and satellite-orbit resources, while avoiding harmful interference",

resolves

1 that, as of 23 March 2020 and for a period until 21 May 2020, the special procedure outlined in the Attachment to this Resolution shall be applied in respect of submissions of Region 1 and 3 administrations under § 4.1.3 of Appendices **30** and **30A** in Regions 1 and 3 meeting the specified requirements in § 1 of the Attachment to this Resolution at an orbital position within orbital arcs for which the Annex 7 to Appendix **30 (Rev.WRC-15)** limitations were suppressed by this conference; and those submissions sent before 23 March 2020 shall be returned to the administration;

2 that submissions received by the Radiocommunication Bureau (BR) in accordance with *resolves* 1 shall be considered as received by BR on 21 May 2020;

3 that, as of 23 November 2019 and for a period until 21 May 2020, all submissions under § 4.1.3 of Appendices **30** and **30A** in Regions 1 and 3 not meeting the specified requirements in § 1 of the Attachment to this Resolution at an orbital position within orbital arcs for which the Annex 7 to Appendix **30 (Rev.WRC-15)** limitations were suppressed by this conference shall be considered as received by BR on 22 May 2020,

instructs the Director of the Radiocommunication Bureau

1 to identify the administrations that meet the conditions of § 1 of the Attachment to this Resolution and inform these administrations accordingly;

2 at the request of administrations identified in *instructs the Director of the Radiocommunication Bureau* 1 which have the intention to apply the procedure indicated in this Resolution, to assist and advise them in complying with the conditions described in the Attachment to this Resolution, including the identification of appropriate new orbital positions and frequency channels.

ATTACHMENT TO RESOLUTION 559 (WRC-19)

Additional temporary regulatory measures following the deletion of part of Annex 7 to Appendix 30 (Rev.WRC-15) by WRC-19

1 The special procedure described in this Attachment can only be applied once by an administration with:

a) no frequency assignments submitted on its own behalf and either included in the List or for which complete Appendix **4** information has been received by the Radiocommunication Bureau (BR) in accordance with the provisions of § 4.1.3 of Appendix **30**; and

b) an assignment in the Regions 1 and 3 Plan of Appendix **30** when the equivalent downlink protection margin (EPM) value corresponding to a test point of its national assignment in the Regions 1 and 3 Plan is equal to or below −10 dB for at least 50% of the total number of EPM values of the assignment in the Regions 1 and 3 Plan in Appendix **30**.

2 Administrations seeking to apply this special procedure shall submit their request to BR, with the information specified in § 4.1.3 of Appendices **30** and **30A**, which shall include, in particular:

a) in the cover letter to BR, the information that the administration requests the use of this special procedure together with the name of the Plan assignments for which the conditions defined in § 1 above are met;

b) a service area limited to the national territory as defined in the relevant BR software application;

c) a set of a maximum of 20 test points inside the national territory;

d) a minimal ellipse determined by the set of test points submitted in c) above using the relevant BR software application. An administration may request BR to create such a diagram;

e)[1] a maximum ten[2] consecutive odd or even channels with standard Appendix **30** assigned frequencies in the same polarization for a Region 1 administration or twelve consecutive odd or even channels with standard Appendix **30** assigned frequencies in the same polarization for a Region 3 administration with a bandwidth of 27 MHz;

f) a corresponding submission for the Appendix **30A** feeder-link Plan in compliance with the principles defined in items b), c), d) and e) above.

3 Upon receipt of the complete information from an administration sent under § 2 above, BR shall process the submissions in date order in accordance with Article 4 of Appendices **30** and **30A**.

4 The notifying administration shall request subsequent world radiocommunication conferences to consider the inclusion of these assignments in the Appendices **30** and **30A** Plans as a replacement of its national assignments appearing in the Plans, pursuant to § 4.1.27 of Article 4 of Appendices **30** and **30A**. Under this Resolution, footnotes 10 and 12 associated with § 4.1.27 of Article 4 of Appendices **30** and **30A**, respectively, are not applicable.

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[1] In case of a submission for the Appendix **30A** feeder-link Plan in the 14 GHz frequency band, the maximum of ten[2] channels for a Region 1 administration or twelve[2] channels for a Region 3 administration with a bandwidth of 27 MHz could be in different polarizations.

[2] This maximum number of channels shall not be greater than the number of channels contained in the assignment referred in § 1 of the Attachment to this Resolution.

RESOLUTION 608 (REV.WRC-19)

Use of the frequency band 1 215-1 300 MHz by systems of the radionavigation-satellite service (space-to-Earth)

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that WRC-2000 introduced a new allocation for the radionavigation-satellite service (RNSS) in the frequency band 1 260-1 300 MHz;

b) that the frequency bands 1 215-1 240 MHz and 1 240-1 260 MHz were already allocated to the RNSS;

c) that, in the frequency band 1 215-1 260 MHz, RNSS (space-to-Earth) systems have been successfully operating for more than 20 years without any reports of interference to the radars which operate in this frequency band;

d) the importance of the continuing need for protection for the radiodetermination systems operating in the frequency band 1 215-1 300 MHz,

noting

a) Recommendation ITU-R M.1902, on characteristics and protection criteria for receiving earth stations in the RNSS (space-to-Earth) operating in the frequency band 1 215-1 300 MHz;

b) Report ITU-R M.2284, on compatibility of RNSS (space-to-Earth) systems and radars operating in the frequency band 1 215-1 300 MHz,

noting further

that the provisions of No. **5.329** as adopted by WRC-03 will provide for operation of the RNSS (space-to-Earth) in the frequency band 1 215-1 300 MHz and will protect the radiolocation systems operating in that frequency band, in addition to the protection already provided to radionavigation service systems operating in the countries listed in No. **5.331**,

recognizing

a) that the ITU Radiocommunication Bureau (ITU-R) carried out studies related to the protection of the radiodetermination systems operating in the frequency band 1 215-1 300 MHz and that these studies should continue pursuant to relevant ITU-R Questions, such as Questions ITU-R 62/5 and ITU-R 217/4, so as to prepare, as appropriate, ITU-R Recommendations;

b) that, up to the end of WRC-2000, use of the RNSS in the frequency band 1 215-1 260 MHz was subject only to the constraint that no harmful interference was caused to the radionavigation service in Algeria, Germany, Austria, Bahrain, Belgium, Benin, Bosnia and Herzegovina, Burundi, Cameroon, China, Croatia, Denmark, United Arab Emirates, France, Greece, India, Iran (Islamic Republic of), Iraq, Kenya, Liechtenstein, Luxembourg, North Macedonia, Mali, Mauritania, Norway, Oman, Pakistan, Netherlands, Portugal, Qatar, Türkiye, Serbia and Montenegro*, Senegal, Slovenia, Somalia, Sudan**, Sri Lanka, Sweden and Switzerland, and, furthermore, that No. **5.43** was applied,

resolves

that no constraints in addition to those in place prior to WRC-2000 (see *recognizing b)*) shall be placed on the use of RNSS (space-to-Earth) frequency assignments in the frequency band 1 215-1 260 MHz brought into use until 2 June 2000,

instructs the Secretary-General

to communicate the contents of this Resolution to the International Civil Aviation Organization (ICAO) for such actions as it may consider appropriate, and to invite ICAO to participate actively in the study activity identified under *recognizing a)*.

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* *Note by the Secretariat:* Serbia and Montenegro became independent States in 2006.

** *Note by the Secretariat:* Sudan was partitioned into two independent States in 2011 (Sudan and South Sudan).

RESOLUTION 609 (REV.WRC-07)

Protection of aeronautical radionavigation service systems from the equivalent power flux-density produced by radionavigation-satellite service networks and systems in the 1 164-1 215 MHz frequency band

The World Radiocommunication Conference (Geneva, 2007),

considering

a) that the band 960-1 215 MHz is allocated on a primary basis to the aeronautical radionavigation service (ARNS) in all Regions;

b) that the band 1 164-1 215 MHz is also allocated on a primary basis to the radionavigation-satellite service (RNSS), subject to the condition in No. **5.328A** that operation of RNSS systems shall be in accordance with this Resolution;

c) that WRC-2000 provided for implementation of a provisional aggregate power flux-density (pfd) limit during the period between WRC-2000 and WRC-03, and requested ITU-R studies on the need for an aggregate pfd limit, and revision, if necessary, of the provisional pfd limit given in No. **5.328A**;

d) that WRC-03 determined that protection of the ARNS from harmful interference can be achieved if the value of the equivalent pfd (epfd) produced by all the space stations of all RNSS (space-to-Earth) systems in the 1 164-1 215 MHz band does not exceed the level of −121.5 dB(W/m^2) in any 1 MHz band;

e) that only a limited number of RNSS systems are expected to be deployed in the 1 164-1 215 MHz band, and only a few of these systems at most would have overlapping frequencies;

f) that ARNS systems can be protected without placing undue constraints on the development and operation of RNSS systems in this band;

g) that to achieve the objectives in *considering f)*, administrations operating or planning to operate RNSS systems will need to agree cooperatively through consultation meetings to equitably share the aggregate epfd in a manner to achieve the level of protection for ARNS systems that is stated in *considering d)*;

h) that it may be appropriate for representatives of administrations operating or planning to operate ARNS systems to be involved in determinations made pursuant to *considering g)*;

i) that WRC-03 decided to apply the coordination provisions of Nos. **9.12**, **9.12A** and **9.13** to RNSS systems and networks for which complete coordination or notification information, as appropriate, is received by the Bureau after 1 January 2005,

noting

a) that WRC-2000 invited ITU-R to conduct the appropriate technical, operational and regulatory studies on the overall compatibility between the RNSS and the ARNS in the band 960-1 215 MHz;

b) that WRC-2000 resolved to recommend that WRC-03 review the results of the studies,

recognizing

that under No. **7.5**, interested administrations have the ability, at any time, to request the assistance of the Bureau with respect to Articles **9** and **11** and associated procedures,

resolves

1 that in order to protect ARNS systems, administrations shall ensure, pursuant to this Resolution, that the epfd level produced by all space stations of all RNSS systems does not exceed the level −121.5 dB(W/m^2) in any 1 MHz band;

2 that administrations operating or planning to operate in the 1 164-1 215 MHz frequency band RNSS systems or networks shall, in collaboration, take all necessary steps, including, if necessary, by means of appropriate modifications to their systems or networks, to ensure that the aggregate interference into ARNS systems caused by such RNSS systems or networks operating co-frequency in these frequency bands is shared equitably among the systems identified in *resolves* 3 and does not exceed the level of the aggregate protection criterion given in *resolves* 1 above;

3 that administrations, in carrying out their obligations under *resolves* 1 and 2 above, shall take into account only those RNSS systems with frequency assignments in the band 1 164-1 215 MHz that have met the criteria listed in the Annex to this Resolution through appropriate information provided to the consultation meetings referred to in *considering g)*;

4 that administrations, in developing agreements to carry out their obligations under *resolves* 1 and 2 above, shall establish mechanisms to ensure that all potential RNSS system operators and administrations are given full visibility of the process;

5 that in order to allow multiple RNSS systems to operate in the frequency band 1 164-1 215 MHz, no single RNSS system shall be permitted to use up the entire interference allowance specified in *resolves* 1 above in any 1 MHz of the 1 164-1 215 MHz band (see Recommendation **608 (Rev.WRC-07)**);

6 that to achieve the objectives in *resolves* 1 and 2 above, administrations operating or planning to operate RNSS systems will need to agree cooperatively through consultation meetings to achieve the level of protection for ARNS systems that is stated in *resolves* 1;

7 that administrations participating in this process of epfd calculation should hold consultation meetings on a regular basis (e.g. yearly);

8 the administrations participating in the consultation meeting shall designate one administration that shall communicate to the Bureau the results of any aggregate sharing determinations made in application of *resolves* 2 above, without regard to whether such determinations result in any modifications to the published characteristics of their respective systems or networks (see Recommendation **608 (Rev.WRC-07)**);

9 that administrations operating or planning to operate ARNS systems in the 1 164-1 215 MHz band should participate, as appropriate, in discussions and determinations relating to the *resolves* above;

10 that the methodology and the reference worst-case ARNS system antenna contained in Recommendation ITU-R M.1642-2 shall be used by administrations for calculating the aggregate epfd produced by all the space stations within all RNSS systems in the band 1 164-1 215 MHz,

instructs the Radiocommunication Bureau

1 to participate in consultation meetings mentioned under *resolves* 6 and to observe carefully results of the epfd calculation mentioned in *resolves* 1;

2 to determine whether the pfd level in *recommends* 1 of Recommendation **608 (Rev.WRC-07)** is exceeded by any subject space station, and to report the findings of this determination to the participants in the consultation meeting;

3 to publish in the International Frequency Information Circular (BR IFIC), the information referred to in *resolves* 8 and *instructs the Radiocommunication Bureau* 2,

invites the Radiocommunication Bureau

to examine the possibility, if needed, of developing software that can be used to calculate the epfd level mentioned under *resolves* 1,

invites administrations

1 to deal with RNSS intersystem matters, as required, as early as possible;

2 to provide the Bureau and all participants in the consultation meeting with access to appropriate software used to calculate the epfd level mentioned under *resolves* 1.

ANNEX TO RESOLUTION 609 (REV.WRC-07)

Criteria for application of Resolution 609 (Rev.WRC-07)

1 Submission of appropriate Advance Publication information.

2 Entry into satellite manufacturing or procurement agreement, and entry into satellite launch agreement.

The RNSS system or network operator should possess:

i) clear evidence of a binding agreement for the manufacture or procurement of its satellites; and

ii) clear evidence of a binding agreement to launch its satellites.

The manufacturing or procurement agreement should identify the contract milestones leading to the completion of manufacture or procurement of satellites required for the service provision, and the launch agreement should identify the launch date, launch site and launch service provider. The notifying administration is responsible for authenticating the evidence of agreement.

The information required under this criterion may be submitted in the form of a written commitment by the responsible administration.

3 As an alternative to satellite manufacturing or procurement and launch agreements, clear evidence of guaranteed funding arrangements for the implementation of the project would be accepted. The notifying administration is responsible for authenticating the evidence of these arrangements and for providing such evidence to other interested administrations in furtherance of its obligations under this Resolution.

RESOLUTION 610 (REV.WRC-19)

Coordination and bilateral resolution of technical compatibility issues for radionavigation-satellite service networks and systems in the frequency bands 1 164-1 300 MHz, 1 559-1 610 MHz and 5 010-5 030 MHz

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that WRC-2000 decided to allocate the frequency bands 1 164-1 215 MHz, 1 260-1 300 MHz and 5 010-5 030 MHz to the radionavigation-satellite service (RNSS) (space-to-Earth) (space-to-space) in addition to the frequency bands 1 215-1 260 MHz and 1 559-1 610 MHz that have already been allocated to the RNSS;

b) that this conference established conditions for the protection of the aeronautical radionavigation service from RNSS systems in the frequency band1 164-1 215 MHz, for the protection of radiodetermination services from RNSS systems in the frequency band 1 215-1 300 MHz, and for the protection of the radio astronomy service in the frequency band 4 990-5 000 MHz from RNSS systems in the frequency band 5 010-5 030 MHz;

c) that, to date, RNSS systems have been able to resolve intersystem technical compatibility issues on a bilateral basis under Section I of Article **9**, without the need for imposition of the coordination procedures of Section II of Article **9**, however, in recent years, there has been an increase in the number of RNSS systems and networks filed with the Radiocommunication Bureau (BR);

d) that this conference has decided to apply, in the frequency bands mentioned in *considering a)*, the coordination provisions of Nos. **9.12**, **9.12A** and **9.13** to RNSS systems and networks for which complete coordination or notification information, as appropriate, is received by BR after 1 January 2005, and the provisions of No. **9.7** already apply to geostationary-satellite networks in the RNSS;

e) that it is necessary to have a basis for administrations with RNSS systems that are not subject to Nos. **9.12**, **9.12A** and **9.13** to engage in bilateral coordinations to resolve intersystem technical compatibility issues within the RNSS;

f) that it is desirable, in order to reduce burdens on administrations operating or planning RNSS systems or networks, to conduct bilateral coordinations between RNSS systems and networks that are either in operation or that are actually in the process of being implemented,

resolves

1 that, for administrations planning to operate RNSS systems subject to coordination under Nos. **9.7**, **9.12**, **9.12A** and/or **9.13** in the frequency bands mentioned in *considering a)*, if an administration with which coordination is requested responds to the request under No. **9.52**, the requesting administration shall, during the process of coordination and upon request by the responding administration, inform the responding administration (with a copy to BR) whether it has met the criteria listed in the Annex to this Resolution with respect to the subject network or system;

2 that administrations responding under No. **9.52** to a request for coordination under Nos. **9.7**, **9.12**, **9.12A** and/or **9.13** in the frequency bands mentioned in *considering a)*, shall, during the process of coordination mentioned in *resolves* 1 and upon request by the requesting administration, inform the requesting administration (with a copy to BR) whether it has met the criteria listed in the Annex to this Resolution with respect to the subject network or system;

3 that administrations operating or planning to operate RNSS systems in the frequency bands mentioned in *considering a)*, which systems are not subject to coordination under Section II of Article **9**, shall take all practicable steps to resolve issues of intersystem compatibility on a bilateral basis;

4 that, in undertaking the obligations under *resolves* 3 above, administrations operating or planning to operate RNSS systems or networks should first address intersystem compatibility between RNSS systems or networks that are actually in operation or are in the process of being implemented;

5 that, for the application of *resolves* 4 above, an RNSS system or network that has satisfied the criteria listed in the Annex to this Resolution with respect to the subject network or system would be considered to be actually in the process of being implemented;

6 that when notifying BR under No. **11.47** that a frequency assignment to station(s) in the RNSS in the frequency bands mentioned in *considering a)* has been brought into use, the notifying administration, if it has not already done so, shall inform BR whether it has met the criteria listed in the Annex to this Resolution;

7 that implementation of this Resolution shall be conducted in such a way as to promote the principle of equality and fairness in ensuring access for RNSS operators and planned RNSS systems in the above-referenced frequency bands,

instructs the Radiocommunication Bureau

to provide, on request, assistance to administrations operating or planning to operate RNSS systems in the frequency bands mentioned in *considering a)* above, which systems are not subject to coordination under Section II of Article **9**, in securing bilateral agreements with other RNSS systems as early as possible.

ANNEX TO RESOLUTION 610 (REV.WRC-19)

Criteria for the application of Resolution 610 (Rev.WRC-19)

1 Submission of appropriate Coordination Request information.

2 Entry into satellite manufacturing or procurement agreement, and entry into satellite launch agreement.

The RNSS system or network operator should possess:

i) clear evidence of a binding agreement for the manufacture or procurement of its satellites; and

ii) clear evidence of a binding agreement to launch its satellites.

The manufacturing or procurement agreement should identify the contract milestones leading to the completion of manufacture or procurement of satellites required for the service provision, and the launch agreement should identify the launch date, launch site and launch service provider. The notifying administration is responsible for authenticating the evidence of agreement.

The information required under this criterion may be submitted in the form of a written commitment by the responsible administration.

3 As an alternative to satellite manufacturing or procurement and launch agreements, clear evidence of guaranteed funding arrangements for the implementation of the project would be accepted. The notifying administration is responsible for authenticating the evidence of these arrangements.

RESOLUTION 612 (REV.WRC-12)

Use of the radiolocation service between 3 and 50 MHz to support oceanographic radar operations

The World Radiocommunication Conference (Geneva, 2012),

considering

a) that there is increasing interest, on a global basis, in the operation of oceanographic radars for measurement of coastal sea surface conditions to support environmental, oceanographic, meteorological, climatological, maritime and disaster mitigation operations;

b) that oceanographic radars are also known in parts of the world as HF ocean radars, HF wave height sensing radars or HF surface wave radars;

c) that oceanographic radars operate through the use of ground-waves intended to propagate over the sea;

d) that oceanographic radar technology has applications in global maritime domain awareness by allowing the long-range sensing of surface vessels, which provides a benefit to the global safety and security of shipping and ports;

e) that operation of oceanographic radars provides benefits to society through environmental protection, disaster preparedness, public health protection, improved meteorological operations, increased coastal and maritime safety and enhancement of national economies;

f) that oceanographic radars have been operated on an experimental basis around the world, providing an understanding of spectrum needs and spectrum sharing considerations, as well as an understanding of the benefits these systems provide;

g) that performance and data requirements dictate the regions of spectrum that can be used by oceanographic radar systems for ocean observations;

h) that below approximately 30 MHz, unintended skywave propagation from oceanographic radar may occur when appropriate propagation conditions exist,

recognizing

a) that oceanographic radars have been operated under provision No. **4.4** since the 1970s by several administrations;

b) that developers of the systems in *recognizing a)* have implemented techniques to make the most efficient use of the spectrum and mitigate interference to other radio services;

c) that protection of stations of existing services from interference caused by oceanographic radars could be ensured if the interfering signal at the receiving antenna location, assuming rural and quiet rural man-made and natural noise characteristics as defined in Recommendation ITU-R P.372-10, does not result in an *I*/*N* ratio of more than −6 dB, and if this value was used to calculate the minimum separation distances for coordination between an oceanographic radar and a potentially affected country;

d) that for the purpose of protecting existing services from harmful interference, the impact of oceanographic radars via ground-wave propagation can be checked by Report ITU-R M.2234, based on Recommendation ITU-R P.368-9,

resolves

1 that, when oceanographic radars are brought into use after 17 February 2012 and notified to the Bureau, the notification shall be in accordance with No. **11.2** of the Radio Regulations and shall contain the station identification (call sign);

2 that the peak e.i.r.p. of an oceanographic radar shall not exceed 25 dBW;

3 that each oceanographic radar station shall transmit a station identification (call sign) on the assigned frequency, in international Morse code at manual speed, at the end of each data acquisition cycle, but at an interval of no more than 20 minutes;

4 that oceanographic radars should, where applicable, use techniques that allow multiples of such radars to operate on the same frequency, reducing to a minimum the spectral occupancy of a regional or global deployment of radars;

5 that oceanographic radars should use directional antennas, where applicable and as required, to facilitate sharing, thereby reducing the e.i.r.p. in the direction of the transmit antenna backlobe;

6 that the separation distances between an oceanographic radar and the border of other countries shall be greater than the distances specified in the following table, unless prior explicit agreements from affected administrations are obtained:

Frequency (MHz)	**Land path (km)**		**Sea or mixed path (km)**	
	Rural	**Quiet rural**	**Rural**	**Quiet rural**
5 (± 1 MHz)	120	170	790	920
9 (± 1 MHz)	100	130	590	670
13 (± 1 MHz)	100	110	480	520
16 (± 1 MHz)	80	100	390	450
25 (± 3 MHz)	80	100	280	320
42 (± 3 MHz)	80	100	200	230

RESOLUTION 642

Relating to the bringing into use of earth stations in the amateur-satellite service

The World Administrative Radio Conference (Geneva, 1979),

recognizing

that the procedures of Articles **9** and **11** are applicable to the amateur-satellite service,

recognizing further

a) that the characteristics of earth stations in the amateur-satellite service vary widely;

b) that space stations in the amateur-satellite service are intended for multiple access by amateur earth stations in all countries;

c) that coordination among stations in the amateur and amateur-satellite services is accomplished without the need for formal procedures;

d) that the burden of terminating any harmful interference is placed upon the administration authorizing a space station in the amateur-satellite service pursuant to the provisions of No. **25.11**,

notes

that certain information specified in Appendix **4** cannot reasonably be provided for earth stations in the amateur-satellite service,

resolves

1 that when an administration (or one acting on behalf of a group of named administrations) intends to establish a satellite system in the amateur-satellite service and wishes to publish information with respect to earth stations in that system it may:

1.1 communicate to the Radiocommunication Bureau all or part of the information listed in Appendix **4**; the Bureau shall publish such information in a Special Section of its BR IFIC requesting comments to be communicated within a period of four months after the date of publication;

1.2 notify under Nos. **11.2** to **11.8** all or part of the information listed in Appendix **4**; the Bureau shall record it in a special list;

2 that this information shall include at least the characteristics of a typical amateur earth station in the amateur-satellite service having the facility to transmit signals to the space station to initiate, modify, or terminate the functions of the space station.

RESOLUTION 646 (REV.WRC-19)

Public protection and disaster relief

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that the term "public protection radiocommunication" refers to radiocommunications used by agencies and organizations responsible for the maintenance of law and order, protection of life and property and emergency situations;

b) that the term "disaster relief radiocommunication" refers to radiocommunications used by agencies and organizations dealing with a serious disruption of the functioning of society, posing a significant widespread threat to human life, health, property or the environment, whether caused by accident, natural phenomena or human activity, and whether developing suddenly or as a result of complex, long-term processes;

c) the growing telecommunication and radiocommunication needs of public protection agencies and organizations, including those dealing with emergency situations and disaster relief, that are vital to the maintenance of law and order, protection of life and property, disaster relief and emergency response;

d) that many administrations wish to promote interoperability and interworking between systems used for public protection and disaster relief (PPDR), both nationally and for cross-border operations in emergency situations and for disaster relief;

e) that existing systems for PPDR applications mainly support narrowband/wideband voice and data applications;

f) that, although narrowband and wideband systems will continue to be used to meet PPDR requirements, there is a growing need for broadband applications to support improved data and multimedia capabilities, which require higher data rates and higher capacity, and appropriate spectrum may need to be made available on a national basis to meet these growing needs;

g) that new technologies for broadband PPDR applications are being developed in various standards organizations, e.g. International Mobile Telecommunications (IMT) technologies that support higher data rates and higher capacity for PPDR applications, and these technologies are also being used to meet the needs of PPDR agencies and organizations;

h) that continuing development of new technologies and systems, such as IMT and intelligent transportation systems (ITS), may be able to further support or supplement advanced PPDR applications;

i) that some commercial terrestrial and satellite systems are complementing the dedicated systems in support of PPDR, and that the use of commercial solutions will be in response to technology development and market demands;

j) that administrations may have different operational needs and spectrum requirements for PPDR applications depending on the circumstances;

k) that an approach based on global and/or regional frequency ranges[1] may enable administrations to benefit from harmonization while continuing to meet national planning requirements,

recognizing

a) the benefits of spectrum harmonization such as:

– increased potential for interoperability;

– clear guidance for standardization;

– increased volume of equipment resulting in economies of scale, more cost-efficient equipment and expanded equipment availability;

– improved spectrum management and planning;

– more effective international aid during disasters and major events; and

– enhanced cross-border coordination and circulation of equipment;

b) that the organizational distinction between public protection activities and disaster relief activities are matters for administrations to determine at the national level;

c) that national spectrum planning for PPDR needs to have regard to cooperation and bilateral consultation with other concerned administrations, which should be facilitated by greater levels of spectrum harmonization;

d) that the Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations (Tampere, 1998), an international treaty deposited with the United Nations Secretary-General, and related United Nations General Assembly resolutions and reports are also relevant in this regard;

e) that Resolution 36 (Rev. Guadalajara, 2010) of the Plenipotentiary Conference urges Member States Parties to the Tampere Convention to take all practical steps for the application of the Tampere Convention and to work closely with the operational coordinator as provided for therein;

f) that Recommendation ITU-R M.1637 offers guidance to facilitate the global cross-border circulation of radiocommunication equipment in emergency and disaster relief situations;

g) that Recommendation ITU R M.2009 identifies radio interface standards applicable to PPDR operations;

h) that Report ITU-R M.2291 provides details of the capabilities of IMT technologies to meet the requirements of applications supporting broadband PPDR operations;

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[1] In the context of this Resolution, the term "frequency range" means a range of frequencies over which radio equipment is envisaged to be capable of operating but limited to specific frequency band(s) according to national conditions and requirements.

i) that Report ITU-R M.2377 provides details of systems and applications supporting PPDR operations in narrowband, wideband and broadband use;

j) that PPDR agencies and organizations have an initial set of requirements, including but not limited to interoperability, secure and reliable communications, sufficient capacity to respond to emergencies, priority access in the use of non-dedicated systems, fast response times, ability to handle multiple group calls and the ability to cover large areas, as described in Reports ITU-R M.2377 and ITU-R M.2291;

k) that Report ITU-R BT.2299 provides a compilation of supporting evidence to the effect that terrestrial broadcasting plays an important role in disseminating information to the public in times of emergencies;

l) that Recommendation ITU-R M.2015 contains regionally harmonized PPDR frequency arrangements, as well as frequency arrangements of individual administrations[2];

m) that in times of disasters, if most terrestrial-based networks are destroyed or impaired, amateur, satellite and other non-ground-based networks may be available to provide communication services to assist in PPDR efforts;

n) that the amount of spectrum needed for public protection on a daily basis differs significantly between countries, and that certain amounts of spectrum are already in use in various countries for PPDR applications;

o) that, in response to a disaster or emergency, access to additional spectrum on a temporary basis may be required for PPDR operations;

p) that not all frequencies within an identified common frequency range will be available for PPDR use within each country;

q) that the identification of common frequency ranges within which equipment could operate may ease interoperability and/or interworking, with mutual cooperation and consultation, especially in national, regional and cross-border emergency situations and disaster relief operations;

r) that when a disaster occurs, the PPDR agencies and organizations are usually the first responders on the scene using their day-to-day communication systems and, additionally, other agencies and organizations may also become involved in disaster relief operations;

s) that some countries in Region 1 have identified certain parts of the frequency range 694-791 MHz for broadband PPDR deployment;

t) that some countries in Region 1 have identified certain parts of the frequency range 790-862 MHz for broadband PPDR deployment;

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[2] For example, as of November 2015 some countries in Region 3 had adopted parts of the frequency ranges 138-174 MHz, 351-370 MHz and 380-400 MHz for narrowband PPDR applications and the frequency ranges 174-205 MHz and 1 447-1 467 MHz for broadband PPDR applications.

u) the provisions contained in Nos. **5.266** and **5.267**, and Resolution **205 (Rev.WRC-19)**;

v) that the meteorological aids and meteorological-satellite services operate on a globally harmonized basis in the frequency band 400.15-406 MHz;

w) that the radio astronomy service operates on a primary basis in the frequency band 406.1-410 MHz and there may be PPDR operations adjacent to that frequency band,

noting

a) that many administrations will continue to use different frequency bands below 1 GHz for narrowband systems and applications supporting PPDR and may decide to use the same range for future PPDR systems;

b) that some administrations also use certain frequency bands above 1 GHz for broadband PPDR applications;

c) that applications requiring large coverage areas and providing good signal availability would generally be accommodated in lower frequency bands;

d) that many administrations have made significant investments in PPDR systems;

e) that flexibility allows disaster relief agencies and organizations to use current and future radiocommunications, so as to facilitate their humanitarian operations;

f) that disasters and emergency events require response not only from PPDR agencies and organizations but also from humanitarian agencies and organizations;

g) that broadband PPDR can be realized and deployed in the frequency bands identified for IMT;

h) the benefits of cooperation between countries for the provision of effective and appropriate humanitarian assistance in case of disasters, particularly in view of the special operational requirements of such activities involving multinational response;

i) the needs of countries, particularly the developing countries[3], for cost-efficient communication equipment;

j) that the use of technologies based on Internet protocols is well established,

emphasizing

a) that the frequency ranges that are covered by the *resolves* part of this Resolution are allocated to a variety of services in accordance with the relevant provisions of the Radio Regulations and are currently used intensively by the fixed, mobile, mobile-satellite and broadcasting services;

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[3] Taking into account, for example, the latest version of the ITU Telecommunication Development Sector (ITU-D) Handbook on disaster relief.

b) that PPDR applications in the ranges listed in *resolves* 2 and 3 are intended to operate in the mobile service allocated on a primary basis according to the provisions of the Radio Regulations;

c) that flexibility must be afforded to administrations to determine:

– how much spectrum to make available at a national level for PPDR from the ranges in the *resolve*s part of this Resolution in order to meet their particular national requirements;

– the need and timing of availability as well as the conditions of usage of the frequency bands used for PPDR, including those covered in this Resolution and Recommendation ITU-R M.2015, in order to meet specific regional or national situations[4];

d) that the provisions of Nos. **1.59** and **4.10** of the Radio Regulations do not apply to PPDR;

e) that administrations can adopt their frequency arrangements for the terrestrial component of IMT from those detailed in Recommendation ITU-R M.1036,

resolves

1 to encourage administrations to use harmonized frequency ranges for PPDR to the maximum extent possible, taking into account the national and regional requirements and also having regard to any needed consultation and cooperation with other concerned countries;

2 to encourage administrations to consider parts of the frequency range 694-894 MHz, as described in the most recent version of Recommendation ITU-R M.2015, when undertaking their national planning for their PPDR applications, in particular broadband, in order to achieve harmonization, taking into account *emphasizing c)* and *e)* above;

3 to further encourage administrations to also consider parts of the following regionally harmonized frequency ranges for their PPDR applications:

– in Region 1: 380-470 MHz;

– in Region 3: 406.1-430 MHz, 440-470 MHz and 4 940-4 990 MHz;

4 that PPDR frequency arrangements within the frequency ranges specified in *resolves* 2 and 3, as well as countries' frequency arrangements for PPDR, should be included in Recommendation ITU-R M.2015;

5 that the use of the frequency ranges for PPDR in *resolves* 2 and 3 above, as well as the use of the countries' frequency arrangements for PPDR, as described in the most recent version of Recommendation ITU-R M.2015, must not cause unacceptable interference, nor constrain the use of these frequency ranges by applications of the services to which they are allocated in the Radio Regulations;

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[4] For example, some countries in Region 1 have identified certain parts of the frequency range 694-862 MHz for broadband PPDR applications.

6 to encourage administrations, in emergency and disaster relief situations, to satisfy temporary needs for frequencies in addition to what may be normally provided for in agreements with the concerned administrations;

7 to encourage administrations to facilitate cross-border circulation of radiocommunication equipment intended for use in emergency and disaster relief situations through mutual cooperation and consultation without hindering national legislation;

8 that administrations encourage PPDR agencies and organizations to utilize relevant ITU Radiocommunication Sector (ITU-R) Recommendations in planning spectrum use and implementing technology and systems supporting PPDR;

9 to encourage administrations to continue to work closely with their PPDR community to further refine the operational requirements for PPDR activities,

invites the ITU Radiocommunication Sector

1 to continue its technical studies and to make recommendations concerning technical and operational implementation, as necessary, to meet the needs of PPDR radiocommunication applications, taking into account the capabilities, evolution and any resulting transition requirements of the existing systems, particularly those of many developing countries, for national and international operations;

2 to review and revise Recommendation ITU-R M.2015 and other relevant ITU-R Recommendations and Reports, as appropriate.

RESOLUTION 647 (REV.WRC-19)

Radiocommunication aspects, including spectrum-management guidelines, for early warning, disaster prediction, detection, mitigation and relief operations relating to emergencies and disasters

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that natural disasters have underscored the importance of utilizing effective measures to mitigate their effects, including prediction, detection and alerting through coordinated and effective use of the radio-frequency spectrum;

b) ITU's comprehensive role in emergency communications, not only in the field of radiocommunications, but also in the area of technical standards to facilitate interconnection and interoperability of networks for monitoring and management at the onset of and during emergency and disaster situations, and as an integral part of the telecommunication development agenda through the Buenos Aires Action Plan;

c) that administrations have been urged to take all practical steps to facilitate the rapid deployment and effective use of telecommunication resources for early warning, emergency, disaster mitigation and relief operations by reducing and, where possible, removing regulatory barriers and strengthening global, regional and transborder cooperation between States;

d) that effective use of telecommunications/information and communication technologies (ICTs) at the onset of and during critical emergencies is essential for disaster forecasting and prediction, timely detection, early warning, mitigation, management, relief strategies and operations, and plays a vital role in the safety and security of relief workers in the field;

e) the particular needs of developing countries and the special requirements of the inhabitants of high-risk areas exposed to disasters, as well as those living in remote areas;

f) the work carried out by the ITU Telecommunication Standardization Sector in standardizing the common alerting protocol (CAP), through the approval of the relevant CAP Recommendation,

recognizing

a) that the Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations (Tampere, 1998)[1], an international treaty deposited with the United Nations Secretary-General, calls on the States Parties, when possible, and in conformity with their national law, to develop and implement measures to facilitate the availability of telecommunication resources for such operations;

[1] However, a number of countries have not ratified the Tampere Convention.

b) Article 40 of the ITU Constitution, on priority of telecommunications concerning safety of life;

c) Article 46 of the Constitution, on distress calls and messages;

d) Resolution 34 (Rev. Buenos Aires, 2017) of the World Telecommunication Development Conference, on the role of telecommunications/ICTs in disaster preparedness, early warning, rescue, mitigation, relief and response, as well as ITU Telecommunication Development Sector Question 5/2, on utilizing telecommunications/ICTs for disaster risk reduction and management;

e) Resolution 36 (Rev. Guadalajara, 2010) of the Plenipotentiary Conference, on telecommunications/ICTs in the service of humanitarian assistance;

f) Resolution 136 (Rev. Dubai, 2018) of the Plenipotentiary Conference, on the use of telecommunications/ICTs for monitoring and management in emergency and disaster situations for early warning, prevention, mitigation and relief;

g) Resolution ITU-R 55, on the ITU Radiocommunication Sector (ITU-R) studies of disaster prediction, detection, mitigation and relief;

h) that Resolution **646 (Rev.WRC-19)** addresses the broader category of public protection and disaster relief (PPDR), as well as the harmonization of frequency bands/ranges for PPDR solutions[2];

i) that some administrations may have different operational needs and spectrum requirements for emergency and disaster-relief applications, depending on their circumstances;

j) that the immediate availability of spectrum to support emergency radiocommunication equipment and administration contact information on disaster-relief issues are important for successful telecommunications in the very early stages of humanitarian assistance intervention for disaster relief,

aware

of the progress made in regional organizations around the world, and in particular in regional telecommunication organizations, on matters related to emergency communications planning and response,

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[2] Resolution **646** (**Rev.WRC-19**) includes *considering* paragraphs to the effect that the term "public protection radiocommunication" refers to radiocommunications used by agencies and organizations responsible for the maintenance of law and order, protection of life and property and emergency situations, and that the term "disaster relief radiocommunication" refers to radiocommunications used by agencies and organizations dealing with a serious disruption of the functioning of society, posing a significant widespread threat to human life, health, property or the environment, whether caused by accident, natural phenomena or human activity, and whether developing suddenly or as a result of complex, long-term processes.

recognizing further

that ITU-R has developed a Handbook on Emergency and Disaster Relief as well as various Reports and Recommendations relating to emergency and disaster-relief operations and radiocommunication resources[3],

noting

a) the close relationship between this Resolution and Resolution **646 (Rev.WRC-19)**, on PPDR;

b) that, when a disaster occurs, the disaster-relief agencies are usually the first on the scene using their day-to-day communication systems, but that in most cases other agencies and organizations may also be involved in disaster-relief operations;

c) that there is a critical requirement to perform immediate spectrum-management actions, including frequency coordination, sharing and spectrum reuse, within a disaster area;

d) that national spectrum planning for emergency and disaster relief should take into account the need for cooperation and bilateral consultation with other concerned administrations, which can be facilitated by spectrum harmonization, as well as agreed spectrum-management guidelines pertaining to disaster relief and emergency planning;

e) that, in times of disasters, radiocommunication facilities may be destroyed or impaired and the national regulatory authorities may not be able to provide the necessary spectrum-management services for the deployment of radio systems for relief operations;

f) that availability of information, such as the identification of administration disaster-relief contact information, frequency availability within individual administrations within which equipment could operate and any relevant instructions or procedures, may ease interoperability and/or interworking, with mutual cooperation and consultation, especially in national, regional and cross-border emergency situations and disaster-relief activities,

noting further

a) that flexibility must be afforded to disaster-relief agencies and organizations to use current and future radiocommunications, so as to facilitate their humanitarian operations;

b) that it is in the interest of administrations and disaster-relief agencies and organizations to have access to updated information on national spectrum planning for emergency and disaster relief,

taking into account

that the Radiocommunication Bureau (BR) has established and maintains a database[3] containing administration contact information, available frequencies/frequency bands for use by terrestrial and space services, and any additional information or instructions relevant to emergency situations within these administrations,

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[3] http://itu.int/go/ITU-R/emergency

resolves

1 that ITU-R continue through its study groups to study those aspects of radiocommunications/ICTs that are relevant to early warning, disaster prediction, detection, mitigation and relief operations, taking into account Resolution ITU-R 55;

2 to encourage administrations to communicate to BR the relevant up-to-date administration contact information and, where available, the frequencies or frequency bands for use in emergency and disaster-relief operations;

3 to reiterate to administrations the importance of having up-to-date information referred to in *resolves* 2 above available for use in the very early stages of humanitarian assistance intervention for disaster relief,

instructs the Director of the Radiocommunication Bureau

1 to support administrations in their work towards the implementation of Resolution 136 (Rev. Dubai, 2018), as well as the Tampere Convention;

2 to coordinate activities between this Resolution and Resolution **646 (Rev.WRC-19)** in order to minimize possible overlap;

3 to continue to assist Member States with their emergency communication preparedness activities by maintaining the database[3] of information from administrations for use in emergency situations, which includes contact information and optionally includes available frequencies;

4 to facilitate online access to the database by administrations, national regulatory authorities, disaster-relief agencies and organizations, in particular the United Nations Emergency Relief Coordinator, in accordance with the operating procedures developed for disaster situations;

5 to collaborate with the United Nations Office for the Coordination of Humanitarian Affairs and other organizations, as appropriate, in the development and dissemination of standard operating procedures and relevant spectrum-management practices for use in the event of a disaster situation;

6 to collaborate, as appropriate, with the United Nations Working Group on Emergency Telecommunications (WGET) and the radio frequency and radio standards group under the UN Emergency Telecommunications Cluster (ETC) for which the World Food Programme (WFP) is the cluster lead;

7 to take into consideration, and collaborate in, as appropriate, all relevant activities in ITU's other two Sectors and General Secretariat;

8 to report on progress on this Resolution to subsequent world radiocommunication conferences,

invites the ITU Radiocommunication Sector

to continue conducting studies as necessary, in accordance with *resolves* 1 and in support of developing and maintaining appropriate spectrum-management guidelines applicable in emergency and disaster-relief operations,

invites the Director of the Telecommunication Standardization Bureau and the Director of the Telecommunication Development Bureau

to collaborate closely with the Director of the Radiocommunication Bureau (BR) to ensure that a consistent and coherent approach is adopted in the development of strategies in response to emergency and disaster situations,

urges administrations

to participate in the emergency communication preparedness activities described above and to provide to BR their information and, in particular, up-to-date contact information related to emergency and disaster-relief radiocommunications for inclusion in the database, taking into account Resolution ITU-R 55.

RESOLUTION 655 (REV.WRC-23)

Definition of time scale and dissemination of time signals via radiocommunication systems

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the ITU Radiocommunication Sector (ITU-R) is responsible for setting standards for the content and structure of time signals to be disseminated via radiocommunication systems, including the standard frequency and time signal service (SFTS) and the standard frequency and time signal-satellite service (SFTSS);

b) that the International Bureau of Weights and Measures (BIPM) is responsible for establishing and maintaining the second of the International System of Units (SI) and the reference time scale UTC with the SI second as its scale unit;

c) that the definition of reference time scale and dissemination of time signals via radiocommunication systems are important for applications and equipment that require a time traceable to the reference time,

considering further

a) that ITU-R has a liaison with the Consultative Committee for Time and Frequency (CCTF) and participates in the General Conference on Weights and Measures (CGPM) as an observer;

b) that BIPM is a Sector Member of ITU-R and participates in the relevant activities of ITU-R,

noting

a) that the international reference time scale UTC is the legal basis for timekeeping for many countries and is the time scale used in the majority of countries;

b) that disseminated time signals are used not only in telecommunications but also in many industries and practically all areas of human activities;

c) that time signals are disseminated by both wired communications covered by Recommendations of the ITU Telecommunication Standardization Sector (ITU-T) and by systems of different radiocommunication services (space and terrestrial), including the standard frequency and time signal service for which ITU-R is responsible,

realizing

that, in BIPM, a Task Group has been created to prepare a draft resolution for CGPM in 2026 related to the new maximum value of the difference between UT1 and UTC, and, in the spirit of close collaboration with ITU, the ITU-R group in charge of the subject has been invited to participate in this Task Group,

recognizing

a) that No. **26.1** states that: "Attention should be given to the extension of this service to those areas of the world not adequately served";

b) that No. **26.6** states that: "In selecting the technical characteristics of standard frequency and time signal transmissions, administrations shall be guided by the relevant ITU-R Recommendations";

c) that the original definition of the international reference time scale UTC resulted from work completed in 1970 by the International Radio Consultative Committee (CCIR) of ITU, in full cooperation with CGPM;

d) that WARC-79 included UTC in the Radio Regulations, and since then UTC, as "strongly endorsed" in Resolution 5 of CGPM (1975), has been used as the main time scale for telecommunication networks (wired and wireless) and for other time-related applications and equipment;

e) that, in 2020, a Memorandum of Understanding was signed between BIPM and ITU concerning the expertise of each organization;

f) that Resolution 2 of the 26th meeting of the CGPM (2018) provides the definition of UTC and confirms that UTC produced by BIPM is the only recommended time scale for international reference and the basis of civil time in most countries;

g) that, in Resolution 4 on the use and future development of UTC, the 27th meeting of the CGPM (2022) decided that the maximum value for the difference allowed between UT1 and UTC will be increased in, or before, 2035;

h) that the various aspects of current and potential future reference time scales, including their impacts and applications, are covered by Report ITU-R TF.2511;

i) that a change in approach to the formation of the continuous UTC time scale will have positive operational and, consequently, economic implications;

j) that implementing a new tolerance (UT1 – UTC) will require a transitional period of up to 15 years, in accordance with Report ITU-R TF.2511, the length of which shall take into account the planned lifetime of equipment and the implementation of backward compatibility for some categories of user;

k) that the maximum value for the difference between UT1 and UTC should be no less than 100 seconds, taking into account the constraints of the technological systems expected to be used to disseminate this value,

resolves to invite the ITU Radiocommunication Sector

1 to continue the cooperation with BIPM, the International Committee for Weights and Measures (CIPM) and CGPM, as well as other relevant organizations, concerned industries and groups, and to maintain a dialogue concerning the expertise of each organization;

2 to further study the content and structure of time signals to be disseminated by radiocommunication systems, including wired technologies, using the combined expertise of the relevant organizations,

resolves

1 that, until the implementation of continuous UTC (see *recognizing g)*), UTC as described in Recommendation ITU-R TF.460-6 shall continue to apply;

2 that ITU-R cooperate further with BIPM, CIPM and CGPM in response to the consultation in *realizing*, to define a new maximum value for the difference between UT1 and UTC and on the implementation date for continuous UTC, possibly in 2035;

3 that ITU-R conduct studies, as appropriate, related to actions consequential upon *resolves* 1 and 2 to provide new and revised ITU-R Reports and Recommendations, such as, but not limited to, a revision to Recommendation ITU-R TF.460-6;

4 to establish a transition period for implementation and allow for the possibility to disseminate the increased difference between UT1 and UTC via radiocommunication system until 2035, but no later than 2040, in cases where existing equipment cannot be replaced earlier;

5 to maintain the name "UTC" as contained in Recommendation ITU-R TF.460-6 when it is revised,

instructs the Director of the Radiocommunication Bureau

to report on the progress of this Resolution to WRC-27,

invites administrations

to participate in the studies by submitting contributions to ITU-R,

instructs the Secretary-General

to bring this Resolution to the attention of the International Maritime Organization, the International Civil Aviation Organization, CGPM, CCTF, CIPM, BIPM, the International Earth Rotation and Reference Systems Service, the International Union of Geodesy and Geophysics, the International Union of Radio Science (URSI), the International Organization for Standardization (ISO), the World Meteorological Organization, the International Astronomical Union, the Institute of Electrical and Electronics Engineers and the Internet Engineering Task Force.

RESOLUTION 660 (WRC-19)

Use of the frequency band 137-138 MHz by non-geostationary satellites with short-duration missions in the space operation service

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that the term "short-duration mission" is used in accordance with Resolution **32 (WRC-19)***;

b) that non-geostationary-satellite orbit (non-GSO) systems identified as short-duration mission are constrained in terms of low on-board power and low antenna gain;

c) that the studies in Report ITU-R SA.2427 have indicated that the frequency bands 150.05-174 MHz and 400.15-420 MHz are not suitable for non-GSO systems in the space operation service (SOS) with short-duration missions;

d) that the overall occupied bandwidth of any emission should be maintained completely within the frequency band allocated to the application identified in the SOS with short-duration missions, including any offsets such as Doppler shift or frequency tolerances;

e) that, due to operational restrictions, only one non-GSO short-duration mission satellite is transmitting per channel at a given time in the same geographic area;

f) that Report ITU-R SA.2425 provides studies related to the spectrum requirements for telemetry, tracking and command (TT&C) in the SOS for non-GSO systems with short-duration missions,

recognizing

a) that the frequency range 108-137 MHz is allocated to the aeronautical mobile (R) service and is used for critical safety-of-life air-ground communications to ensure the safe operation of aircraft;

b) that the technical characteristics for TT&C in the SOS below 1 GHz for non-GSO systems with short-duration missions are found in Report ITU-R SA.2426,

resolves

1 that the use of the SOS (space-to-Earth) for non-GSO systems with short-duration missions in the frequency range 137-138 MHz shall be limited to the frequency band 137.025-138 MHz;

2 that, in the frequency band 137.025-138 MHz, the power flux-density at any point on the Earth's surface produced by a space station of non-GSO SOS systems used for short-duration missions in accordance with Appendix **4** shall not exceed −140 dB(W/(m^2 · 4 kHz));

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* *Note by the Secretariat:* This Resolution was revised by WRC-23.

3 that administrations wishing to implement the SOS (space-to-Earth) in the frequency band 137.025-138 MHz by means of non-GSO systems for short-duration missions shall ensure compliance with *considering d)*,

invites the ITU Radiocommunication Sector

to conduct, as a matter of urgency, relevant studies of technical, operational and regulatory aspects in relation to the implementation of this Resolution,

instructs the Director of the Radiocommunication Bureau

to present to the next world radiocommunication conference a progress report relating to the implementation of this Resolution.

RESOLUTION 663 (REV.WRC-23)

Studies on possible new additional allocations to the radiolocation service on a primary basis in the frequency range 231.5-275 GHz, and possible new identifications for radiolocation service applications in frequency bands within the frequency range 275-700 GHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that all millimetric and sub-millimetric wave systems and applications in the radiolocation service (RLS) to be considered by this Resolution fall under the categories of ranging, imaging (including material analysis) and localization;

b) that those systems and applications are typically designed in two main configurations: active (radars) and receive-only (radiometers);

c) that those RLS systems and applications:

– have been recognized by scientific communities and governmental organizations as well suited for stand-off detection of concealed objects in the imaging category;

– will make a significant contribution to public safety, such as counterterrorism and the security of high-risk/high-value assets or areas in the imaging and localization categories;

– will significantly contribute to improving transportation safety in the near ranges around vehicles and in the Intelligent Transport Systems (ITS) context in general in the ranging, localization and imaging categories;

d) that the RLS systems and applications are divided into:

– active use, which may require a frequency bandwidth up to 30 GHz to achieve range resolutions in the order of half a centimetre;

– receive-only use, which will detect the extremely weak power that is naturally radiated by objects and require a much wider frequency bandwidth than active systems to collect enough power for detection;

e) that globally harmonized spectrum for those millimetric and sub-millimetric wave RLS systems and applications is highly desirable for achieving economies of scale;

f) that the optimal frequency range for the operation of those active millimetric and sub-millimetric wave RLS systems is 231.5-320 GHz, where the atmospheric absorption is relatively low;

g) that there are some narrower existing allocations to the RLS in the frequency range 217-275 GHz in the three ITU Regions, which however may not support the bandwidth required for these millimetric and sub-millimetric wave RLS systems and applications;

h) that those RLS systems and applications in:

– the imaging category will operate at low transmit powers, in ranges up to 300 metres, and are limited in space and in time;

– the ranging category are expected to be ubiquitously deployed specifically in the near ranges around vehicles, while the category localization is used in general in the ITS context;

– all categories may be severely affected by other power sources operating in the same frequency band;

i) that the technical and operational characteristics for those receive-only and active millimetric and sub-millimetric wave systems and applications in the different categories need to be described, including protection criteria in particular for receive-only systems and applications;

j) that the combination of chosen transmitting power and bandwidth for some of the applications listed in *considering c)* within the regulatory framework depends on the operational requirements in the frequency band(s) used,

noting

a) that No. **5.563A** applies in the frequency bands 235-238 GHz, 250-252 GHz and 265-275 GHz, identifying these frequency bands for use by ground-based passive atmospheric sensing;

b) that No. **5.340** applies in the frequency band 250-252 GHz, prohibiting all emissions in this frequency band;

c) that consideration of receive-only imaging systems and the naturally compatible Earth exploration-satellite service (EESS) (passive) and radio astronomy service (RAS) might be possible when making common assignments in order to improve the overall spectrum usage efficiency;

d) that No. **5.565** states that the use of the frequency range 275-1 000 GHz by the passive services does not preclude use of this frequency range by active services;

e) that No. **5.564A** identifies the frequency range 275-450 GHz for the use by administrations for the implementation of land mobile and fixed service applications with certain limitations to protect the EESS (passive) in the frequency bands 296-306 GHz, 313-318 GHz and 333-356 GHz and to protect the RAS in general, in accordance with Resolution **731 (Rev.WRC-23)**,

recognizing

a) that the frequency ranges 231.5-275 GHz and 275-700 GHz are also allocated to other radiocommunication services and that those allocations are used by a variety of incumbent systems in many administrations, and that the protection of these services, including adjacent services, should be studied;

b) that, for the determination of the incumbent services, the relevant provisions of the Radio Regulations in force apply;

c) that administrations wishing to make frequencies available in the frequency range 275-1 000 GHz for active service applications are urged to take all practicable steps to protect the passive services from harmful interference until the date when the Table of Frequency Allocations is established for the relevant frequencies,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

1 the description of the technical and operational characteristics, including required protection criteria, for those receive-only and active millimetric and sub-millimetric wave RLS systems and applications in the categories listed in *recognizing a)*;

2 studies on globally harmonized spectrum for the RLS, in particular for those millimetric and sub-millimetric wave RLS systems and applications above 231.5 GHz;

3 sharing and compatibility studies (in-band and adjacent bands) for active millimetric and sub-millimetric wave RLS systems and applications with other services in the frequency range 231.5-275 GHz, while ensuring protection for the current use and further development of the incumbent services allocated to this frequency range;

4 sharing and compatibility studies (in-band and adjacent bands) for RLS applications with EESS (passive), space research service (passive) and RAS applications in the frequency range 275-700 GHz, while maintaining protection for the passive service applications identified in No. **5.565**;

5 sharing and compatibility studies (in-band and adjacent bands) for RLS applications with fixed service and land mobile service applications in the frequency range 275-450 GHz, as identified in No. **5.564A**,

invites the 2027 world radiocommunication conference

1 to determine, based on the results of the ITU-R studies described in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference,* possible new allocations to the RLS in the frequency range 231.5-275 GHz on a primary basis, considering required regulatory measures, while taking into account and ensuring the protection of the current use and further development of existing services in the frequency bands considered and in adjacent frequency bands;

2 to determine, based on the results of the ITU-R studies described in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference*, possible identifications of frequency bands in the frequency range 275-700 GHz for use by RLS applications, considering required regulatory measures, while ensuring the protection of the applications identified in Nos. **5.564A** and **5.565** in the frequency bands considered and, as appropriate, in adjacent frequency bands.

RESOLUTION 664 (REV.WRC-23)

Studies on a possible new primary allocation to the Earth exploration-satellite service (Earth-to-space) in the frequency band 22.55-23.15 GHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the frequency band 25.5-27 GHz, allocated worldwide to the Earth exploration-satellite service (EESS) (space-to-Earth) on a primary basis currently does not have a paired band for potential associated Earth-to-space links;

b) that an EESS (Earth-to-space) allocation in the frequency band 22.55-23.15 GHz would allow for uplinks and downlinks on the same transponder, increasing efficiency and reducing satellite complexity;

c) that an EESS (Earth-to-space) allocation in the frequency band 22.55-23.15 GHz would allow for its use for satellite tracking, telemetry and command (TT&C) in combination with the existing EESS (space-to-Earth) allocation referred to in *considering a)*,

noting

a) that the frequency band 22.55-23.15 GHz is allocated to the fixed, inter-satellite and mobile services on a primary basis;

b) that the frequency band 22.55-23.15 GHz is also allocated to the space research service (SRS) (Earth-to-space) on a primary basis, paired with the space research service (SRS) (space-to-Earth) allocation in the frequency band 25.5-27 GHz;

c) that the frequency band 22.21-22.5 GHz is allocated to the radio astronomy service (RAS) and EESS (passive) on a primary basis;

d) that, for the RAS in the frequency bands 22.81-22.86 GHz and 23.07-23.12 GHz, No. **5.149** applies;

e) that the frequency band 23.6-24 GHz is allocated to the EESS (passive) and RAS on a primary basis (No. **5.340** applies),

recognizing

a) that the possible development of the EESS (Earth-to-space) in the frequency band 22.55-23.15 GHz should not constrain the use and development of the EESS (passive) operating in the frequency band 23.6-24 GHz;

b) that protection of the RAS sites operating in the frequency bands indicated in *noting c), d)* and *e)* may be achieved through sufficient geographic separation from EESS earth stations,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference

studies on spectrum requirements and studies on sharing and compatibility between EESS (Earth-to-space) and the existing services, taking into account *noting a)* to *e)*, while ensuring the protection of these services, using relevant technical and operational parameters of their current and planned use,

invites administrations

to participate actively in ITU Radiocommunication Sector (ITU-R) studies and provide the technical and operational characteristics of the systems involved by submitting contributions to ITU-R,

invites the 2031 world radiocommunication conference

to consider, based on the results of the studies under *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference*, a new worldwide primary allocation to the EESS (Earth-to-space) in the frequency band 22.55-23.15 GHz,

invites the Secretary-General

to bring this Resolution to the attention of the international and regional organizations concerned.

RESOLUTION 673 (REV.WRC-23)

The importance of Earth observation radiocommunication applications

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the collection and exchange of Earth observation data are essential for maintaining and improving the accuracy of weather forecasts, which contribute to the protection of life and preservation of property throughout the world;

b) that Earth observation data are also essential for monitoring and predicting climate changes, for disaster prediction, monitoring and mitigation, for increasing the understanding, modelling and verification of all aspects of climate change, and for related policy-making;

c) that Earth observations are also used to obtain pertinent data regarding natural resources, this being particularly crucial for the benefit of developing countries;

d) that observations of the Earth's surface are also used for a large variety of other applications (e.g. urban developments, utilities deployments, agriculture, security);

e) that many observations are performed over the entire world which require spectrum-related issues to be considered on a worldwide basis;

f) that the importance of Earth observation radiocommunication applications has been stressed by a number of international bodies such as the World Meteorological Organization (WMO), the Intergovernmental Panel on Climate Change and the Group on Earth Observation, and that ITU-R collaboration with these bodies is essential;

g) that, although meteorological and Earth observation satellites are currently operated by only a limited number of countries, the data and/or related analyses resulting from their operation are distributed and used globally, in particular by national weather services in developed and developing countries and by climate change-related organizations;

h) that Earth observations are performed for the benefit of the whole international community and the data are generally made available at no cost,

recalling

a) the Plan of Action of the World Summit on the Information Society (Geneva, 2003), on e-environment, calling for the establishment of monitoring systems, using information and communication technologies (ICTs), to forecast and monitor the impact of natural and man-made disasters, particularly in developing countries, least developed countries and small economies;

b) Resolution 136 (Rev. Bucharest, 2022) of the Plenipotentiary Conference, on the use of telecommunications/ICTs for humanitarian assistance and for monitoring and management in emergency and disaster situations, including health-related emergencies, for early warning, prevention, mitigation and relief;

c) Resolution 182 (Rev. Bucharest, 2022) of the Plenipotentiary Conference, on the role of telecommunications/ICTs in regard to climate change and the protection of the environment,

recognizing

a) Recommendations ITU-R RS.1859, on use of remote sensing systems for data collection to be used in the event of natural disasters and similar emergencies, and ITU-R RS.1883, on use of remote sensing systems in the study of climate change and the effects thereof;

b) the Report on Question ITU-D 22/2, on utilization of ICTs for disaster management, resources and active and passive space-based sensing systems as they apply to disaster and emergency relief situations;

c) the joint WMO-ITU Handbook *Use of Radio Spectrum for Meteorology: Weather, Water and Climate Monitoring and Prediction* and the ITU-R Handbook *Earth Exploration-Satellite Service*,

recognizing further

Report ITU-R RS.2178, on the essential role and global importance of radio spectrum use for Earth observations and for related applications,

noting

a) that *in situ* and remote Earth observation capabilities depend on the availability of radio frequencies under a number of radio services, allowing for a wide range of passive and active applications on satellite- or ground-based platforms (see Report ITU-R RS.2178);

b) that, according to the United Nations Framework Convention on Climate Change, more than 90 per cent of natural disasters are climate- or weather-related;

c) that for certain Earth observation applications, long-term consistency of measurements is essential (e.g. climate change);

d) that certain frequency bands used by Earth observation applications have unique physical characteristics (e.g. spectral lines), so that migration to alternative frequency bands is not possible;

e) that ground-based radiometer measurements at the frequencies of water vapour absorption lines are essential for weather prediction and climate monitoring;

f) that some essential passive frequency bands are covered by No. **5.340** of the Radio Regulations;

g) that some essential passive Earth observation sensors could suffer from interference resulting in erroneous data or even complete loss of data,

resolves

1 to continue to recognize that the use of spectrum by Earth observation applications has a considerable societal and economic value;

2 to urge administrations to take into account Earth observation radio-frequency requirements and in particular protection of the Earth observation systems in the related frequency bands;

3 to encourage administrations to consider the importance of the use and availability of spectrum for Earth observation applications prior to taking decisions that would negatively impact the operation of these applications.

RESOLUTION 674 (WRC-23)

Studies on possible allocations to the Earth exploration-satellite service (passive) in the bands 4 200-4 400 MHz and 8 400-8 500 MHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the frequency band 6 425-7 250 MHz has been used by the Earth exploration-satellite service (EESS) (passive) to perform sea surface temperature (SST) measurements;

b) that SST measurements are important for detecting and forecasting meteorological events that drastically impact the safety and security of administrations and the populations of their countries;

c) that SST data sets are an essential resource for monitoring and understanding climate variability and climate change;

d) that SST measurement by satellite, in the microwave domain, remains the only measurement enabling daily and global measurement of SST, independently of meteorological conditions (i.e. the presence of clouds);

e) that SST measurement over different frequency channels might improve radio-frequency interference mitigation;

f) that certain frequency bands used for SST measurement have unique physical characteristics, so complementary frequency bands need to be carefully studied,

noting

that, under No. **5.458**, passive microwave sensor measurements are carried out over the oceans in the frequency band 6 425-7 075 MHz and planned to be carried out over the oceans in the frequency band 8 400-8 500 MHz, and passive microwave sensor measurements are carried out in the frequency band 7 075-7 250 MHz,

recognizing

a) that some complementary bands need to be determined in order to ensure continuity of SST measurement by the EESS (passive);

b) that, due to the sensitivity of the brightness temperature of the sea surface with regard to frequency, it is appropriate to perform SST measurements in frequency bands within the range 4-9 GHz,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

sharing and compatibility studies to determine the possibility of a future allocation to the EESS (passive) in the frequency bands 4 200-4 400 MHz and 8 400-8 500 MHz,

invites administrations

to participate actively in the studies and provide the information required for the studies listed in *resolves to invite ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* by submitting contributions to ITU-R,

invites the 2027 world radiocommunication conference

to examine the results of these studies with a view to considering a new primary allocation in all Regions to the EESS (passive) in the frequency bands 4 200-4 400 MHz and 8 400-8 500 MHz, without protection from existing services in these frequency bands and in adjacent bands.

RESOLUTION 675 (WRC-23)

Importance of meteorological aids service (space weather) applications

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the collection and exchange of space weather data are important for detecting solar activity events, including solar flares and high energetic particles and their relevant consequences for the Earth's geomagnetic and ionospheric conditions, and other space weather phenomena that impact services critical to the economy, safety and security of administrations and the populations of their countries;

b) that space weather data is critical for forecasting and providing alerts of space weather events and important to understanding the physical processes to develop prediction models for space weather events and their impacts on societal-infrastructure services;

c) that space weather data is important in understanding the physical process to provide prediction models for space weather events and their impacts;

d) that spectrum-reliant space weather sensor technology has been developed and operational systems have been deployed without much regard for domestic or international spectrum regulations, or for the potential need for protection from interference;

e) that spectrum-reliant space weather sensors may be vulnerable to interference from both terrestrial and spaceborne systems;

f) that some space weather sensors operate by receiving signals of low-level natural phenomena, mainly originating from solar activity and occurring beyond the major portion of the Earth's atmosphere, that impact the Earth's environment, and that they may therefore suffer harmful interference at levels which could be tolerated by other radiocommunication applications;

g) that the importance of space weather radiocommunication applications has been stressed by a number of international bodies, such as the World Meteorological Organization, the Intergovernmental Panel on Climate Change, the United Nations Office for Disaster Risk Reduction (UNDRR), the International Civil Aviation Organization (ICAO) and the United Nations Committee on the Peaceful Uses of Outer Space, and that ITU Radiocommunication Sector (ITU-R) collaboration with these bodies is essential;

h) that space weather data collection is performed for the benefit of the whole international community and the data is generally made freely available to users,

recalling

a) the Plan of Action of the World Summit on the Information Society (Geneva, 2003), on e-environment, calling for the establishment of monitoring systems, using information and communication technologies (ICTs), to forecast and monitor the impact of natural and man-made disasters, particularly in developing countries, least developed countries and small economies;

b) Resolution 136 (Rev. Bucharest, 2022) of the ITU Plenipotentiary Conference, on the use of telecommunications/ICTs for humanitarian assistance and for monitoring and management in emergency and disaster situations, including health-related emergencies, for early warning, prevention, mitigation and relief;

c) Resolution 182 (Rev. Bucharest, 2022) of the Plenipotentiary Conference, on the role of telecommunications/ICTs in regard to climate change and the protection of the environment;

d) the Global Framework for Climate Services as identified at the eighteenth session of the World Meteorological Congress (Geneva, June 2019), which provides information to help society adapt to climate variability and change;

e) that UNDRR and the International Science Council identified hazards related to space weather in the initial list of the hazards for disaster risk management in 2021 under the Sendai Framework for Disaster Risk Reduction 2015-2030;

f) United Nations General Assembly Resolution 76/3 of 25 October 2021, on the 'Space2030' Agenda: space as a driver of sustainable development, objective 3.8: increase awareness of the risks of adverse space weather and mitigate those risks, in order to ensure increased global resilience against space weather effects, and improve the international coordination of space weather-related activities, including outreach, communication and capacity-building, as well as the establishment of an international mechanism to promote increased high-level coordination in relation to space weather and increased global resilience against space weather effects;

g) Amendment 78 to Annex 3 to the Convention on International Civil Aviation (International Standards and Recommended Practices, Meteorological Service for International Air Navigation), adopted on 7 March 2018 at the 213th session of the ICAO Council, which has introduced space weather advisory information services on space weather phenomena expected to affect aeronautical radiocommunication and radionavigation systems,

recognizing

a) that Report ITU-R RS.2456, on space weather sensor systems using radio spectrum, contains:

– a summary of spectrum-reliant space weather sensors; and

– the documentation of the systems used for operational space weather monitoring, prediction and early warning deployed globally;

b) that the ITU-R *Handbook on Radio Astronomy* contains further information on space weather observations;

c) that existing services and their systems and applications should be protected in the frequency bands used for space weather observations and no undue constraints should be imposed on the future development of these services,

noting

a) that *in situ* (local) and remote-sensing space weather observation capabilities depend on the availability of radio frequencies;

b) that, according to the United Nations Office for Outer Space Affairs, society is becoming increasingly dependent on space-based systems and it is vital to understand how space weather could affect space systems and human space flight, electric power transmission, high-frequency radiocommunications, and global navigation satellite system (GNSS) signals;

c) that certain frequency bands used by space weather applications have unique physical characteristics, so that migration to alternative frequency bands is not possible;

d) the need to include within the agenda of a world radiocommunication conference (WRC) an item for studies to be conducted on compatibility and frequency sharing for space weather sensors with incumbent radiocommunication services and for possible allocations for the meteorological aids service (MetAids) (space weather), on the basis of the outcomes of ITU-R studies,

resolves

1 that the following definition for space weather shall be used:

space weather: natural phenomena, mainly originating from solar activity and occurring beyond the major portion of the Earth's atmosphere, that impact Earth's environment and human activities;

2 that space weather sensor systems may operate under MetAids (space weather) allocations;

3 that an active space weather sensor is a system in the MetAids (space weather) by means of which information is obtained by transmission and reception of radio waves;

4 that a receive-only space weather sensor is a system in the MetAids (space weather) by means of which information is obtained by reception of radio waves of natural origin, or by the opportunistic reception of transmissions of other specific radiocommunication services;

5 to recognize the importance of spectrum usage by space weather applications for monitoring space weather phenomena and events that impact services critical to the economy, safety and security of administrations and the populations of their countries;

6 to urge administrations to take into account space weather radio-frequency requirements and in particular protection of the related frequency bands;

7 to encourage administrations to consider the importance of the use and availability of spectrum for space weather applications prior to taking decisions that would negatively impact their operations;

8 that no notification of frequency assignments to a station used for space weather observation be made by administrations under the existing MetAids allocations until a future competent WRC introduces the corresponding allocations to MetAids (space weather) in Article **5**,

instructs the Director of the Radiocommunication Bureau

to consider any frequency assignments to space weather sensors that are notified within existing MetAids allocations prior to such a decision being taken by a competent WRC in accordance with *resolves* 8 above as being not in conformity with No. **11.31**.

RESOLUTION 676 (WRC-23)

Prevention and mitigation of harmful interference to the radionavigation-satellite service in the frequency bands 1 164-1 215 MHz and 1 559-1 610 MHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the radionavigation-satellite service (RNSS) in the frequency bands 1 164-1 215 MHz and 1 559-1 610 MHz is used in several aeronautical and maritime communication, navigation and surveillance safety-of-life systems;

b) that the RNSS is used for safety-of-life applications, for scientific applications and in many applications and devices around the world and across all sectors of the global economy, as described in Report ITU-R M.2458;

c) that harmful interference to the RNSS has potential consequences for safety systems used by aeronautical and maritime applications, and for the regularity and efficiency of civil aviation operations;

d) that the International Civil Aviation Organization (ICAO) has taken action to reinforce the resilience to interference of aeronautical positioning, navigation and timing (PNT) systems (see ICAO Assembly Resolution 41-8, Appendix C);

e) that ICAO has established a strategy for retaining essential conventional PNT infrastructure for contingency support in the case of RNSS outages, and for developing mitigation techniques for loss of services (see Convention on International Civil Aviation, Annex 10, Vol. I, Att. H); however, such infrastructure and mitigation techniques may not be available in some areas (e.g. over the high seas);

f) that the International Maritime Organization (IMO) through its Maritime Safety Committee (MSC), despite actions taken to mitigate the impact of harmful interference on the RNSS and its applications, has recognized that harmful interference impacting the RNSS poses a substantial risk to the safety of navigation, the safety of life and property, and the protection of the marine environment (see MSC.1/Circ. 1644);

g) that harmful interference to the RNSS may be difficult to detect and trace to origin,

recognizing

a) that disruption to the RNSS has been identified globally by the aeronautical community and the maritime community;

b) that there are different types of activities, notably the use of unauthorized transmitters, which may cause disruption;

c) that ICAO decided at its 40th Assembly in October 2019 to take measures to prevent and avoid interference to the RNSS;

d) that the Radiocommunication Bureau, in response to a decision of the Radio Regulations Board, issued Circular Letter CR/488, containing recommendations to Member States concerning mitigation of harmful interference to the RNSS;

e) that Article 45 of the ITU Constitution states that "All stations, whatever their purpose, must be established and operated in such a manner as not to cause harmful interference to the radio services or communications of other Member States or of recognized operating agencies, or of other duly authorized operating agencies which carry on a radio service, and which operate in accordance with the provisions of the Radio Regulations";

f) that Article 47 of the Constitution states that "Member States agree to take the steps required to prevent the transmission or circulation of false or deceptive distress, urgency, safety or identification signals, and to collaborate in locating and identifying stations under their jurisdiction transmitting such signals";

g) that No. **4.10** states that "the safety aspects of radionavigation and other safety services require special measures to ensure their freedom from harmful interference";

h) that No. **5.328A** states that "Stations in the radionavigation-satellite service in the band 1 164-1 215 MHz shall operate in accordance with the provisions of Resolution **609 (Rev.WRC-07)** and shall not claim protection from stations in the aeronautical radionavigation service in the band 960-1 215 MHz. No. **5.43A** does not apply. The provisions of No. **21.18** shall apply";

i) that prevention, identification, reporting and handling of cases of harmful interference, are subject to the provisions of Article **15**;

j) that there are other RNSS applications in the frequency bands 1 164-1 215 MHz and 1 559-1 610 MHz and that there are other RNSS applications operating in other frequency bands that need to be protected and that are not within the scope of this Resolution,

resolves to urge administrations

1 to apply necessary measures to avoid the proliferation, circulation and operation of unauthorized transmitters that cause, or have the potential to cause, harmful interference to RNSS systems and networks operating in the frequency bands 1 164-1 215 MHz and 1 559-1 610 MHz, including possible measures that might need to be taken with respect to *recognizing j)*;

2 to take the following actions to prevent and mitigate harmful interference affecting the RNSS operating in the frequency bands 1 164-1 215 MHz and 1 559-1 610 MHz without prejudice to the right of administrations to deny access to the RNSS, for security or defence purposes:

2.1 to encourage collaboration between spectrum regulators, enforcement authorities and RNSS stakeholders, in particular in the aeronautical and maritime domains;

2.2 to encourage cooperation between aeronautical, maritime and security authorities, as well as spectrum regulators, as appropriate, to address interference risks to RNSS systems that may stem from the activities of these security authorities;

3 to report cases, as the affected administration deems appropriate, of harmful interference to the RNSS, in accordance with Article **15**,

instructs the Director of the Radiocommunication Bureau

to provide, on request, assistance to administrations in accordance with No. **13.2**,

instructs the Secretary-General

to bring this Resolution to the attention of ICAO and IMO.

RESOLUTION 677 (WRC-23)

Use of the frequency range 40-50 MHz allocated to the Earth exploration-satellite service (active) for spaceborne radar sounders

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that spaceborne active sensors operating in the Earth exploration-satellite service (EESS) (active), described in Recommendation ITU-R RS.2042, can provide unique information on the physical properties of the Earth, such as characteristics of polar ice sheets and subterranean fossil aquifers in desertic environments;

b) that spaceborne active remote sensing requires specific frequency ranges depending on the physical phenomena to be observed;

c) that worldwide, periodic measurements of subsurface water/ice deposits require the use of spaceborne radar sounder active sensors;

d) that the measurement of reflectivity from subsurface scattering layers as deep as 10-100 metres for shallow aquifers and groundwater conduits, and on the order of 5 km for basal interface topography and ice-sheet thickness, is necessary;

e) that spaceborne radar sounders operating in the EESS (active) are intended to be operated from polar orbits, only in either uninhabited, sparsely populated or remote areas, with particular focus on deserts and polar ice fields;

f) that the 40-50 MHz frequency range is preferable to satisfy all operational requirements for such spaceborne radar sounder active sensors,

recognizing

a) that, given the complexity of the EESS (active) instrument implementation in these low frequencies and the high investment costs associated with these observation missions, very few such platforms are expected to be in orbit at the same time; consequently, aggregate interference from multiple spaceborne radar sounders into incumbent services is not anticipated and could be mitigated by coordination between the operators of such instruments;

b) that measurements by these radar sounders are only possible when the total electron content of the ionosphere is near its daily minimum, which normally occurs in a window of a few hours, centred at approximately 4 a.m. local time;

c) that No. **21.16.8** provides the equation to determine mean power flux-density (pfd) values for the EESS (active);

d) that wind profiler radars in the VHF band are addressed in Resolution **217 (Rev.WRC-23)** and are ideally suited for meteorological measurements (wind, atmospheric turbulence, tropopause height) up to high altitudes of 20-25 km that cannot be accommodated in other frequency bands;

e) that coordination between operators of EESS (active) systems and operators of wind profiler radars in the 40-50 MHz band may be needed on a case-by-case basis to ensure coexistence between the corresponding stations, acknowledging that there is no compatibility issue between those stations when they operate in adjacent bands;

f) that, at a pfd level of −189 dB(W/(m^2 · 4 kHz)), EESS (active) systems are not functional or are in mute mode,

resolves

1 that the use of the frequency band 40-50 MHz by the EESS (active) is limited to spaceborne radar sounders, as described in the most recent version of Recommendation ITU-R RS.2042;

2 that, for the purpose of protecting in-band and adjacent-band services, the following conditions outlined in *resolves* 2.1 to 2.4 shall apply to the EESS (active) in the frequency band 40-50 MHz when the subsatellite[1] point is located within any of the following areas:

a) the spherical cap formed by latitudes between 72 and 90 degrees North;

b) the spherical cap formed by latitudes between 60 and 90 degrees South;

c) the quadrangle formed by latitudes between 59 and 72 degrees North and longitudes between 25 and 55 degrees West;

2.1 stations operating in the EESS (active) shall transmit within the areas defined in *resolves* 2 for no more than a total of 90 minutes within a 24-hour period;

2.2 the mean pfd level per spaceborne radar sounder produced at any given point on the surface of the Earth shall not exceed −147 dB(W/(m^2 · 4 kHz)), under clear sky propagation conditions, for more than 0.05% of the time within a 24-hour period;

2.3 the mean pfd level per spaceborne radar sounder produced at any given point on the surface of the Earth shall not exceed −136 dB(W/(m^2 · 4 kHz)), under clear sky propagation conditions;

[1] The subsatellite point is defined as the location of the projection of the satellite's nadir-pointing vector onto the Earth's surface.

2.4 if more than one spaceborne radar sounder is in operation:

– administrations shall ensure collectively that the pfd limit in *resolves* 2.2 is not exceeded for more than 0.1% of the time and shall have consultations accordingly;

– until such consultations enable to ensure compliance with that pfd limit, each system will have to ensure that the limit in *resolves* 2.2 is not exceeded for more than 0.1/*N*% of the time, where *N* is the number of spaceborne radar sounders;

3 that, for the purpose of protecting in-band and adjacent-band services, the following conditions shall apply when the subsatellite point is located outside the areas provided in *resolves* 2;

3.1 in order to ensure that the spaceborne radar sounder is not operational or is in mute mode, the peak pfd level per spaceborne radar sounder produced at the surface of the Earth shall not exceed −189 dB(W/(m^2 · 4 kHz)), under free-space propagation conditions;

3.2 for the use of the frequency band 40-50 MHz by the EESS (active) for operation of spaceborne radar sounders outside the areas defined in *resolves* 2, if the pfd level of −189 dB(W/(m^2 · 4 kHz)) per spaceborne radar sounder produced at the surface of the Earth over the territory of any administration is exceeded, this exceedance is only permitted subject to an explicit agreement obtained;

3.3 stations operating in the EESS (active) in the 40-50 MHz frequency band shall not claim protection from stations operating in the radiolocation service in the frequency bands 42-42.5 MHz in Region 1, 41-44 MHz in countries included in No. **5.161,** and 46-50 MHz in countries included in No. **5.162A**; No. **5.43A** does not apply,

invites the ITU Radiocommunication Sector

to regularly review the number and characteristics of spaceborne radar sounders and the application of *resolves* 2.4 by Member States concerned,

instructs the Radiocommunication Bureau

to ensure the examination of the maximum pfd level given in *resolves* 2.3,

instructs the Director of the Radiocommunication Bureau

to report to future competent world radiocommunication conferences on the number of EESS satellites in operation in the frequency band 40-50 MHz and on the application of *resolves* 2.4 above.

RESOLUTION 678 (WRC-23)

Use of the frequency band 14.8-15.35 GHz by the space research service (space-to-space) (Earth-to-space) (space-to-Earth) and associated transitional measures

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that there is a need for broadband communication downlinks in the space research service (SRS) for the purpose of transmitting future scientific data at high data transmission speeds;

b) that SRS operators need more stable regulatory certainty in order to be able to ensure long-term operation of systems in this service of public interest, and that operating on the basis of a secondary allocation conflicts with this objective;

c) that the frequency band 15.35-15.4 GHz is currently allocated to the radio astronomy service (RAS) on a primary basis;

d) that the frequency band 14.8-15.35 GHz is currently allocated to the fixed and mobile services on a primary basis;

e) that some applications in the aeronautical mobile service in the frequency band 14.8-15.35 GHz are non-commercial applications that need high flexibility of operations in order to achieve their mission;

f) that the helicopter television transmission system is used to transmit real-time television signals and data from a helicopter to the receiving stations on the ground or a ship, operated in the aeronautical mobile service in the frequency band 14.8-15.35 GHz,

noting

a) that Recommendations ITU-R F.758, ITU-R M.2068 and ITU-R M.2089 contain characteristics of, and protection criteria for, systems operating in the fixed, land and aeronautical mobile services, respectively, in the frequency range 14.5-15.35 GHz;

b) that Recommendations ITU-R RA.769, ITU-R RA.1513 and ITU-R RA.1631 contain protection criteria used for radio astronomical measurements in the frequency range 15.35-15.4 GHz, including percentage-of-time criteria, and reference radio astronomy antenna pattern to be used for compatibility analyses between non-geostationary orbit (non-GSO) systems and RAS stations based on the equivalent power flux-density (epfd) concept, respectively;

c) that Recommendation ITU-R SA.2141 provides technical and operational system characteristics for the SRS in the frequency range 14.8-15.35 GHz,

recognizing

a) that the frequency band 14.8-15.35 GHz is currently used by data relay satellites in inter-satellite links, which permits the establishment of communications with satellites in non-GSO, including manned flights in the SRS;

b) that the frequency band 14.8-15.35 GHz is planned for use by high-speed data links from non-GSO satellites within the SRS;

c) that the use of the frequency band 14.8-15.35 GHz by the SRS should not cause harmful interference to stations of the RAS in the frequency band 15.35-15.4 GHz,

resolves

1 that, for the purpose of protecting in-band and adjacent-band services, the following conditions outlined in *resolves* 1.1 to 1.6 shall apply to the SRS in the frequency band 14.8-15.35 GHz:

1.1 any earth station in the SRS operating in the frequency band 14.8-15.35 GHz shall not exceed the power flux-density (pfd) level of −156 dB(W/m^2) for more than 2% of the time in a 50 MHz bandwidth in the frequency band 15.35-15.4 GHz, at any radio astronomy site observing in the frequency band 15.35-15.4 GHz;

1.2 the pfd produced in the frequency band 15.35-15.40 GHz by a space station of a GSO satellite network in the SRS (space-to-Earth) (space-to-space) shall not exceed the protection criteria specified in Recommendation ITU-R RA.769-2 for more than 2% of the time, at any radio astronomy site observing in the frequency band 15.35-15.4 GHz;

1.3 the epfd produced in the frequency band 15.35-15.40 GHz by all space stations of a non-GSO satellite system in the SRS (space-to-Earth) (space-to-space) shall not exceed −240 dB(W/m^2) for more than 2% of the time in a 50 MHz bandwidth in the frequency band 15.35-15.4 GHz at any radio astronomy site observing in the frequency band 15.35-15.4 GHz; the above limit shall be evaluated in accordance with Recommendation ITU-R RA.1513-2;

1.4 space stations in the SRS, operating in the space-to-space and Earth-to-space directions, shall not claim protection from stations in the fixed service; No. **5.43A** does not apply;

1.5 the pfd produced by a space station in the SRS at any point on the Earth's surface shall not exceed:

−124 dB(W/(m^2 · MHz)) for space-to-space links;

−145.6 dB(W/(m^2 · MHz)) for space-to-space links for more than 1% of time within a 24-hour period and

−138 dB(W/(m^2 · MHz)) for space-to-Earth links;

1.6 receiving earth stations in the SRS shall not claim protection from stations in the aeronautical mobile service operating in the frequency band 14.8-15.35 GHz within the respective border(s) of neighbouring countries, unless otherwise agreed between the administrations; No. **9.18** does not apply to stations in the aeronautical mobile service,

instructs the Director of the Radiocommunication Bureau

that, in reviewing the findings under No. **11.50** of the frequency assignments to a station in the space research service (space-to-space) (Earth-to-space) (space-to-Earth) in the frequency band 14.8-15.35 GHz, recorded in the Master International Frequency Register (MIFR) prior to 16 December 2023, the Bureau shall review as follows:

a) the original date of receipt of the recorded assignment in the MIFR shall be kept;

b) the Bureau shall examine each frequency assignment recorded in the MIFR in accordance with No. **11.31**;

c) when the examination with respect to No. **11.31** leads to a favourable finding, the assignment shall be upgraded to a primary status;

d) when the finding with respect to No. **11.31** is unfavourable, the assignment shall be modified in the MIFR to "for information purposes" and subject to application of No. **8.5**, only if the administration undertakes that it will be operated in accordance with No. **4.4**; otherwise the assignment shall be removed from the MIFR.

RESOLUTION 679 (WRC-23)

Use of the frequency bands 18.1-18.6 GHz, 18.8-20.2 GHz and 27.5-30 GHz by the inter-satellite service

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that there is a need for non-geostationary-satellite orbit (non-GSO) space stations to be able to relay data to the Earth, and that part of this need could be met by allowing such non-GSO space stations to communicate with inter-satellite service (ISS) space stations operating in the geostationary-satellite orbit (GSO) and in the non-GSO in the frequency bands 18.1-18.6 GHz, 18.8-20.2 GHz and 27.5-30 GHz, or parts thereof;

b) that the administration responsible for the notification of non-GSO space stations communicating with GSO or non-GSO space stations in the ISS at higher altitude does not need to be the same administration that has already notified assignments in the ISS;

c) that imposing the hard limits necessary to protect other services would provide regulatory certainty for notifying administrations both of non-GSO space stations communicating with ISS space stations and of potentially impacted services;

d) that there is growing interest in utilizing satellite-to-satellite links for a variety of applications;

e) that the ITU Radiocommunication Sector (ITU-R) has carried out studies on sharing and compatibility between incumbent services in the frequency bands 18.1-18.6 GHz, 18.8-20.2 GHz and 27.5-30 GHz and adjacent bands and satellite-to-satellite transmissions in the ISS;

f) that these studies were based on certain principles, including the limitation of the use of frequency bands to a specific direction, in accordance with the existing fixed-satellite service (FSS) allocations in these frequency bands, the use of power control and antenna steering capabilities, and compliance with applicable equivalent power flux-density (epfd), power flux-density (pfd) and off-axis equivalent isotropically radiated power (e.i.r.p.) limits to protect incumbent services;

g) that the frequency bands 18.1-18.6 GHz (space-to-Earth), 18.8-20.2 GHz (space-to-Earth) and 27.5-30 GHz (Earth-to-space) are also allocated to terrestrial and space services used by a variety of different systems, and these existing services and their future development need to be protected, without the imposition of additional constraints, from the operation of satellite-to-satellite links in the ISS;

h) that there are no protection criteria for evaluation of time-varying interference into non-GSO satellite systems established in ITU-R; therefore, the following protection criteria were used as a basis for sharing studies involving links between two non-GSO space stations and interfered-with non-GSO FSS systems: *I/N* of 0 dB not to be exceeded more than 0.02% of the time, −6 dB no more than 0.6% of the time and −10.5 dB no more than 20% of the time,

recognizing

a) that any course of action taken under this Resolution has no impact on the original date of receipt of the frequency assignments of the GSO FSS satellite network or the non-GSO FSS system with which non-GSO space stations communicate or on the coordination requirements of that satellite network;

b) that the protection of frequency assignments to GSO FSS satellite networks in the frequency bands 18.1-18.6 GHz, 18.8-20.2 GHz and 27.5-30 GHz, or parts thereof, is a fundamental and important issue due to the fact that those frequency bands are used for the telecommunication/information and communication technology (ICT) infrastructure of many countries, in particular developing countries,

resolves

1 that, for a non-GSO space station subject to this Resolution communicating with a GSO or non-GSO ISS space station within the frequency bands 18.1-18.6 GHz, 18.8-20.2 GHz, and 27.5-30 GHz, or parts thereof, the following conditions shall apply:

1.1 the non-GSO ISS space station transmitting in the frequency band 27.5-30 GHz and receiving in the frequency bands 18.1-18.6 GHz and 18.8-20.2 GHz, or parts thereof, shall only operate inter-satellite links when its apogee altitude[1] is lower than the minimum operational altitude[2] of the GSO or non-GSO space station with which it communicates and when the off-nadir angle between that GSO or non-GSO space station and the non-GSO space station with which it communicates is less than or equal to θ_{Max} (as defined in Annex 1 to this Resolution);

1.2 the GSO or non-GSO space station receiving in the frequency band 27.5-30 GHz and transmitting in the frequency bands 18.1-18.6 GHz and 18.8-20.2 GHz, or parts thereof, shall only operate inter-satellite links when its minimum operational altitude is higher than the apogee altitude of the non-GSO space station with which it communicates;

1.3 that the use of inter-satellite links by GSO or non-GSO space stations transmitting in the frequency bands 18.1-18.6 GHz and 18.8-20.2 GHz and receiving in the frequency band 27.5-30 GHz is limited to those with recorded assignments in the relevant FSS (space-to-Earth) and (Earth-to-space) allocations in those frequency bands;

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[1] See item A.4.b.4.d of Appendix **4**.

[2] See item A.4.b.4.f of Appendix **4**.

2 that, for a non-GSO ISS space station transmitting in the frequency band 27.5-30 GHz, the following conditions shall apply:

2.1 this non-GSO ISS space station shall transmit only when within the cone whose apex is the GSO or non-GSO receiving space station and whose angle is θ_{Max} (as defined in Annex 1 to this Resolution);

2.2 the emissions of this non-GSO ISS space station shall remain within the envelope of the recorded characteristics of the associated transmitting FSS earth stations of the GSO FSS network or non-GSO FSS system with which it communicates;

2.3 this non-GSO space station shall comply with the limits contained in Article **21**, Table **21-4**, taking into account the provisions in Annex 2 to this Resolution for protection of terrestrial services in the frequency band 27.5-29.5 GHz and shall not cause unacceptable interference to or otherwise impose constraints on the operation or the development of terrestrial services; in the frequency band 29.5-30 GHz, with respect to the terrestrial services on the territory of administrations listed in footnote No. **5.542**, the operation of inter-satellite links in the frequency band 29.5-30 GHz should not adversely impact the required protection of terrestrial services operated by the administrations listed in footnote No. **5.542**;

2.4 the requirement not to cause unacceptable interference to terrestrial services shall not release the notifying administration from its obligation as contained in *resolves* 2.3 above;

2.5 this non-GSO space station shall not cause unacceptable interference to, or otherwise impose constraints on, the operation or the development of non-GSO FSS systems and shall comply with the provisions contained in Annex 4 to this Resolution;

2.6 this non-GSO space station shall not cause unacceptable interference to, or otherwise impose constraints on, the operation or development of FSS feeder links to non-GSO mobile-satellite service (MSS) systems operating in the frequency band 29.1-29.5 GHz; the conditions in section b) of Annex 4 to this Resolution shall apply;

2.7 the emission of this non-GSO space station shall not produce a pfd at any point in the GSO arc greater than the pfd produced by earth stations associated with the satellite network/system with which they communicate, and Annex 5 to this Resolution shall apply;

3 that for a space station transmitting in the frequency bands 18.1-18.6 GHz and 18.8-20.2 GHz or parts thereof, the following conditions shall apply:

3.1 this non-GSO or GSO space station shall transmit only when the non-GSO ISS receiving space station is within the cone whose apex is the GSO or non-GSO transmitting space station and whose angle is θ_{Max} (as defined in Annex 1 to this Resolution);

3.2 the transmissions shall remain within the envelope of the recorded characteristics of the transmitting GSO FSS or non-GSO FSS space station towards its associated FSS earth stations;

3.3 with respect to the Earth exploration-satellite service (EESS) (passive) operating in the frequency band 18.6-18.8 GHz, any non-GSO FSS system with an altitude of apogee of less than 20 000 km communicating with lower-orbiting non-GSO space stations in the frequency bands 18.3-18.6 GHz and 18.8-19.1 GHz and for which complete notification information has been received by the Radiocommunication Bureau after 1 January 2025 shall comply with the provisions indicated in Annex 3 to this Resolution;

4 that non-GSO ISS space stations receiving in the frequency bands 18.1-18.6 GHz and 18.8-20.2 GHz, or parts thereof, shall not claim protection from FSS and MSS networks and systems or meteorological-satellite service networks, or from terrestrial services operating in conformity with the Radio Regulations;

5 that the notifying administration for a non-GSO FSS system communicating with a non-GSO space station in the frequency bands 18.1-18.6 GHz, 19.7-20.2 GHz, 27.5-28.6 GHz and 29.5-30 GHz shall ensure that the epfd produced by the emissions from all combined operations of inter-satellite links in the ISS and Earth-to-space and space-to-Earth links in the FSS comply with the epfd limits contained in Article **22**, Tables **22-1B**, **22-1C** and **22-2**;

6 that the notifying administration for a non-GSO ISS system communicating with a non-GSO space station in the frequency bands18.1-18.6 GHz and 19.7-20.2 GHz and receiving in the frequency bands 27.5-28.6 GHz and 29.5-30 GHz shall ensure that the epfd produced by the emissions from operations of inter-satellite links in the ISS comply with the epfd limits contained in Article **22**, Tables **22-1B**, **22-1C** and **22-2**;

7 that space stations receiving inter-satellite transmissions in the frequency band 27.5-30 GHz from non-GSO space stations shall not claim protection for inter-satellite links from FSS and MSS networks and systems or from terrestrial services operating in conformity with the Radio Regulations;

8 that assignments to inter-satellite links in the frequency bands 18.1-18.6 GHz, 18.8-20.2 GHz and 27.5-30 GHz shall not cause unacceptable interference to, or claim protection from, GSO FSS services operating in the frequency band allocated to the FSS,

further resolves

1 that, subject to this Resolution:

a) the notifying administration for the non-GSO system choosing to operate inter-satellite links and receiving in the frequency bands 27.5-28.6 GHz and 29.5-30 GHz shall indicate to the Bureau its commitment that the epfd produced at any point in the GSO by emissions from all combined operations of inter-satellite links and associated earth station transmissions shall not exceed the limits given in Article **22**, Table **22-2**;

b) the notifying administration for a non-GSO ISS space station transmitting in the frequency band 27.5-30 GHz towards a GSO network and receiving in the frequency bands 18.1-18.6 GHz and 18.8-20.2 GHz shall send the Bureau the relevant Appendix **4** advance publication information containing the characteristics of the non-GSO ISS space station and the name of the associated notified GSO FSS network with which it intends to communicate;

c) the notifying administration for a non-GSO ISS space station transmitting in the frequency bands 27.5-29.1 GHz and 29.5-30 GHz towards a non-GSO system and receiving in the frequency bands 18.1-18.6 GHz and 18.8-20.2 GHz shall send the Bureau the relevant Appendix **4** advance publication information containing the characteristics of the non-GSO ISS space station and the name of the associated notified non-GSO FSS system(s) with which it intends to communicate;

d) the notifying administration for a non-GSO system operating inter-satellite links and receiving in the frequency bands 27.5-29.1 GHz and 29.5-30 GHz or of a GSO network operating inter-satellite links and receiving in the frequency band 27.5-30 GHz is responsible for eliminating any case of unacceptable interference;

2 that the notifying administration for a GSO network/non-GSO system receiving in the frequency band 27.5-30 GHz shall submit, with the Appendix **4** data, a firm, objective, actionable, measurable and enforceable commitment that, in the event of reported unacceptable interference, it undertakes to immediately eliminate the interference or reduce it to an acceptable level, following the procedures in *further resolves* 3:

a) that in case no action is taken with regard to the obligation referred to in *further resolves* 2 above, the Bureau shall send a reminder requesting the notifying administration for the GSO network/non-GSO system to comply with the requirements referred to in the commitment;

b) should the interference persist 30 days after the dispatch date of the above-mentioned reminder, the Bureau shall submit the case to the subsequent meeting of the Radio Regulations Board for review and the necessary actions (including suppression of the frequency assignment in question), as appropriate;

3 that in the event of unacceptable interference caused by a non-GSO ISS space station transmitting in the frequency band 27.5-30 GHz or parts thereof:

a) the notifying administration for that non-GSO ISS space station shall cooperate with an investigation into the matter and provide the information on the operation of the transmitting space station needed to assess the interference and a point of contact to provide such information;

b) the notifying administration for the non-GSO ISS space station transmitting in the frequency band 27.5-30 GHz and the notifying administration for the GSO or non-GSO network or system with which the non-GSO transmitting space station communicates shall, jointly or individually, as the case may be, upon receipt of a report of unacceptable interference, take the required actions to eliminate or reduce the interference to an acceptable level;

4 that the notifying administration for the GSO or non-GSO FSS space station receiving inter-satellite transmissions in the frequency band 27.5-30 GHz shall ensure that:

a) the non-GSO ISS space stations transmitting in this frequency band employ techniques to maintain pointing accuracy with the associated receiving space station and to avoid inadvertently tracking an adjacent GSO space station of any other notifying administration or a space station in a non-GSO system of any other notifying administration;

b) all necessary measures are taken so that non-GSO ISS space stations transmitting in this frequency band are subject to permanent monitoring and control by a network Control and Monitoring Centre (NCMC) or equivalent facility and are capable of receiving and acting upon at least "enable transmission" and "disable transmission" commands from the NCMC or equivalent facility; and

c) a permanent point of contact is provided for the purpose of tracing any cases of unacceptable interference from non-GSO ISS space stations transmitting in this frequency band and responding immediately to requests from the focal point;

5 that, upon examination of the information submitted by the notifying administration under *further resolves* 1*b)* or 1*c)*, if no recorded frequency assignments with typical earth stations for the relevant frequency bands can be identified for the GSO FSS network or non-GSO FSS system with which the notifying administration for the non-GSO ISS space station intends to communicate, the Bureau shall return the information to the notifying administration,

invites the ITU Radiocommunication Sector

1 to develop a suitable methodology for calculating the epfd produced by the emissions from operations of all ISS links in the frequency bands 27.5-28.6 GHz and 29.5-30 GHz, within a given non-GSO ISS system, for use by the Bureau in examining whether the system is in compliance with the epfd limits contained in Article **22**, Table **22-2**;

2 to develop a suitable methodology for calculating the epfd produced by the emissions from operations of all ISS links in the frequency bands 18.1-18.6 GHz and 19.7-20.2 GHz, within a given non-GSO ISS system, for use by the Bureau in examining whether the system is in compliance with the epfd limits contained in Article **22**, Tables **22-1B** and **22-1C**,

instructs the Director of the Radiocommunication Bureau

1 to take all necessary actions to facilitate the implementation of this Resolution, together with providing any assistance for the resolving of interference, if and when required;

2 to report to future world radiocommunication conferences on any difficulties or inconsistencies encountered in the implementation of this Resolution;

3 to use the methodology given in Annex 2 to this Resolution when assessing compliance with the pfd limits in Article **21**, Table **21-4**;

4 to use the methodology given in Appendices 1 to 3 to Annex 5 to this Resolution when assessing compliance with Annex 5;

5 not to examine, under No. **11.31**, the conformity of non-GSO ISS systems with the provisions of *resolves* 3.3 of this Resolution in view of the fact that the detailed characteristics of non-GSO ISS system transmitters are not available;

6 that, until the methodology is developed according to *invites the ITU Radiocommunication Sector* 1 and 2 above, the Bureau shall issue a qualified favourable finding for examination under No. **11.31**; when the methodology is available, the Bureau shall review its finding under No. **11.31**.

ANNEX 1 TO RESOLUTION 679 (WRC-23)

Determination of the off-nadir angle

1 A non-geostationary (non-GSO) inter-satellite service (ISS) space station transmitting in the frequency band 27.5-30 GHz and receiving in the frequency bands 18.1-18.6 GHz and 18.8-20.2 GHz shall communicate with a non-GSO space station only when the off-nadir angle between this non-GSO space station and the non-GSO space station with which it communicates is equal to or smaller than:

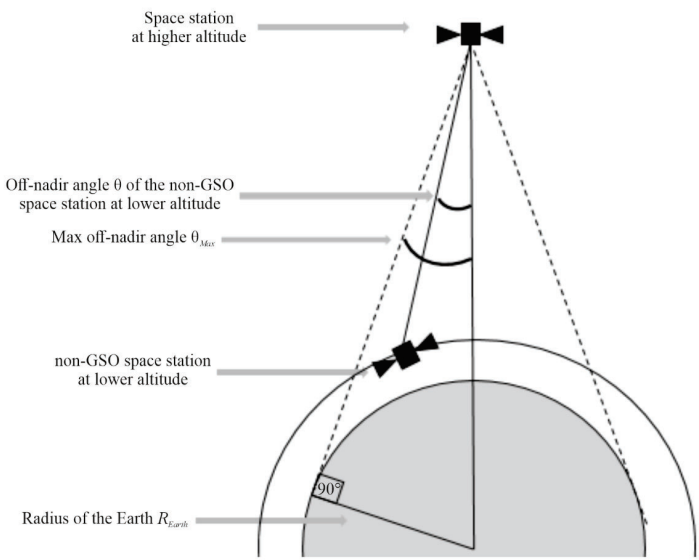
$$\theta_{Max} = \sin^{-1}\left(\frac{R_{Earth}}{R_{Earth} + Alt_{Higher}}\right)$$

where:

R_{Earth} = 6 378 km

Alt_{Higher} = altitude of the non-GSO space station at a higher orbital altitude in km.

FIGURE 1



2 A non-GSO ISS space station transmitting in the frequency band 27.5-30 GHz and receiving in the frequency bands 18.1-18.6 GHz and 18.8-20.2 GHz shall communicate with a geostationary (GSO) space station only when the off-nadir angle between this GSO space station and the non-GSO space station with which it communicates is equal to or smaller than:

– if the altitude of the non-GSO space station is less than 2 000 km:

$$\theta_{Max} = \sin^{-1}\left(\frac{R_{Earth} + Alt_{non-GSO}}{R_{Earth} + Alt_{GSO}}\right)$$

– if the altitude of the non-GSO space station is greater than or equal to 2 000 km:

$$\theta_{Max} = \sin^{-1}\left(\frac{R_{Earth}}{R_{Earth} + Alt_{GSO}}\right)$$

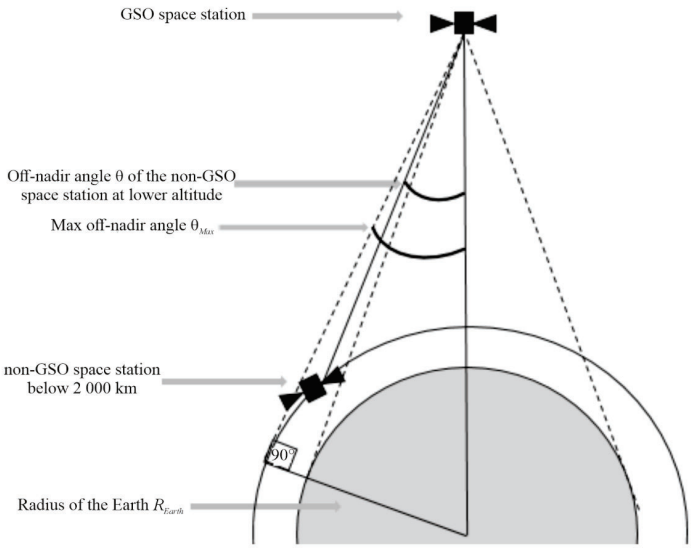
where:

R_{Earth} = 6 378 km

Alt_{GSO} = altitude of the GSO space station in km

$Alt_{non\text{-}GSO}$ = altitude of the non-GSO space station in km.

FIGURE 2



3 If the altitude of the non-GSO space station transmitting in the frequency band 27.5-30 GHz and receiving in the frequency bands 18.1-18.6 GHz and 18.8-20.2 GHz is less than 2 000 km, the angle between the vector from this space station to the centre of the Earth and the vector between this space station and the GSO space station shall be at least 90°.

4 Where the notified service area of the GSO or non-GSO network/system at a higher orbital altitude is not global, the maximum off-nadir angle θ_{Max} will vary at each azimuth according to the notified service area and there will be a specific maximum off-nadir angle associated with each azimuth, based on the position in space of the FSS network/system at higher orbital altitude and the geographical coordinates (latitude, longitude) of the border of the notified service area at each azimuth, which are extracted from the Graphical Interference Management System (GIMS) database container that was submitted to the Bureau when notifying a specific non-global service area:

$$\theta_{Max} = \cos^{-1}\left(\frac{\left(R_{Earth} + Alt_{Higher}\right)^2 + dist^2 - R_{Earth}^{\ 2}}{2\times\left(R_{Earth} + Alt_{Higher}\right)\times dist}\right)$$

with:

$$dist = \sqrt{\left(X_E - X_S\right)^2 + \left(Y_E - Y_S\right)^2 + \left(Z_E - Z_S\right)^2}$$

$$X_E = R_{Earth} \times \cos\left(lat_{sab}(\varphi)\right) \times \cos\left(lon_{sab}(\varphi)\right)$$

$$Y_E = R_{Earth} \times \cos\left(lat_{sab}(\varphi)\right) \times \sin\left(lon_{sab}(\varphi)\right)$$

$$Z_E = R_{Earth} \times \sin\left(lat_{sab}(\varphi)\right)$$

$$X_S = \left(R_{Earth} + Alt_{Higher}\right) \times \cos\left(lat_{SS}\right) \times \cos\left(lon_{SS}\right)$$

$$Y_S = \left(R_{Earth} + Alt_{Higher}\right) \times \cos\left(lat_{SS}\right) \times \sin\left(lon_{SS}\right)$$

$$Z_S = \left(R_{Earth} + Alt_{SS}\right) \times \sin\left(lat_{Higher}\right)$$

where:

$lat_{sab}(\varphi)$ = latitude of the service area border for the azimuth φ

$lon_{sab}(\varphi)$ = longitude of the service area border for the azimuth φ

lat_{SS} = latitude of the sub-satellite point of the GSO/non-GSO space station

lon_{SS} = longitude of the sub-satellite point of the GSO/non-GSO space station.

ANNEX 2 TO RESOLUTION 679 (WRC-23)

Provisions for non-GSO ISS space stations transmitting in the frequency band 27.5-30 GHz to protect terrestrial services in the frequency band 27.5-30 GHz

To check the compliance of non-geostationary-satellite (non-GSO) inter-satellite service (ISS) emissions with the power flux-density (pfd) mask described in Table **21-4**, the following procedures shall be followed:

1 Parameter a is the orbital altitude (km) of the non-GSO ISS system identified in *further resolves* 1*b)* or in *further resolves* 1*c)* of this Resolution. PSD is the power spectral density in the reference bandwidth associated with the pfd limit. Compute the off-axis gain pattern $Gtx(\varphi)$, with φ being the off-axis angle in the direction of the terrestrial receiver. Assume the Earth is a sphere whose radius, R_e, is 6 378 km.

2 Compute the angle, as seen from the non-GSO ISS system transmitting in the frequency band 27.5-30 GHz (the user space station), between the centre of the Earth and the geostationary-satellite (GSO) network or non-GSO systems receiving in the frequency band 27.5-30 GHz (the service provider space station), assuming that the user is at the edge of the cone of coverage with the formula:

$$\delta = \arcsin\left(\frac{R_e}{R_e + a}\right)$$

3 Sweep the angle of arrival to the terrestrial station, θ, from 0° to 90° in 0.1° increments.

4 Compute the satellite angle $\gamma = \arcsin\left(\frac{\sin(90+\theta)}{R_e + a} * R_e\right)$.

5 Compute the off-axis angle $\varphi = 180 - \delta - \gamma$.

6 Compute the gain Gtx in dBi towards the Earth point for each of the angles from Step 5, using the user space station transmit antenna pattern.

7 Compute the slant range $d = (R_e + a)\frac{\sin(90-\gamma-\theta)}{\sin(90+\theta)}$.

8 Compute the *PFD* on the ground:

$$PFD = PSD + Gtx(\theta) - 10 \times \log_{10}\left(4\pi d^2\right)$$

ANNEX 3 TO RESOLUTION 679 (WRC-23)

Provisions for non-GSO space station[3] links in the frequency bands 18.3-18.6 GHz and 18.8-19.1 GHz towards non-GSO space stations with respect to the Earth exploration-satellite service (passive) in the frequency band 18.6-18.8 GHz

Non-geostationary (non-GSO) space stations operating with an altitude of apogee of more than 2 000 km and less than 20 000 km in the frequency bands 18.3-18.6 GHz and 18.8-19.1 GHz, when communicating with a non-GSO inter-satellite service space station as described in *resolves* 1 of this Resolution, shall not exceed a power flux-density (pfd) produced at the surface of the oceans across the 200 MHz of the 18.6-18.8 GHz band of −118 dB(W/(m² · 200 MHz)).

Non-GSO space stations operating with an altitude of apogee of less than 2 000 km in the frequency bands 18.3-18.6 GHz and 18.8-19.1 GHz, when communicating with a non-GSO space station as described in *resolves* 1 of this Resolution, shall not exceed a pfd produced at the surface of the oceans across the 200 MHz of the 18.6-18.8 GHz band of −110 dB(W/(m² · 200 MHz)).

ANNEX 4 TO RESOLUTION 679 (WRC-23)

Provisions for non-GSO inter-satellite links in the frequency band 27.5-30 GHz to protect non-GSO space stations

The following conditions for non-geostationary (non-GSO) inter-satellite service (ISS) space stations transmitting in the frequency band 27.5-30 GHz shall apply for the protection of non-GSO space stations:

a) The emissions from any non-GSO ISS space station transmitting in the frequency bands 27.5-29.1 GHz and 29.5-30 GHz to communicate with a geostationary-satellite (GSO) fixed-satellite service (FSS) network shall not exceed the following on-axis equivalent isotropically radiated power (e.i.r.p.) spectral density limits:

– for non-GSO space station transmit on-axis antenna gains greater than or equal to 40.6 dBi: 52.5 dBW/10 MHz;

– for non-GSO space station transmit on-axis antenna gains less than 40.6 dBi: 52.5 – (40.6 – X) dBW/10 MHz;

where X is the on-axis gain of the non-GSO space station antenna in dBi, where the 10 MHz reference bandwidth is in any 10 MHz (e.g. adjacent but non-overlapping).

[3] These provisions do not apply to non-GSO systems using orbits with an altitude of apogee of less than 2 000 km that employ a frequency reuse factor of at least 3.

b) To protect FSS feeder links to non-GSO mobile-satellite service systems, the following conditions for non-GSO space stations and systems transmitting in the frequency band 29.1-29.5 GHz shall apply:

– emissions from any non-GSO space station communicating with a GSO network shall not exceed a maximum power spectral density of −66 dBW/Hz at the input of the antenna of the non-GSO space station;

– any non-GSO space station communicating with a GSO network shall have a minimum antenna diameter of 0.3 m whose gain shall not exceed the gain envelope in the most recent version of Recommendation ITU-R S.580;

– non-GSO space stations communicating with a GSO network shall operate only in orbits with inclination between 75° and 105°;

– non-GSO systems communicating with a GSO network shall not contain more than 100 satellites.

c) The emissions from any non-GSO space station transmitting in the frequency bands 27.5-29.1 GHz and 29.5-30 GHz to communicate with a non-GSO system with a minimum operational altitude higher than or equal to 2 000 km shall not exceed an on-axis e.i.r.p. spectral density of −20 dBW/Hz, and the total e.i.r.p. from any non-GSO space station shall not exceed:

Transmitting non-GSO space station operational altitude (km)	**Maximum total e.i.r.p. (dBW) (brought into use on or before 31 December 2036)**	**Maximum total e.i.r.p. (dBW) (brought into use after 31 December 2036)**
altitude < 450	63	66
450 ≤ altitude < 600	61	64
600 ≤ altitude < 750	58	58
750 ≤ altitude < 900	55	55
900 ≤ altitude < 1 350	25	44
altitude ≥ 1 350	Not applicable	Not applicable

d) The emissions from any non-GSO space station transmitting in the frequency bands 27.5-29.1 GHz and 29.5-30 GHz to communicate with a non-GSO system with a minimum operational altitude lower than 2 000 km shall not exceed an on-axis e.i.r.p. spectral density of −28 dBW/Hz, and the total e.i.r.p. from any non-GSO space station shall not exceed:

Transmitting non-GSO space station operational altitude (km)	Maximum total e.i.r.p. (dBW) (brought into use on or before 31 December 2036)	Maximum total e.i.r.p. (dBW) (brought into use after 31 December 2036)
altitude < 375	61	64
375≤ altitude < 450	60	63
450 ≤ altitude < 600	58	61
600 ≤ altitude < 750	55	55
750 ≤ altitude < 900	53	53
900 ≤ altitude < 1 350	25	44
altitude ≥ 1 350	Not applicable	Not applicable

e) For off-axis angles greater than 3.5°, the off-axis e.i.r.p. emissions of a non-GSO space station transmitting in the frequency bands 27.5-29.1 GHz and 29.5-30 GHz to communicate with a non-GSO system with a minimum operational altitude higher than or equal to 2 000 km shall not exceed the envelope generated by the combination of an input power spectral density at the antenna flange of −62 dBW/Hz coupled with the following off-axis gain:

– 29-25 log(φ) dBi for angles between 3.5° and 4.9°;

– 11.71 dBi for angles between 4.9° and 9.5°;

– 43-32log(φ) dBi for angles between 9.5° and 20°.

ANNEX 5 TO RESOLUTION 679 (WRC-23)

Provisions for non-GSO inter-satellite links in the frequency band 27.5-30 GHz bands to protect GSO space stations

1 In the frequency band 27.5-30 GHz, when a non-geostationary-satellite (non-GSO) system, as identified in *further resolves* 1*b)* of this Resolution, identifies an associated geostationary-satellite (GSO) network, as described in *further resolves* 1*b)*, to operate inter-satellite links, the Radiocommunication Bureau shall perform the examination described in Appendix 1 to this Annex.

2 The notifying administration for the GSO network identified in § 1 above shall respect all coordination agreements that have already been recorded, noting the provisions of *further resolves* 3 and 4 of this Resolution.

3 The notifying administration for the GSO network identified in § 2 above shall provide, upon any request from the notifying administration of a GSO network involved in the coordination agreements referred to above, additional information on how the relevant coordination agreements will be respected with regard to protection from inter-satellite links. This information shall be provided within 90 days after the receipt of the request.

4 In the frequency bands 27.5-29.1 GHz and 29.5-30 GHz, when a non-GSO system, as identified in *further resolves* 1*c)* of this Resolution, identifies a non-GSO system, as described in *further resolves* 1*c)*, to operate inter-satellite links, the Bureau shall perform the examination described in Appendix 2 to this Annex.

5 The notifying administration for the receiving non-GSO network identified in § 3 above shall respect all coordination agreements that have already been recorded, noting the provisions of *further resolves* 3 and 4 of this Resolution.

6 In the frequency bands 27.5-28.6 GHz and 29.5-30 GHz, the power flux-density (pfd) produced at any point in the geostationary-satellite orbit by a non-GSO space station, as mentioned in *further resolves* 1*c)*, shall not exceed a pfd of −164 dB(W/m²) in any 40 kHz band. A computation methodology is provided in Appendix 3 to this Annex.

7 In cases where all of the conditions identified in Appendix 4 to this Annex are met, the notifying administration for frequency assignments to the GSO inter-satellite service (ISS) space stations shall seek agreement from the notifying administration for the GSO fixed-satellite service (FSS) or mobile-satellite service (MSS) network. In the absence of agreement, frequency assignments to the ISS space station shall operate under the express condition that the ISS space station does not cause harmful interference to, or claim protection from, frequency assignments to the GSO FSS or MSS network operating in accordance with the Radio Regulations.

7.1 The Bureau shall not perform an examination under § 7 of this Annex.

7.2 In the event of the harmful interference actually being caused by an ISS space station under § 7 of this Annex, for the case of ISS links between a non-GSO space station and a GSO space station, to any GSO FSS or MSS with recorded frequency assignments operating in accordance with the Radio Regulations, the notifying administration for the GSO ISS space station shall, upon receipt of a report providing the particulars relating to the harmful interference given in the form indicated in Appendix **10**, immediately eliminate this harmful interference.

7.3 In the case of unresolved harmful interference under § 7 of this Annex, the Bureau shall submit the case to the subsequent meeting of the Radio Regulations Board for review and the necessary actions (including suppression of the frequency assignment in question), as appropriate.

7.4 The notifying administration for the GSO ISS space station shall inform the notifying administration for the non-GSO ISS space station of the status of the agreement being sought under § 7 of this Annex.

APPENDIX 1 TO ANNEX 5

The aim of this Appendix is to provide a method to be used by the Radiocommunication Bureau to assess whether the emissions from a non-geostationary (non-GSO) space station operating inter-satellite links with a geostationary (GSO) space station are within the envelope of the typical earth stations of the GSO network.

Step 1: For each group of the transmitting non-GSO notification.

Step 2: For each of the receiving GSO networks, as listed in *further resolves* 1*b)* of this Resolution.

Step 3: For each beam in the Earth-to-space direction of the receiving GSO network notification, compute the maximum equivalent isotropically radiated power (e.i.r.p.) produced in one hertz (*EIRPSD*).

Step 4: Compute the reduction in free-space loss at the altitude of the user using:

$$\Delta FSL = 20\log_{10}\left(\frac{GSO_{alt}}{GSO_{alt} - NGSO_{alt}}\right)$$

where $NGSO_{alt}$ is the altitude of the transmitting non-GSO system space stations and GSO_{alt} = 35 786 km. It should be noted that, if several altitudes are included in the notification, each altitude shall be tested.

Step 5: Compute the reduced e.i.r.p. spectral density as $EIRPSD_{reduced} = EIRPSD - \Delta FSL$.

Step 6: For all beams in the non-GSO system notification with a class of station ES, the e.i.r.p. spectral density mask is given in Appendix **4**, data item A.27.e.

Step 7: For all emissions in the GSO network notification, compute the e.i.r.p. spectral density mask for all off-axis angles between 0° and 80°, with a step of 1°, and reduce it by ΔFSL. The e.i.r.p. spectral density mask computation should assume that the maximum gain is for an off-axis angle of 0°.

Step 8: Frequency assignments to non-GSO systems shall receive a favourable finding with respect to Annex 5 if, for all beams:

– the maximum value of the e.i.r.p. spectral density mask from Step 6 does not exceed the $EIRPSD_{reduced}$ quantity, computed at the same altitude; and

– the e.i.r.p. spectral density mask of the transmitting non-GSO space station from Step 6 is less than the reduced e.i.r.p. spectral density mask, compared in one hertz, from Step 7 for all angles for at least one emission in the GSO network notification.

Otherwise, the assignments shall receive an unfavourable finding.

APPENDIX 2 TO ANNEX 5

The aim of this Appendix is to provide a method to be used by the Radiocommunication Bureau to assess whether the emissions from a non-geostationary (non-GSO) space station operating inter-satellite links with a non-GSO space station are within the envelope of the typical earth stations of the non-GSO system.

Step 1: For each group of the transmitting non-GSO notification.

Step 2: For each of the receiving non-GSO systems, as listed in *further resolves* 1*c)* of this Resolution.

Step 3: For each beam in the Earth-to-space direction of the receiving non-GSO system notification, compute the maximum equivalent isotropically radiated power (e.i.r.p.) produced in one hertz (*EIRPSD*).

Step 4: Compute the reduction in free-space loss at the altitude of the user using:

$$\Delta FSL = 20\log_{10}\left(\frac{GSO_{alt}}{GSO_{alt} - NGSO_{alt}}\right)$$

where $NGSO_{alt}$ is the altitude of the transmitting non-GSO system space stations and GSO_{alt} = 35 786 km. It should be noted that if several altitudes are included in the notification, each altitude shall be tested.

Step 5: Compute the reduced e.i.r.p. spectral density as $EIRPSD_{reduced} = EIRPSD - \Delta FSL$.

Step 6: For all beams in the non-GSO system notification with a class of station ES, the e.i.r.p. spectral density mask is given in Appendix **4**, data item A.27.e.

Step 7: For all emissions in the receiving non-GSO network notification, compute the e.i.r.p. spectral density mask for all off-axis angles between 0° and 80°, with a step of 1°, and reduce it by ΔFSL. The e.i.r.p. spectral density mask computation should assume that the maximum gain is for an off-axis angle of 0°.

Step 8: Frequency assignments to non-GSO systems shall receive a favourable finding with respect to Annex 5 if, for all beams:

– the maximum value of the mask from Step 6 does not exceed the $EIRPSD_{reduced}$ quantity, computed at the same altitude; and

– the e.i.r.p. spectral density mask of the transmitting non-GSO space station from Step 6 is less than the reduced e.i.r.p. spectral density mask from Step 7 for all angles.

Otherwise, the assignments shall receive an unfavourable finding.

APPENDIX 3 TO ANNEX 5

To check the compliance of non-geostationary-satellite (non-GSO) emissions with the power flux-density (pfd) limit given in Annex 5, § 6, the following procedure shall be followed.

Step 1: For each of the latitudes in the equivalent isotropically radiated power (e.i.r.p.) spectral density mask given in Appendix **4** data item A.27.e, select the corresponding value to the geostationary-satellite (GSO) arc avoidance and denote it as $eirp_{\alpha}$. If the mask is non-monotonic, select the largest value in the e.i.r.p. mask considering all angles greater than or equal to the GSO arc avoidance angle as given in Appendix **4**, data item A.27.d.

Step 2a: compute the slant distance to the GSO arc as:

$$d = \sqrt{(6378 + alt)^2 + 42164^2 - 2 \times (6378 + alt) \times 42164 \times \cos(latitude)}$$

where *alt* is the altitude of the transmitting non-GSO space station, in km**,** and latitude is at the nadir of the non-GSO space station.

Step 2b: Compute the *PFD* on the GSO arc using:

$$PFD = eirp_{\alpha} - 10\log\left(4\pi\left(d \times 1000\right)^2\right)$$

Step 3: Frequency assignments to non-GSO systems shall receive a favourable finding with respect to Annex 5, § 6, if all pfd values calculated in Step 2b are below the threshold given in Annex 5, § 6.

APPENDIX 4 TO ANNEX 5

§ 7 of this Annex applies when all of the following conditions are met between frequency assignments for the notifying administration for a geostationary-satellite (GSO) fixed-satellite service (FSS) or mobile-satellite service (MSS) network and frequency assignments to the GSO inter-satellite service (ISS) space station receiving in the frequency band 27.5-30 GHz and transmitting in the frequency bands 18.1-18.6 GHz and 18.8-20.2 GHz:

– the date of receipt under No. **9.6** of the frequency assignments to the GSO FSS or MSS network is before the date of recording of the ISS frequency assignments in the Master International Frequency Register, and

– frequency overlap, and

– orbital separation of less than or equal to 2°, and

– the maximum off-axis equivalent isotropically radiated power (e.i.r.p.) spectral density of the non-GSO ISS space station towards the affected GSO FSS or MSS space station exceeds −65 + 29 – 25 * log(θ) dBW/Hz, where θ is the topocentric angular separation between the notified affected GSO FSS or MSS space station and the notified GSO ISS space station, and

– the service area of the potentially affected GSO FSS or MSS network includes the territory of its notifying administration.

RESOLUTION 680 (WRC-23)

Studies on frequency-related matters, including possible new or modified space research service (space-to-space) allocations, for future development of communications on the lunar surface and between lunar orbit and the lunar surface

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that there is increased interest in conducting scientific discovery and space exploration activities in lunar orbit and on the lunar surface;

b) that wireless communication technology is well-developed and widely deployed on the Earth and could be applied to lunar communications;

c) that point-to-multipoint systems on the lunar surface used for scientific or technological research purposes could operate in the space research service (SRS) (space-to-space) currently;

d) that lunar missions may require signals for accurate Positioning, Navigation and Timing (PNT) in the lunar region originating from Moon-orbiting satellites;

e) that the lunar environment has unique atmospheric, soil and topographic conditions;

f) that the shielded zone of the Moon (SZM) and the absence of appreciable water vapour and oxygen in the lunar atmosphere allow for radioastronomical observations which are not possible on Earth;

g) that the interests of scientific discovery and space exploration are of a global nature;

h) that lunar scientific and exploration activities can advance the development of potential future space activities beyond space research, which may in the future include other relevant radiocommunication services for lunar communications,

noting

a) that Section V of Article **22** addresses protection of radio astronomy in the SZM;

b) that Recommendation ITU-R RA.479-5 relates to the protection of frequencies for radioastronomical measurements in the SZM, with a view to preserving the unique radioastronomical capabilities in this zone;

c) that the impact of unintended electromagnetic radiation from electrical and electronic systems into radio astronomy receivers should be assessed (see Question ITU-R 243/1);

recognizing

a) that studies on sharing and compatibility between potential systems on the Moon's surface and systems orbiting the Moon would need to take into account any existing SRS applications and other affected services in the same or, as appropriate, adjacent bands;

b) that frequencies for communications between the Earth and the Moon are provided through the existing allocations to the SRS;

c) that frequencies for communications between satellites orbiting the Moon can operate in existing frequency allocations to the SRS (space-to-space) and the inter-satellite service;

d) that existing allocations to the amateur radio service have also been used for communications between the Earth and the Moon, and Earth-to-Earth via passive reflection from the Moon;

e) that dedicated frequencies are needed in the lunar vicinity for local communications between systems operating on the lunar surface and between systems in lunar orbit and systems on the lunar surface;

f) that future development of communications on the lunar surface and between lunar orbit and the lunar surface should take into account the need to maintain the opportunities for radio astronomy observations and the operation of space research sensors, including active and passive sensors on the Moon;

g) that the frequency bands 7 190-7 235 MHz (Earth-to-space) and 8 450-8 500 MHz (space-to-Earth) are allocated to the SRS on a primary basis;

h) that the frequency band 5 250-5 570 MHz is allocated to the SRS (active) on a primary basis;

i) that the frequency bands 3 500-3 800 MHz (space-to-Earth) and 5 725-5 925 MHz (Earth-to-space) are allocated to the fixed-satellite service on a primary basis;

j) that the frequency band 25.25-27.5 GHz is allocated to the inter-satellite service on a primary basis, limited to space research and Earth exploration-satellite applications, and also transmissions of data originating from industrial and medical activities in space, as stipulated in No. **5.536**;

k) that the fixed and mobile (in some bands mobile, except aeronautical mobile) services are allocated on a primary basis within the frequency ranges 390-399.9 MHz, 400.05-401 MHz by No. **5.262**, 420-430 MHz, 440-450 MHz, 2 400-2 690 MHz, 3 500-3 800 MHz, 5 650-5 850 MHz by No. **5.453**, 7 190-7 235 MHz, 8 450-8 500 MHz and 25.25-28.35 GHz;

l) that the mobile, except aeronautical mobile, service is allocated on a primary basis in the frequency ranges 5 150-5 350 MHz and 5 470-5 725 MHz, the aeronautical mobile service is allocated on a primary basis under Nos. **5.446C** and **5.446D** in the frequency band 5 150-5 250 MHz, the fixed service is allocated on a primary basis under No. **5.447E** in the frequency band 5 250-5 350 MHz and the fixed service is allocated on a primary basis in the frequency band 5 670-5 850 MHz in No. **5.455**;

m) that the aeronautical radionavigation service is allocated on a primary basis in the frequency bands 5 150-5 250 MHz and 5 350-5 460 MHz and by No. **5.450** in the frequency band 5 470-5 650 MHz, the radionavigation service is allocated on a primary basis in the frequency band 2 450-2 500 MHz (Regions 2 and 3), in the frequency band 5 250-5 350 by No. **5.448** and in the frequency band 5 460-5 470 MHz, the maritime radionavigation is allocated on a primary basis in the frequency range 5 470-5 650 MHz, the radiolocation service (RLS) is allocated on a primary basis in the frequency range 5 250-5 850 MHz, and the RLS is allocated on a primary basis under No. **5.269** in the frequency bands 420-430 MHz and 440-450 MHz,

n) that the broadcasting-satellite service (BSS) is allocated on a primary basis in the frequency range 2 520-2 670 MHz, and the BSS (sound) and complementary terrestrial sound broadcasting service are allocated on a primary basis under No. **5.418** in the frequency band 2 535-2 565 MHz;

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

1 studies of the spectrum needs of systems in the SRS which may operate on the lunar surface, or systems in lunar orbit communicating with systems on the lunar surface, in the following frequency ranges or portions thereof, taking into account *noting a)*, *b)* and *c)*:

– 390-406.1 MHz, 420-430 MHz and 440-450 MHz, limited to outside the SZM

– 2 400-2 690 MHz, 3 500-3 800 MHz, 5 150-5 570 MHz, 5 570-5 725 MHz, 5 775-5 925 MHz, 7 190-7 235 MHz, 8 450-8 500 MHz and 25.25-28.35 GHz;

2 studies of the technical and operational characteristics, as well as protection criteria, of systems in the SRS that are planned for operation in the frequency bands in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* 1, as well as protection criteria to be applied for the protection of the radio astronomy service (RAS) and SRS active and passive sensors on the lunar surface and lunar orbit;

3 studies of the propagation considerations for lunar surface systems and lunar-orbiting systems operating in the frequency ranges in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* 1;

4 studies of sharing and compatibility related to systems in the SRS that are planned for operation in the frequency ranges identified in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* 1 to ensure protection of:

– radiocommunication services, as specified in *recognizing g)* to *n)*, and

– the RAS on the Earth and in the SZM in the same, adjacent or nearby bands;

5 studies of potential new or modified frequency allocations and/or identifications to the SRS with appropriate regulatory provisions, for communications on the lunar surface or in lunar orbit communicating with systems on the lunar surface,

invites the ITU Radiocommunication Sector

1 to begin studying, taking into account *considering h)*, future spectrum needs for lunar communications and systems, beyond those identified in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* 1, which may be needed for communications between the Earth, lunar-orbiting spacecraft and the lunar surface;

2 to study whether future radiocommunications in the vicinity of the Moon, as described in *considering h)*, can be accommodated within existing space radiocommunication services and whether the regulatory provisions described in the Radio Regulations are sufficient,

invites administrations

to participate in the studies by submitting contributions to the ITU Radiocommunication Sector,

invites the 2027 world radiocommunication conference

to consider, based on the results of the studies referred to in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* 1 to 5, new or modified allocations and/or identifications in the SRS in the frequency ranges in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* 1 above, or portions thereof, for use in the vicinity of the Moon,

instructs the Director of the Radiocommunication Bureau

to report to WRC-27 on the progress of the studies referred to in *invites the ITU Radiocommunication Sector* 1 and 2 above,

invites a future competent world radiocommunication conference after WRC-27

to consider, if necessary, appropriate regulatory actions based upon the studies called for in *invites the ITU Radiocommunication Sector* 1 and 2 above.

RESOLUTION 681 (WRC-23)

Studies of technical and regulatory provisions necessary to protect radio astronomy operating in specific Radio Quiet Zones and, in radio astronomy service primary allocated frequency bands globally, from aggregate radio-frequency interference caused by systems in the non-geostationary-satellite orbit

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that radio astronomy is a pivotal scientific discipline that plays a crucial role in unravelling the mysteries of the cosmos;

b) that the number of non-geostationary-satellite orbit (non-GSO) satellite launches has increased in recent years and even more launches are planned for the next decade;

c) that for the purpose of this Resolution, a Radio Quiet Zone (RQZ) is any recognized geographic area within which the usual spectrum management procedures are modified for the specific purpose of reducing or avoiding interference with radio telescopes, thereby maintaining the required standards for quality and availability of observational data, as defined in Report ITU-R RA.2259;

d) that aggregate emissions from single and multiple non-GSO satellite systems may cause interference to the radio astronomy service (RAS), even in RQZs, which may be challenging to resolve with only national regulation;

e) that non-GSO satellite systems are being considered for future use as part of terrestrial networks under the mobile-satellite service (MSS);

f) that a number of administrations have implemented regulations to establish RQZs which may not be applicable to satellite operations;

g) that the 2023 Radiocommunication Assembly instructed ITU Radiocommunication Sector (ITU-R) Study Group 7 to facilitate information sharing to enable better coordination between satellite operators and RAS sites, including, for example, the creation of a database of RQZs;

h) that the potential impact of non-GSO satellite systems on astronomy has been recognized and is currently being discussed in the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) under the name “Dark and Quiet Skies”;

i) that the impact of non-GSO satellite systems on radio astronomy has been recognized by the International Astronomical Union by creating the Centre for the Protection of the Dark and Quiet Sky from Satellite Constellation Interference;

j) that a small number of remote RAS stations are of the utmost importance as they are designed to make observations of significance, resulting in new knowledge of astronomical phenomena, which may require observations of objects not previously studied, or observing objects with increased precision;

k) that, for the purpose of this Resolution, the facilities which fall into the category defined in *considering j)* are:

– the Square Kilometre Array Observatory in South Africa;

– the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile;

l) that the RAS stations in *considering k)* must be able to operate in much larger frequency ranges than those currently allocated to the RAS in order to meet their scientific goals;

m) that the RAS stations in *considering k)* are afforded a national RQZ, while only a small fraction of other RAS stations are surrounded by RQZs;

n) that current approaches and procedures may not be sufficient to ensure protection of the RAS from emissions produced by the increasing number of non-GSO satellite systems,

noting

a) that Recommendation ITU-R RA.769 provides thresholds for the non-GSO satellite interference received through the far side lobes of radio astronomy telescopes;

b) that Recommendation ITU-R RA.1031 addresses the protection of radio astronomy in shared bands;

c) that Recommendation ITU-R RA.1513 provides the acceptable levels of data loss to radio astronomy observations and percentage-of-time criteria resulting from degradation by interference for frequency bands allocated to the RAS on a primary basis;

d) that Recommendation ITU-R M.1583 provides the calculations for interference between non-GSO MSS or radio navigation-satellite service (RNSS) and radio astronomy telescope sites;

e) that Recommendation ITU-R S.1586 provides the method for calculating unwanted emission levels produced by a non-GSO FSS at radio astronomy sites;

f) that Report ITU-R RA.2259 contains characteristics of national RQZs and measures to establish them,

recognizing

a) that No. **29.12** highlights the susceptibility of radio astronomy to harmful interference from space-borne transmitters;

b) that the spectrum requirements for radio astronomy stations in *considering k)* are fulfilled by the primary and secondary allocations, as well as by national arrangements;

c) that there are no examinations currently performed by the Bureau with regard to RAS protection from satellite systems under Articles **9** or **11**;

d) that the compatibility issues between the RAS and non-GSO systems may be addressed by technical mitigation measures before satellites are launched and operational;

e) that for non-GSO systems the equivalent power flux density (epfd) method, which is developed in Recommendations ITU-R M.1583 and ITU-R S.1586, provides a sufficiently accurate estimate of the total power that is introduced into RAS receivers and can be used to incorporate the effects of other technical parameters;

f) that national regulations for radio astronomy in the RQZ may be different for each administration, leading to varying protection measures;

g) that some non-GSO systems currently operate in frequency bands adjacent to RAS primary allocations;

h) that the specific protection measures for the RAS agreed between administrations are outside the scope of this Resolution,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

1 studies on how the interference from unwanted emissions from a single non-GSO satellite system operating in the adjacent and nearby frequency bands in Table 1 affects the operation of RAS stations in frequency bands allocated to the RAS on a primary basis in Table 1;

2 studies on how the aggregate interference from unwanted emissions from multiple non-GSO satellite systems operating in the adjacent and nearby frequency bands in Table 1 affect the operation of RAS stations in frequency bands allocated to the RAS on a primary basis in Table 1;

3 studies on the possible recognition of the RQZs specified in *considering k)* above, based on their characteristics and existing ITU-R studies;

4 studies on how the aggregate interference from single and multiple non-GSO satellite systems affects the operation of RAS stations in the RQZs specified in *considering k)*;

5 studies on new coexistence measures between non-GSO satellite systems and RAS stations in the RQZs specified in *considering k)*;

6 studies of methods to calculate the necessary separation distances between gateways of non-GSO systems operating in bands adjacent to or near RAS allocations and RAS stations protected by the RQZs specified in *considering k)*,

invites administrations

to participate actively in the studies and provide the technical and operational characteristics of the systems involved and other information required for the studies by submitting contributions to the ITU-R,

invites the 2027 world radiocommunication conference

1 to consider appropriate technical and/or regulatory measures based on the results of the studies mentioned in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* 1;

2 to consider, if deemed appropriate, based on the studies mentioned in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* 3, 4, 5 and 6, potential solutions to characterize the RQZs in *considering k)* in the Radio Regulations and/or in a WRC Resolution,

instructs the Secretary-General

to bring this Resolution to the attention of COPUOS and other international and regional organizations concerned.

TABLE 1

RAS frequency bands to be studied and corresponding active services to be included

Radio astronomy frequency band	Active space service operating in adjacent or nearby frequency band	Active space service (space-to-Earth)	Scope
10.6-10.7 GHz	10.7-10.95 GHz	FSS	*Resolves etc.* 1 and 2
42.5-43.5 GHz	42-42.5 GHz	FSS	*Resolves etc.* 2
76-77.5 GHz	74-76 GHz	FSS, MSS	*Resolves etc.* 2
94.1-95 GHz	95-100 GHz	RNSS, MSS	*Resolves etc.* 2
100-102 GHz	95-100 GHz	RNSS, MSS	*Resolves etc.* 1 and 2
114.25-116 GHz	116-119.98 GHz	ISS	*Resolves etc.* 1 and 2
130-134 GHz	123-130 GHz	FSS, MSS, RNSS	*Resolves etc.* 2

RESOLUTION 682 (WRC-23)

Consideration of regulatory provisions and potential primary allocations to the meteorological aids service (space weather) to accommodate receive-only space weather sensor applications in the Radio Regulations

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that space weather data is important to understanding the physical process of providing prediction models for space weather events and their impacts on services critical to the economy, safety and security of administrations and the population of their countries as:

– space weather observations are important for detecting natural phenomena, mainly originating from solar activity and occurring beyond the major portion of the Earth's atmosphere;

– the collection and exchange of space weather data are important to understanding the origin of these phenomena and the physical processes;

b) that the importance of space weather radiocommunication applications has been stressed by a number of international bodies, such as the World Meteorological Organization, the Intergovernmental Panel on Climate Change, the United Nations Office for Disaster Risk Reduction, the International Civil Aviation Organization, the United Nations Office for Outer Space Affairs and the United Nations Committee on the Peaceful Uses of Outer Space, and that ITU Radiocommunication Sector (ITU-R) collaboration with these bodies is essential;

c) that these observations could be made from space- and ground-based systems, and guidance in the design of those systems is necessary;

d) that the observational frequencies used by these space weather sensors have been chosen based on the physical properties of the observed phenomena;

e) that some receive-only sensors operate by receiving low-level emissions, including, but not limited to, emissions from the Sun, the Earth's atmosphere and other celestial bodies, and may therefore suffer harmful interference in the future;

f) that radio regulatory protection is needed for space weather observation systems that are used operationally in the production of forecasts and warnings of space weather events that can cause harm to important sectors of national economies and security, as well as human welfare;

g) that the bandwidth requirement for observations by receive-only space weather sensors may typically encompass a minimum continuous bandwidth,

noting

a) that Resolution **675 (WRC-23)**:

– defines space weather;

– designates space weather sensors to the meteorological aids service (MetAids) in the subset MetAids (space weather);

b) that Report ITU-R RS.2456, on space weather sensor systems using radio-frequency spectrum, contains:

– a summary of spectrum-reliant space weather sensors; and

– a description of the systems for operational space weather monitoring, prediction and warnings deployed globally;

c) that, within ITU-R, work is ongoing to determine the spectrum requirements of receive-only space weather sensors and their protection criteria in response to Question ITU-R 256/7;

d) that Resolution 136 (Rev. Bucharest, 2022) of the Plenipotentiary Conference highlights the use of telecommunications/information and communication technologies for monitoring and management in emergency and disaster situations for early warning, prevention, mitigation and relief,

recognizing

a) that no frequency bands have been documented in any manner in the Radio Regulations for space weather sensor applications;

b) that, while data products are used for forecasts and warnings related to public safety, among other purposes, the provisions of Nos. **1.59** and **4.10** do not apply to spectrum-reliant space weather sensors;

c) that some receive-only space weather sensors in operation utilize bands not currently allocated to the MetAids service, and some of them need to continue their current operation;

d) that the current provisions of Article **11** do not allow an administration to notify a frequency assignment to a receive-only terrestrial radio station, except for certain types of station (see Nos. **11.2**, **11.9** and **11.12**), and that therefore no procedure for notifying receive-only MetAids (space weather) stations is provided;

e) that receive-only space weather sensors are considered in the studies under this Resolution on the understanding that these sensors will be deployed only at a limited number of specific locations and not in a ubiquitous manner,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

1 studies on spectrum needs and appropriate protection criteria for receive-only space weather sensors, as well as system characteristics, as appropriate, taking into account *noting a)*;

2 sharing and compatibility studies pertaining to potential new primary allocations to MetAids (space weather) in the following frequency bands for receive-only sensors, taking into account *further resolves* 2:

– 27.5-28.0 MHz;

– 29.7-30.2 MHz;

– 32.2-32.6 MHz;

– 37.5-38.325 MHz;

– 73.0-74.6 MHz;

– 608-614 MHz;

3 studies on possible regulatory provisions of the Radio Regulations to accommodate the possibility for an administration that desires to notify a receive-only space weather sensor station to be included in the Master International Frequency Register,

further resolves

1 that no notification of frequency assignments to a station used for space weather observation be made by administrations under MetAids (space weather) until WRC-27 introduces the corresponding allocations in Article **5**;

2 that any possible new primary MetAids (space weather) allocations to be made under *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* 2 shall not claim protection from, or constrain the future development of, incumbent services in these frequency bands or in adjacent bands,

invites administrations

to participate actively in the studies and provide the information required for the studies listed under *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* by submitting contributions to ITU-R,

invites the 2027 world radiocommunication conference

to take appropriate actions, including potential new primary receive-only MetAids (space weather) allocations, based on the results of the studies under *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference*, taking into account *further resolves* 2,

invites relevant international organizations

to participate actively in the relevant ITU-R studies by providing information that should be taken into account in ITU-R studies,

instructs the Secretary-General

to bring this Resolution to the attention of the relevant international organizations.

RESOLUTION 683 (WRC-23)

Study of technical and operational issues and regulatory provisions to support inter-satellite service transmissions in the frequency bands 3 700-4 200 MHz and 5 925-6 425 MHz for non-geostationary-satellite space stations communicating with geostationary-satellite space stations[1]

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that many non-geostationary-satellite orbit (non-GSO) satellites operate with limited and non-real-time connectivity to earth stations;

b) that inter-satellite service (ISS) communications between such non-GSO satellites and geostationary-satellite orbit (GSO) satellites would enhance the efficiency of operations and that the effective reuse of some frequency bands allocated to the fixed-satellite service (FSS) for transmissions between such space stations may increase the efficiency of use of those frequency bands;

c) that there is growing interest in utilizing ISS links for a variety of applications and that there have been expressions of interest by some administrations in using the frequency bands 3 700-4 200 MHz and 5 925-6 425 MHz for ISS transmissions between space stations in those frequency bands,

noting

a) that the use of frequency bands by the FSS in the frequency bands 3 700-4 200 MHz and 5 925-6 425 MHz is subject to existing Resolutions, coordination requirements and country footnotes, taking into account, in particular, the protection of incumbent services;

b) that the frequency band 3 700-4 200 MHz is allocated to the fixed and mobile services on a primary basis in Regions 2 and 3;

[*c)*[*] that, in Region 1, the frequency band 3 700-4 200 MHz is allocated to the fixed service on a primary basis and the frequency band 3 700-3 800 MHz is allocated to the mobile service on a primary basis;]

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[1] *Note by the Secretariat:* The square brackets appearing in this Resolution have been kept with the understanding that this Resolution, which is on the WRC-31 preliminary agenda (see Resolution **814 (WRC-23)**), should be considered at WRC-27.

[[*] This Region 1 allocation for fixed and mobile services is pending the WRC-23 outcome, and this *noting* should be revised or removed based on the conclusion of WRC-23 agenda item 1.2/1.3.]

[*d)*[**] that, in Region 2, the frequency band 3 600-3 700 MHz is identified on a regional basis for International Mobile Telecommunications (IMT) and the frequency band 3 700-3 800 MHz is identified for IMT via No. **5.435B**;]

e) that any future use of the ISS in the frequency band 3 700-4 200 MHz shall not claim protection from terrestrial services operating in conformity with the Radio Regulations;

f) that the FSS and fixed and mobile services are allocated globally on a co-primary basis in the frequency band 5 925-6 425 MHz;

g) that the use of the frequency bands 3 700-4 200 MHz and 5 925-6 425 MHz by the non-GSO FSS is subject to the application of the provisions of Nos. **22.5C** and **22.5D**;

h) that the frequency band 5 925-6 425 MHz may be used for the FSS (Earth-to-space) for the provision of earth stations located on board vessels, subject to Nos. **5.457A** and **5.457B**;

i) that the use of the frequency band 5 925-6 425 MHz for aeronautical mobile telemetry is subject to the application of the provisions of No. **5.457C**,

noting further

that sharing and compatibility studies were performed between ISS links intending to operate between space stations in the frequency bands 18.1-18.6 GHz, 18.8-20.2 GHz and 27.5-30 GHz and current and planned stations of the FSS and other existing services allocated in the same frequency bands and adjacent frequency bands, including passive services, with a view to ensuring protection of the primary services,

recognizing

a) that the frequency bands 3 700-4 200 MHz and 5 925-6 425 MHz are also allocated to other radiocommunication services on a primary basis, that those allocations are used by a variety of incumbent systems in many administrations and that the protection of those services should be studied;

b) that, for the determination of the incumbent services, the relevant provisions of the Radio Regulations in force apply,

recognizing further

a) that any future ISS use in the frequency band 3 700-4 200 MHz shall not claim protection from terrestrial services or other FSS applications operating consistent with the Radio Regulations;

b) that sharing scenarios may vary because of the wide variety of orbital characteristics of non-GSO FSS space stations,

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[**These Region 2 identifications for IMT are pending the WRC-23 outcome, and this *noting* should be revised or removed based on the conclusion of WRC-23 agenda item 1.2.]

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference

1 studies on spectrum requirements, technical and operational characteristics and sharing and compatibility, with incumbent [*, **, including secondary,] services, taking into account *noting a)* to *i)*, for non-GSO space stations that operate or plan to operate ISS links with GSO FSS networks in the following frequency bands:

a) in the Earth-to-space direction in the frequency band 5 925-6 425 MHz, for transmissions from non-GSO user space stations operating at lower orbital altitudes, in communication with GSO FSS service provider space stations; and

b) in the space-to-Earth direction in the frequency band 3 700-4 200 MHz, for transmissions from GSO FSS service provider space stations, towards non-GSO user space stations;

2 to develop technical conditions and regulatory provisions to ensure protection of other services allocated in those frequency bands for the operation of ISS links taking into account the results of the studies called for in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference* 1 above,

invites administrations

to participate actively in the studies and provide the information required for the studies listed under *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference* by submitting contributions to the ITU Radiocommunication Sector (ITU-R),

invites the 2031 world radiocommunication conference

to consider, based on the results of ITU-R studies, to support ISS allocations in the frequency bands 3 700-4 200 MHz and 5 925-6 425 MHz, and associated regulatory provisions, to enable links between non-GSO and GSO satellites.

RESOLUTION 684 (WRC-23)

Studies on possible new allocations to the radionavigation-satellite service (space-to-Earth) in the frequency bands [5 030-5 150 MHz and 5 150-5 250 MHz] or parts thereof*

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that radionavigation-satellite service (RNSS) systems and networks are intended to provide accurate information for many positioning, navigation and timing applications;

b) that, with growing user demands and technology improvement, the current RNSS allocations might not be sufficient to respond to requirements for higher positioning accuracy, network availability and robustness in the future;

c) that the frequency band 5 010-5 030 MHz is allocated worldwide to the RNSS (space-to-Earth) on a primary basis;

d) that the frequency band 5 150-5 216 MHz is allocated to the radiodetermination-satellite service (RDSS) (space-to-Earth) under the provisions described in No. **5.446**,

noting

a) that the frequency band 5 030-5 091 MHz is allocated to the aeronautical mobile (R) service (AM(R)S) (see No. **5.443C**), aeronautical mobile-satellite (R) service (AMS(R)S) (see No. **5.443D**) and aeronautical radionavigation service (ARNS) (see No. **5.444**) on a primary basis;

b) that the frequency band 5 091-5 150 MHz is allocated to the fixed-satellite service (FSS) (Earth-to-space) (see No. **5.444A**), aeronautical mobile service (see No. **5.444B**), AMS(R)S (see No. **5.443AA**) and ARNS (see No. **5.444**) on a primary basis;

c) that the frequency band 5 150-5 250 MHz is allocated to the FSS (Earth-to-space), the mobile, except aeronautical mobile, service subject to No. **5.446A** and the ARNS (see No. **5.444**) on a primary basis;

d) that the frequency band 5 250-5 350 MHz is allocated to the Earth exploration-satellite (active), mobile, except aeronautical mobile, (see Nos. **5.446A** and **5.447F**), radiolocation and space research (active) (see No. **5.447D**) services on a primary basis;

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* The appearance of square brackets around certain frequency bands in this Resolution is understood to mean that WRC-27 will consider and review the inclusion of these frequency bands with square brackets and decide, as appropriate.

e) that the frequency bands 5 150-5 250 MHz and 5 250-5 350 MHz are used by wireless access systems, including radio local area networks, under the mobile service and their operation is subject to Resolution **229 (Rev.WRC-23)**;

f) that the AM(R)S in the frequency band 5 091-5 150 MHz is limited to surface applications at airports and operated in accordance with standards and recommended practices (SARPs) in Annex 10 to the Convention on International Civil Aviation;

g) that the ARNS in the frequency band 5 030-5 091 MHz is operated in accordance with SARPs in Annex 10 to the Convention on International Civil Aviation, and that SARPs are under development for the AM(R)S and AMS(R)S in this band,

recognizing

a) that the possible addition of the RNSS (space-to-Earth) in the frequency bands [5 030-5 150 MHz and 5 150-5 250 MHz], or parts thereof, shall ensure protection of, and not impose constraints on, the development of incumbent services in the same and adjacent bands;

b) that the use of the frequency band 5 150-5 216 MHz by the RDSS is limited to feeder links in conjunction with the RDSS operating in the frequency bands 1 610-1 626.5 MHz and/or 2 483.5-2 500 MHz, and that the total power flux-density (pfd) at the Earth's surface shall in no case exceed −159 dB(W/m^2) in any 4 kHz band for all angles of arrival (see No. **5.446**);

c) that the characteristics and protection criteria for the receiving earth stations and also the transmitting space stations of RNSS in the frequency band 5 010-5 030 MHz are presented in Recommendation ITU-R M.2031;

d) that, in order not to cause harmful interference to the microwave landing system operating above 5 030 MHz, the aggregate pfd produced at the Earth's surface in the frequency band 5 030-5 150 MHz by all the space stations within any RNSS system (space-to-Earth) operating in the frequency band 5 010-5 030 MHz shall not exceed −124.5 dB(W/m^2) in a 150 kHz band (see No. **5.443B**);

e) that, in order not to cause harmful interference to the radio astronomy service (RAS) in the frequency band 4 990-5 000 MHz, RNSS systems operating in the frequency band 5 010-5 030 MHz shall comply with the limits in the frequency band 4 990-5 000 MHz defined in Resolution **741 (Rev.WRC-15)** (see No. **5.443B**);

f) that Recommendation ITU-R SM.1535 provides information on the protection of safety services from unwanted emissions,

resolves to invite the ITU Radiocommunication Sector to conduct and complete in time for the 2031 world radiocommunication conference

1 studies on spectrum requirements and technical and operational characteristics for the RNSS, in particular in the space-to-Earth direction between [5 030 and 5 250 MHz];

2 studies on sharing and compatibility between RNSS and the incumbent services allocated in the frequency range [5 030-5 250 MHz] and the adjacent-band services and studies related to the protection of the RAS in the frequency band 4 990-5 000 MHz, taking into account *recognizing a)*,

invites the 2031 world radiocommunication conference

to consider, based on the results of studies, possible allocations to the RNSS (space-to-Earth) in the frequency bands [5 030-5 150 MHz and 5 150-5 250 MHz] or parts thereof,

invites administrations

to participate actively in ITU Radiocommunication Sector (ITU-R) studies and provide the technical and operational characteristics of the systems involved by submitting contributions to ITU-R,

instructs the Secretary-General

to bring this Resolution to the attention of the international and regional organizations concerned.

RESOLUTION 685 (WRC-23)

Studies towards frequency allocations for the Earth exploration-satellite service (space-to-Earth) within the frequency range [37.5-52.4 GHz]*

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the frequency band 40-40.5 GHz is allocated worldwide to the Earth exploration-satellite service (EESS) (Earth-to-space) on a primary basis;

b) that a frequency allocation to the EESS (space-to-Earth) above 37.5 GHz would allow its use for payload data transmissions in combination with the existing EESS (Earth-to-space) allocation referred to in *considering a)*;

c) that a frequency allocation to the EESS (space-to-Earth) above 37.5 GHz would allow for uplinks and downlinks on the same transponder, increasing efficiency and reducing satellite complexity,

noting

a) that the frequency band 37.5-40.5 GHz is allocated worldwide to the EESS (space-to-Earth) on a secondary basis;

b) that the frequency band 37.5-40.5 GHz is allocated to a number of services on a primary basis,

recognizing

a) the importance of the appropriate regulatory status and certainty to accommodate the requirements of future Earth observation missions;

b) that, in order to meet those requirements, primary allocation to the EESS (space-to-Earth) in certain frequency bands above 37.5 GHz might be required,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference

1 the review of the existing allocation to the EESS (space-to-Earth) in the frequency band [37.5-40.5 GHz], and sharing and compatibility studies as necessary, in order to determine the feasibility of upgrading this frequency allocation to primary status while ensuring the protection of the primary services;

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* The appearance of square brackets around certain frequency bands in this Resolution is understood to mean that WRC-27 will consider and review the inclusion of these frequency bands with square brackets and decide, as appropriate.

2 the identification of frequency bands within the frequency range [40.5-52.4 GHz], and sharing and compatibility studies as necessary, in order to determine the feasibility of creating new primary allocations to the EESS (space-to-Earth) in these bands, while ensuring the protection of the primary services,

invites administrations

to participate actively in the studies by submitting contributions to the ITU Radiocommunication Sector,

invites the 2031 world radiocommunication conference

to consider, based on the results of studies, an upgrade of the secondary allocation to the EESS (space-to-Earth) in the frequency band [37.5-40.5 GHz] or possible new worldwide allocations on a primary basis to the EESS (space-to-Earth) in certain frequency bands within the frequency range [40.5-52.4 GHz],

instructs the Secretary-General

to bring this Resolution to the attention of international and regional organizations concerned.

RESOLUTION 686 (WRC-23)

Possible secondary allocation to the Earth exploration-satellite service (active) in the frequency bands [3 000-3 100 MHz] and [3 300-3 400 MHz]*

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that spaceborne active radio-frequency sensors can provide unique information on the physical properties of the Earth;

b) that spaceborne active remote sensing requires specific frequency ranges, depending on the physical phenomena to be observed;

c) that there is an interest in using active spaceborne sensors in the 3 GHz frequency range primarily for measurement of ice boundaries, type and age, ocean wave structure, ocean wind speed and direction and mapping of ocean circulation (currents and eddies);

d) that the frequency band 3 100-3 300 MHz is already allocated to the Earth exploration-satellite service (EESS) (active) on a secondary basis and is currently being used for altimeters and synthetic aperture radars (SARs);

e) that a frequency band of at least 400 MHz is preferable to satisfy the requirements for high-resolution SARs;

f) that SARs in the 3 GHz frequency range are not intended to be operated in populated areas of the globe, but primarily over oceans and seas,

recognizing

a) that the frequency band 3 000-3 100 MHz is allocated to the radiolocation service (RLS) and radionavigation service on a primary basis;

b) that the frequency band 3 300-3 400 MHz is allocated to the RLS on a primary basis;

c) that the frequency band 3 300-3 400 MHz is also allocated to the amateur service on a secondary basis in Regions 2 and 3;

d) that the frequency band 3 300-3 400 MHz is also allocated to the fixed and mobile services on a secondary basis in Region 2;

e) that the frequency band 3 300-3 400 MHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis in certain countries under Nos. **5.429A**, **5.429C** and **5.429E**;

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* The appearance of square brackets around certain frequency bands in this Resolution is understood to mean that WRC-27 will consider and review the inclusion of these frequency bands with square brackets and decide, as appropriate.

f) that the frequency band 3 300-3 400 MHz is identified for the implementation of International Mobile Telecommunications in certain countries in Regions 1 and 2 under Nos. **5.429B** and **5.429D**;

g) that, in accordance with No. **5.149**, administrations are urged to take all practicable steps to protect the radio astronomy service from harmful interference in the frequency bands 3 332-3 339 MHz and 3 345.8-3 352.5 MHz,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference

studies on spectrum needs and studies on the possibility of sharing between the EESS (active) and incumbent radio services in the frequency bands [3 000-3 100 MHz] and [3 300-3 400 MHz],

invites the 2031 world radiocommunication conference

to consider the results of studies for a possible new secondary allocation to the EESS (active) for spaceborne SARs in the frequency bands [3 000-3 100 MHz] and [3 300-3 400 MHz], taking into account the protection of incumbent services, and take appropriate action,

invites administrations

to participate actively in the studies by submitting contributions to the ITU Radiocommunication Sector.

RESOLUTION 703 (REV.WRC-07)

Calculation methods and interference criteria recommended by ITU-R for sharing frequency bands between space radiocommunication and terrestrial radiocommunication services or between space radiocommunication services

The World Radiocommunication Conference (Geneva, 2007),

considering

a) that, in frequency bands shared with equal rights by space radiocommunication and terrestrial radiocommunication services, it is necessary to impose certain technical limitations and coordination procedures on each of the sharing services for the purpose of limiting mutual interference;

b) that, in frequency bands shared by space stations located on geostationary satellites, it is necessary to impose coordination procedures for the purpose of limiting mutual interference;

c) that the calculation methods and interference criteria relating to coordination procedures referred to in *considering a)* and *b)* are based upon ITU-R Recommendations;

d) that, in recognition of the successful sharing of the frequency bands by space radiocommunication and terrestrial radiocommunication services, and the continuing improvements in space technology and that of the Earth segment, each Radiocommunication Assembly has improved upon some of the technical criteria recommended by the preceding Assembly;

e) that the ITU Radiocommunication Assembly has approved a procedure for approving Recommendations between Radiocommunication Assemblies;

f) that the Constitution recognizes the right of Member States to make special arrangements on telecommunication matters; however, such arrangements shall not be in conflict with the terms of the Constitution, Convention or of the Regulations annexed thereto as far as harmful interference to the radio services of other countries is concerned;

g) that the use of this Resolution may reduce the need for incorporation by reference of some ITU-R Recommendations,

is of the opinion

a) that future decisions of ITU-R are likely to make further changes in the recommended calculation methods and interference criteria;

b) that the administrations should whenever possible apply the current ITU-R Recommendations on sharing criteria when planning systems for use in frequency bands shared with equal rights between space radiocommunication and terrestrial radiocommunication services, or between space radiocommunication services,

invites administrations

to submit contributions to the Radiocommunication Study Groups, providing information on practical results and experience of sharing between terrestrial and space radiocommunication services or between space services, which help to bring about significant improvements in coordination procedures, calculation methods and harmful interference thresholds, and thereby to optimize the available orbit/spectrum resources,

resolves

1 that the Director of the Radiocommunication Bureau, in consultation with Study Group Chairmen, shall annually prepare a list identifying the relevant newly approved ITU-R Recommendations relating to sharing between space radiocommunication and terrestrial radiocommunication services, or between space radiocommunication services;

2 that the Director of the Radiocommunication Bureau shall, once a year, publish this list electronically for the information of all administrations.

RESOLUTION 705 (REV.WRC-15)

Mutual protection of radio services operating in the frequency band 70-130 kHz

The World Radiocommunication Conference (Geneva,2015),

considering

a) that various radio services, including radionavigation systems used by maritime and aeronautical services, operate in frequency bands between 70 and 130 kHz;

b) that, radionavigation being a safety service, all practical steps consistent with the Radio Regulations should be taken to prevent harmful interference to any radionavigation system;

c) that the ITU-R has noted that users of phased pulse radionavigation systems in the frequency band 90-110 kHz receive no protection outside the frequency band, yet may receive benefit from their signals outside the occupied bandwidth,

noting

that ITU-R studies show:

– that for continuous wave radionavigation systems in the frequency bands 70-90 kHz and 110-130 kHz, the protection ratio should be 15 dB within the receiver passband of ±7 Hz at 3 dB;

– that phased pulse radionavigation systems require a 15 dB protection ratio within the frequency band 90-110 kHz;

– that these pulse radionavigation systems would be aided by protection ratios of 5 dB and 0 dB for frequency separations between wanted and interfering signal of 10-15 kHz and 15-20 kHz, respectively,

further noting

that the ITU-R has recommended the exchange of information between authorities operating radionavigation systems in the frequency band 90-110 kHz and those operating other systems in the frequency band 70-130 kHz employing emissions of very high stability,

recognizing

a) that radio services other than radionavigation operating in the frequency bands 70-90 kHz and 110-130 kHz fulfil essential functions that may be affected;

b) the provisions of Nos. **4.5**, **4.10**, **5.60** and **5.62**,

resolves that administrations

1 in assigning frequencies to services in the frequency bands 70-90 kHz, 90-110 kHz and 110-130 kHz, consider the potential mutual impairment to other stations operating in accordance with the Table of Frequency Allocations and apply protective measures;

2 use the relevant ITU-R Recommendations and encourage the exchange of information between authorities operating radionavigation systems in the frequency band 90-110 kHz and those operating other systems in the frequency band 70-130 kHz employing emissions of very high stability, to assist in preventing potential interference problems;

3 encourage consultation, both nationally and internationally, between operators of radionavigation systems using the frequency band 90-110 kHz and of other systems using the frequency band 70-130 kHz,

requests the ITU-R

to continue studies in this matter, particularly the development of technical criteria and standards to permit compatible operations within the allocated frequency bands.

RESOLUTION 712 (WRC-23)

Studies on compatibility between the Earth exploration-satellite service (passive), the radio astronomy service in certain bands above 76 GHz, and active services in adjacent and nearby frequency bands

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that WRC-2000 made a number of different allocation changes to the frequency bands above 71 GHz, including primary allocations to the Earth exploration-satellite service (EESS) (passive) subject to No. **5.340**, based on the requirements known at the time of that conference;

b) that primary allocations have been made to various active services in frequency bands adjacent to frequency bands above 86 GHz allocated to the EESS (passive) subject to No. **5.340**;

c) that primary service allocations have been made, in adjacent or nearby frequency bands, to the radio astronomy service (RAS) and to various space services, such as the fixed-satellite service (FSS), mobile-satellite service (MSS), broadcasting-satellite service (BSS) and radionavigation-satellite service (RNSS), hereinafter referred to as "active satellite services", in frequency bands above 76 GHz;

d) that unwanted emissions from active services have the potential to cause unacceptable interference to the EESS (passive) and the RAS;

e) that, in many cases, the frequencies used by EESS (passive) sensors and stations of the RAS are chosen to study natural phenomena producing radio emissions at frequencies fixed by the laws of nature, and therefore shifting frequency to avoid or mitigate interference problems is not possible;

f) that the current regulatory provisions and procedures may require review to ensure protection of the EESS (passive) and the RAS from harmful interference produced by active services as listed in Tables 1 and 2 below,

noting

a) that Resolution **750 (Rev.WRC-19)** deals with compatibility between the EESS (passive) and some active services;

b) that Resolution **750 (Rev.WRC-19)** already contains provisions to protect the EESS (passive) in the frequency band 86-92 GHz from emissions of the fixed service in the frequency bands 81-86 GHz and 92-94 GHz and that there is no intention to change these provisions;

c) that there is no intention to change the existing allocations or status of allocations in Article **5** for the frequency bands above 86 GHz;

d) that interference criteria for EESS (passive) sensors have been developed and are given in Recommendation ITU-R RS.2017;

e) that typical technical and operational characteristics of EESS (passive) systems are given in Recommendation ITU-R RS.1861;

f) that the allocation to the inter-satellite service in the frequency band 116-119.98 GHz is subject to No. **5.562C**;

g) that Resolution **739 (Rev.WRC-19)** applies under No. **5.208B** for the frequency bands listed in the Annex to that Resolution;

h) that, according to *resolves* 3 of Resolution **739 (Rev.WRC-19)**, in case the unwanted emissions from the space station or satellite system cannot meet the values given in the Annex to that Resolution, the concerned administrations enter into a consultation process in order to achieve a mutually acceptable solution;

i) that Resolution **739 (Rev.WRC-19)** defines thresholds to be met by any geostationary space station (Table 1 of Annex to Resolution **739 (Rev.WRC-19**) or by any single network of non-geostationary-satellite orbit (non-GSO) space stations (Table 2 of Annex to Resolution **739 (Rev.WRC-19)**) in order to protect radio astronomy stations;

j) that Recommendation ITU-R RA.769 provides, in Annex 1, the general consideration and assumptions used in the calculation of interference levels;

k) that Recommendation ITU-R RA.769 provides, in Table 1 and Table 2, the threshold levels for interference detrimental to radio astronomy observations in some radio astronomy bands;

l) that Recommendation ITU-R RA.1631 provides the typical maximum RAS antenna gains in order to derive the equivalent power flux-density (epfd) resulting from unwanted emission levels produced by a non-GSO system at radio astronomy stations,

recognizing

a) that Resolution **739 (Rev.WRC-19)** contains no power flux-density (pfd)/epfd threshold for unwanted emission from any geostationary-satellite orbit (GSO)/non-GSO space station in the bands listed in Table 2 to this Resolution;

b) that the current values provided in Resolution **739 (Rev.WRC-19)** are derived from Recommendations ITU-R RA.769 and ITU-R RA.1631,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

1 compatibility studies between the EESS (passive) and the corresponding active services in adjacent frequency bands as listed in Table 1 below:

TABLE 1

EESS (passive) frequency bands to be studied and corresponding active services to be included

EESS (passive) frequency band	Active service frequency band	Active service
86-92 GHz	81-86 GHz	Fixed-satellite service (FSS) (Earth-to-space), mobile service (MS)
	92-94 GHz	MS, radiolocation service (RLS)
114.25-116 GHz	111.8-114.25 GHz	Fixed service (FS), MS
164-167 GHz	158.5-164 GHz	FS, FSS (space-to-Earth), MS, mobile-satellite service (MSS) (space-to-Earth)
	167-174.5 GHz	FS, FSS (space-to-Earth), inter-satellite service (ISS), MS
200-209 GHz	191.8-200 GHz	FS, ISS, MS, MSS, radionavigation service (RNS), radionavigation-satellite service (RNSS)
	209-217 GHz	FS, FSS (Earth-to-space), MS

2 compatibility studies between the RAS and the active satellite services in certain adjacent and nearby frequency bands listed in Table 2 below with a view to setting the relevant threshold levels for unwanted emissions from any GSO and non-GSO space stations and revising and updating Resolution **739 (Rev.WRC-19)** accordingly:

TABLE 2

RAS frequency bands to be studied and corresponding active services to be included

Radio astronomy frequency band	Active satellite service frequency band	Active satellite service (space-to-Earth)
76-81 GHz	71-76 GHz	Fixed-satellite service (FSS), mobile-satellite service (MSS), broadcasting-satellite service (BSS)
130-134 GHz	123-130 GHz	FSS, MSS, radionavigation-satellite service (RNSS)
164-167 GHz	167-174.5 GHz	FSS
226-231.5 GHz	232-235 GHz	FSS

invites administrations

to participate actively in the studies and provide the technical and operational characteristics of the systems involved by submitting contributions to the ITU Radiocommunication Sector,

invites the 2027 world radiocommunication conference

1 to determine, based on the results of studies, any required regulatory measures regarding the protection of the EESS (passive) in the frequency bands listed in Table 1 above from unwanted emissions of active services and update Resolution **750 (Rev.WRC-19)** accordingly;

2 to determine, based on the results of studies, any required regulatory measures regarding the protection of the RAS in the frequency bands listed in Table 2 above and update Resolution **739 (Rev.WRC-19)** accordingly,

instructs the Secretary-General

to bring this Resolution to the attention of the international and regional organizations concerned.

RESOLUTION 716 (REV.WRC-23)

Use of the frequency bands 1 980-2 010 MHz and 2 170-2 200 MHz in all three Regions and 2 010-2 025 MHz and 2 160-2 170 MHz in Region 2 by the fixed and mobile-satellite services and associated transition arrangements

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that WARC-92 allocated the bands 1 980-2 010 MHz and 2 170-2 200 MHz for the mobile-satellite service (MSS) with a date of entry into force of 1 January 2005, these allocations being co-primary with fixed and mobile service allocations;

b) that the use of the frequency bands 1 980-2 010 MHz and 2 170-2 200 MHz in all three Regions and 2 010-2 025 MHz and 2 160-2 170 MHz in Region 2 by the MSS, in accordance with the provisions of Nos. **5.389A** and **5.389C** of the Radio Regulations, as adopted by WRC-95 and WRC-97, is subject to a date of entry into force of 1 January 2000, 1 January 2002 (for Region 2) or 1 January 2005;

c) that these bands are shared with the fixed and mobile[1] services on a primary basis and that they are widely used by the fixed service in many countries;

d) that the studies made have shown that, while sharing of the MSS with the fixed service in the short to medium term would be generally feasible, in the long term sharing will be complex and difficult in both bands, so that it would be advisable to transfer the fixed service stations operating in the bands in question to other segments of the spectrum;

e) that for many developing countries, the use of the 2 GHz band offers a substantial advantage for their radiocommunication networks and that it is not attractive to transfer these systems to higher frequency bands because of the economic consequences that this would entail;

f) that ITU-R has developed a new frequency plan for the fixed service in the 2 GHz band, set out in Recommendation ITU-R F.1098 which will facilitate the introduction of new fixed service systems in band segments that do not overlap with the above-mentioned MSS allocations at 2 GHz;

g) that sharing between fixed service systems using tropospheric scatter and Earth-to-space links in the MSS in the same frequency band segments is generally not feasible;

h) that some countries utilize these bands in application of Article 48 of the ITU Constitution,

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[1] This Resolution does not apply to the mobile service. In this respect, the use of these bands by the MSS is subject to coordination with the mobile service under the provisions of No. **9.11A**, where applicable.

recognizing

a) that the bands 1 885-2 025 MHz and 2 110-2 200 MHz have been identified for worldwide use by International Mobile Telecommunications (IMT), the satellite component being limited to the bands 1 980-2 010 MHz and 2 170-2 200 MHz, and that the development of IMT can offer great potential in helping the developing countries develop more rapidly their telecommunication infrastructure;

b) that WARC-92 resolved to request the Telecommunication Development Bureau, when formulating its immediate plans for assistance to the developing countries, to consider the introduction of specific modifications in the radiocommunication networks of the developing countries and that a future world development conference should examine the needs of developing countries and should assist them with the resources needed to implement the required modifications to their radiocommunication networks,

noting

that in response to Resolution **716 (WRC-95)**[*, 2], ITU-R developed Recommendation ITU-R F.1335, which provides planning tools necessary to assist those administrations considering replanning of their terrestrial networks to accommodate the MSS in the 2 GHz bands,

resolves

1 to request administrations to notify to the Radiocommunication Bureau the basic characteristics of frequency assignments to existing or planned fixed stations requiring protection, or those typical[3] of existing and planned fixed stations brought into use before 1 January 2000 in the frequency bands 1 980-2 010 MHz and 2 170-2 200 MHz in all three Regions and 2 010-2 025 MHz and 2 160-2 170 MHz in Region 2;

2 that administrations proposing to bring an MSS system into service must take account of the fact that, when coordinating their system with administrations having terrestrial services, such administrations may have existing or planned installations covered by Article 48 of the Constitution;

3 that in respect of stations of the fixed service taken into account in the application of No. **9.11A**, administrations responsible for MSS networks operating in the bands 1 980-2 010 MHz and 2 170-2 200 MHz in all three Regions and 2 010-2 025 MHz and 2 160-2 170 MHz in Region 2 shall ensure that unacceptable interference is not caused to fixed service stations notified and brought into use before 1 January 2000;

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[*] *Note by the Secretariat:* This Resolution was revised by WRC-12 and WRC-23.

[2] Reference to Resolution **716 (WRC-95)** is provided as background information.

[3] With respect to the notification of frequency assignments to stations in the fixed and mobile services, it was possible to notify the characteristics of typical stations in the fixed service in accordance with No. **11.17** without restriction up until 1 January 2000.

4 that to facilitate the introduction and future use of the 2 GHz bands by the MSS:

4.1 administrations are urged to ensure that frequency assignments to new fixed service systems, to be brought into operation after 1 January 2000, do not overlap with the frequency bands 1 980-2 010 MHz and 2 170-2 200 MHz in all three Regions and 2 010-2 025 MHz and 2 160-2 170 MHz in Region 2 MSS allocations, for example by using the channel plans of the most recent version of Recommendation ITU-R F.1098;

4.2 administrations are urged to take all practicable steps to phase out troposcatter systems operating in the band 1 980-2 010 MHz in all three Regions and 2 010-2 025 MHz in Region 2 by 1 January 2000. New troposcatter systems shall not be brought into operation in these bands;

4.3 administrations are encouraged, where practicable, to draw up plans for the gradual transfer of the frequency assignments to their fixed service stations in the bands 1 980-2 010 MHz and 2 170-2 200 MHz in all three Regions and 2 010-2 025 MHz and 2 160-2 170 MHz in Region 2 to non-overlapping bands, giving priority to the transfer of their frequency assignments in the band 1 980-2 010 MHz in all three Regions and 2 010-2 025 MHz in Region 2, considering the technical, operational and economical aspects;

5 that administrations responsible for the introduction of mobile-satellite systems should take into account and address the concerns of affected countries, especially developing countries, to minimize the possible economic impact of transition measures in respect to existing systems;

6 to invite the Telecommunication Development Bureau to provide assistance to developing countries requesting it for the introduction of specific modifications to their radiocommunication networks that will facilitate their access to the new technologies being developed in the 2 GHz band as well as in all coordination activities;

7 that administrations responsible for the introduction of mobile-satellite systems urge their mobile-satellite system operators to participate in the protection of terrestrial fixed services especially in the least developed countries,

invites the ITU Radiocommunication Sector

to conduct, as a matter of urgency, further studies, in conjunction with the Bureau, to develop and provide to administrations the necessary tools in a timely manner to assess the impact of interference in the detailed coordination of mobile-satellite systems,

invites the ITU Telecommunication Development Sector

to evaluate, as a matter of urgency, the financial and economic impact on the developing countries of the transfer of fixed services, and to present its results to a future competent world radiocommunication conference and/or world telecommunication development conference,

invites the Director of the Telecommunication Development Bureau

to implement *invites the ITU Telecommunication Development Sector* by encouraging joint activities between the relevant study groups of both ITU-D and ITU-R,

instructs the Director of the Radiocommunication Bureau

to submit a report on the implementation of this Resolution to world radiocommunication conferences.

RESOLUTION 721 (WRC-23)

Studies on potential new allocations to fixed, mobile, radiolocation, amateur, amateur-satellite, radio astronomy, Earth exploration-satellite (passive and active) and space research (passive) services in the frequency range 275-325 GHz with the consequential update of Nos. 5.149, 5.340, 5.564A and 5.565

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that technologies above 275 GHz are considered as emerging enablers to enhance the radio interface to support high-capacity transmission and scientific research;

b) that sub-terahertz and terahertz spectrum have been discussed for use by various active service applications;

c) that there have been radio observatories and passive remote sensing satellites operating above 275 GHz;

d) that studies on technical and operational characteristics of fixed service and land mobile service (LMS) applications operating in the frequency range 275-450 GHz have been carried out by the ITU Radiocommunication Sector (ITU-R) and resulted in No. **5.564A** being added by WRC-19;

e) that amateur and amateur satellite service applications have been utilized in the frequency range 275-450 GHz in a number of countries;

f) that Recommendation ITU-R RS.2017 provides performance and interference criteria for satellite passive remote sensing up to 1 000 GHz;

g) that protection criteria for the radio astronomy service (RAS) above 275 GHz is included in Report ITU-R RA.2189;

h) that frequency bands above 275 GHz in which emissions are prohibited are not specified by a provision of the Radio Regulations;

i) that propagation characteristics of frequencies above 275 GHz are being studied by ITU-R Study Group 3;

j) that international standards are being developed for equipment operating in the frequency range 275-450 GHz;

k) that it is appropriate to ensure that any frequency allocations above 275 GHz to the fixed, land mobile, radiolocation, amateur, amateur-satellite, radio astronomy and Earth exploration-satellite (passive and active), space research (passive) and any other radiocommunication services should correspond to up-to-date technical and operational characteristics for those applications and take into account compatibility between these services,

noting

a) that Nos. **5.564A** and **5.565** apply to the frequency range 275-450 GHz;

b) that Reports ITU-R F.2416, ITU-R M.2417 and ITU-R RS.2431 provide technical and operational characteristics of fixed service, LMS and Earth exploration-satellite service (EESS) (passive) applications in the frequency range 275-450 GHz, respectively;

c) that Report ITU-R SM.2352 contains technology trends of active services in the frequency range 275-3 000 GHz;

d) that Report ITU-R SM.2540 provides sharing and compatibility study results between land mobile, fixed and passive services in the frequency range 275-450 GHz;

e) that Report ITU-R RS.2194 contains passive bands of scientific interest to the EESS/space research service (SRS) from 275 to 3 000 GHz,

recognizing

a) that the frequency range 275-325 GHz is also identified for other radiocommunication services and that those identifications are used by a variety of incumbent systems in many administrations, and that the protection of these services, including adjacent services, should be studied;

b) that for the determination of the incumbent services, the relevant provisions of the Radio Regulations in force apply;

c) that identifications do not preclude the use of the frequency bands by any application of the services to which the frequency bands are identified and do not establish priority over any other applications of radiocommunication services;

d) that the frequency bands 296-306 GHz, 313-318 GHz and 333-356 GHz may only be used by fixed and land mobile service applications when specific conditions to ensure the protection of EESS) (passive) applications are determined in accordance with Resolution **731 (Rev.WRC-23)**;

e) that in the frequency bands 275-323 GHz, 327-371 GHz, 388-424 GHz and 426-442 GHz, where radio astronomy applications are used, specific conditions (e.g. minimum separation distances and/or avoidance angles) may be necessary to ensure protection of radio astronomy sites from land mobile and/or fixed service applications, on a case-by-case basis in accordance with Resolution **731 (Rev.WRC-23)**,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference

1 studies on the spectrum needs for the fixed, mobile, radiolocation, amateur, amateur-satellite, radio astronomy, Earth exploration-satellite (passive and active) and space research (passive) services in the frequency range 275-325 GHz;

2 studies on sharing and compatibility between services referenced in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference* 1;

3 studies on possible new allocations to services referenced in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference* 1, while ensuring the protection of passive services in the frequency range 275-325 GHz and adjacent frequency bands, taking into account the frequency bands identified in Nos. **5.564A** and **5.565**, and the results of the studies under *resolves to invites the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference* 1 and 2,

invites the 2031 world radiocommunication conference

based on the results of the studies, to consider potential new allocations in the frequency range 275-325 GHz for radiocommunication services referenced in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference* 1 and update Nos. **5.149**, **5.340**, **5.564A** and **5.565**, as appropriate,

encourages administrations

to participate actively in the studies and provide the information required for the studies listed under *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference* by submitting contributions to the ITU Radiocommunication Sector,

instructs the Secretary-General

to bring this Resolution to the attention of the international and regional organizations concerned.

RESOLUTION 722 (WRC-23)

Studies on the coexistence between spaceborne synthetic aperture radars operating in the Earth exploration-satellite service (active) and radiodetermination service in the frequency band [9 200-10 400 MHz]*

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the Earth exploration-satellite service (EESS) (active) is used for various active spaceborne sensor applications, among which synthetic aperture radar (SAR) is the most widely used application;

b) that, following the decisions of WRC-07 and WRC-15, the allocation of the EESS (active) was extended from the frequency band 9 500-9 800 MHz to 9 200-10 400 MHz, which is shared with the radiodetermination service, including radiolocation and radionavigation services;

c) that ITU Radiocommunication Sector (ITU-R) studies had concluded that the percentage of time of exceedance of the protection criteria of the radiodetermination service due to SAR emissions of space stations would be low and even lower when taking the processing gain of radar systems into account;

d) that, since 2015, the number of advance publication information and coordination requests for SAR application satellite networks/systems in the frequency band 9 200-10 400 MHz has increased;

e) that the growing usage of spaceborne SAR transmitters, as described in *considering d),* may increase the probability of interference between radiodetermination radars and SAR satellites,

noting

a) that No. **5.474A** stipulates that the use of the frequency bands 9 200-9 300 MHz and 9 900-10 400 MHz by the EESS (active) is subject to agreement to be obtained under No. **9.21** from a number of administrations;

b) that No. **21.16** provides the power flux-density limit at the Earth's surface produced by emissions from the EESS (active) in the frequency band 9 900-10 400 MHz with respect to the protection of the fixed service;

c) that Recommendations ITU-R M.1796 and ITU-R M.1849 contain the technical characteristics and protection criteria for radars operating in the radiodetermination service in the frequency range 8 500-10 680 MHz;

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* The appearance of square brackets around certain frequency bands in this Resolution is understood to mean that WRC-27 will consider and review the inclusion of these frequency bands with square brackets and decide, as appropriate.

d) that Report ITU-R RS.2313 contains sharing analyses of wideband EESS (active) transmissions with stations in the radio determination service operating in the frequency bands 8 700-9 300 MHz and 9 900-10 500 MHz,

recognizing

a) the importance of the continuing operation of SAR satellites and the need for protection for the radiodetermination systems operating in the frequency band 9 200-10 400 MHz;

b) that No. **5.476A** states that in the frequency band 9 300-9 800 MHz, stations in the Earth exploration-satellite service (active) and space research service (active) shall not cause harmful interference to, or claim protection from, stations of the radionavigation and radiolocation services;

c) that No. **5.474D** states that stations in the Earth exploration-satellite service (active) shall not cause harmful interference to, or claim protection from, stations of the maritime radionavigation and radiolocation services in the frequency band 9 200-9 300 MHz, the radionavigation and radiolocation services in the frequency band 9 900-10 000 MHz and the radiolocation service in the frequency band 10.0-10.4 GHz;

d) that the aeronautical radionavigation service (ARNS) operating in the frequency band 9 000-9 200 MHz and the maritime radionavigation service operating in the frequency band 9 200-9 500 MHz are used by safety service systems, in accordance with Nos. **1.59** and **4.10**;

e) that Recommendation ITU-R M.1796 contains the technical characteristics and protection criteria for radars operating in the radiodetermination service in the frequency range 8 500-10 680 MHz,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference

1 studies on the technical and operational characteristics of SARs in the EESS (active) in the frequency band 9 200-10 400 MHz;

2 studies on the coexistence between SARs operating in the EESS (active) and the radiodetermination service in the frequency band 9 200-10 400 MHz,

invites administrations

to participate actively in the studies and provide the information required for the studies listed in *resolves to invite ITU-R to complete in time for the 2031 world radiocommunication conference* by submitting contributions to ITU-R,

resolves to invite the 2031 world radiocommunication conference

to consider the results of the above ITU-R studies and take actions, as appropriate.

RESOLUTION 726 (WRC-23)

Possible new primary allocation to the fixed-satellite service (space-to-Earth) in the frequency band 17.3-17.7 GHz and possible new primary allocation to the broadcasting-satellite service (space-to-Earth) in the frequency band 17.3-17.8 GHz in Region 3, and consideration of equivalent power flux-density limits to be applied in Regions 1 and 3 to non-geostationary-satellite systems in the fixed-satellite service (space-to-Earth) in the frequency band 17.3-17.7 GHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) the need to encourage the development and implementation of new technologies in the fixed-satellite service (FSS) for broadband applications and in the broadcasting-satellite service (BSS) for ultra-high-definition television (UHDTV) applications;

b) that FSS systems based on the use of new technologies associated with geostationary-satellite orbit (GSO) and non-geostationary-satellite orbit (non-GSO) systems are capable of providing high-capacity and low-cost means of broadband communication even to the most isolated regions of the world, and BSS systems are capable of providing high-quality and low-cost means of wideband broadcasting;

c) that, due to the orbital characteristics of non-GSO satellite systems, the constellations are capable of providing services globally, and there is therefore a need for harmonized Radio Regulations;

d) that the Radio Regulations should enable the introduction of new applications of radiocommunication technology to ensure the operation of as many systems as possible in order to ensure efficient use of the spectrum;

e) that there is a mismatch in usable downlink bandwidth in the FSS in Region 3 in the frequency range 17-20 GHz associated with the uplink frequency range of 27-30 GHz;

f) that, in Region 3, the frequency band 17.3-18.1 GHz is allocated on a primary basis to the FSS (Earth-to-space), subject to the application of No. **5.516**;

g) that there are no relevant provisions applying to the non-GSO FSS in the frequency band 17.7-17.8 GHz;

h) that, under the present Resolution, the equivalent power flux-density (epfd) limits in *noting e)* are to be considered as a reference, without the intent of a modification at WRC-27 for Region 2;

noting

a) that technology has been developed to provide more efficient use of the spectrum and to enable both bidirectional and same-directional sharing;

b) that bidirectional sharing between the FSS (Earth-to-space) and the FSS (space-to-Earth) is already considered in Regions 1 and 2 for the frequency band 17.3-17.7 GHz;

c) that extending the FSS (space-to-Earth) allocation in the frequency band 17.3-17.7 GHz and the BSS (space-to-Earth) allocation in the frequency band 17.3-17.8 GHz to Region 3 will contribute to global harmonization;

d) that there are other primary services, including the fixed and mobile services, in the band 17.7-17.8 GHz in Region 3;

e) that Article **22** (Tables **22-1B**, **22-3** and **22-4B**) contains epfd limits to ensure the protection of GSO satellite networks from non-GSO FSS satellite systems in the frequency band 17.3-17.7 GHz in Region 2,

resolves

that the studies referred to in *invites the ITU Radiocommunication Sector to conduct and complete in time for the 2027 world radiocommunication conference* below shall protect radiocommunication services to which the frequency band is allocated on a primary basis, including the fixed and mobile services, in particular assignments to the BSS feeder links contained in Appendix **30A**,

invites the ITU Radiocommunication Sector to conduct and complete in time for the 2027 world radiocommunication conference

1 studies on sharing and compatibility between the FSS (space-to-Earth), the BSS (space-to-Earth) and the FSS (Earth-to-space) designated by No. **5.516** in order to consider a possible new primary allocation to the FSS (space-to-Earth) in the frequency band 17.3-17.7 GHz for Region 3 and to the BSS (space-to-Earth) in the frequency band 17.3-17.8 GHz for Region 3, while ensuring the protection of existing primary allocations in the same and adjacent frequency bands, and without adversely affecting the existing allocations to the FSS (Earth-to-space) designated by No. **5.516**, including assignments to the BSS feeder links contained in Appendix **30A**;

2 consideration of the applicability of Region 2 non-GSO FSS epfd limits (see *noting e)*) pertaining to the frequency band 17.3-17.7 GHz to Regions 1 and 3, so as to ensure the protection of GSO networks,

invites the 2027 world radiocommunication conference

to consider the results of the above ITU Radiocommunication Sector (ITU-R) studies and take necessary actions, as appropriate, with respect to the following issues:

1) a possible new primary allocation to the FSS (space-to-Earth) in the frequency band 17.3-17.7 GHz for Region 3;

2) a possible new primary allocation to the BSS (space-to-Earth) in the frequency band 17.3-17.8 GHz for Region 3;

3) ensuring the protection of existing primary allocations in the same and adjacent frequency bands, without adversely affecting the existing allocations to the fixed and mobile services in the frequency band 17.7-17.8 GHz and to the FSS (Earth-to-space) as designated by No. **5.516**, including assignments to the BSS feeder links contained in Appendix **30A**;

4) the application of Region 2 epfd limits to non-GSO FSS systems (as given in *noting e)*) operating in the frequency band 17.3-17.7 GHz in Regions 1 and 3,

invites administrations

to participate actively in the studies described in *resolves to invite the ITU Radiocommunication Sector to conduct and complete in time for the 2027 world radiocommunication conference* and provide the technical and operational characteristics of the systems involved by submitting contributions to ITU-R.

RESOLUTION 729 (REV.WRC-07)

Use of frequency adaptive systems in the MF and HF bands*

The World Radiocommunication Conference (Geneva, 2007),

considering

a) that the efficiency of spectrum use will be improved by the use of frequency adaptive systems in the MF and HF bands shared by the fixed and the mobile services;

b) that trials and deployment of frequency adaptive systems have been under way during the past 30 years and have demonstrated the effectiveness of such systems and improved spectrum efficiency;

c) that such improved efficiency is attained through:

– shorter call set-up and improved transmission quality by selection of the most suitable assigned channels;

– reduced channel occupancy, permitting the same channels to be used by different networks, yet decreasing the probability of harmful interference;

– minimization of the transmitter power required for each transmission;

– continued optimization of the emissions owing to the sophistication of the systems;

– simple operation by the use of intelligent peripheral equipment;

– reduced need for skilled radio operators;

d) that following WRC-95, the Radiocommunication Bureau no longer undertakes examination with respect to the probability of harmful interference caused by new assignments recorded in the Master International Frequency Register (MIFR) in the non-planned bands below 28 MHz;

e) that WRC-97 introduced a means for notification of block assignments;

f) that frequency adaptive systems will actively contribute to the avoidance of interference since, when other signals are observed on the channel, the frequency adaptive system will move to another frequency,

resolves

1 that, in authorizing the operation of frequency adaptive systems in the fixed and mobile services for the MF and HF bands, administrations shall:

1.1 not make assignments in those bands:

– governed by the Appendix **25** frequency allotment Plan for the maritime mobile service or the Appendix **27** frequency allotment Plan for the aeronautical mobile (R) service;

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* This Resolution should be brought to the attention of ITU-D Study Group 2.

– shared on a co-primary basis with the broadcasting service, radiodetermination service or the amateur services;

– allocated to the radio astronomy service;

1.2 avoid use which may affect frequency assignments involving safety services made in accordance with Nos. **5.155**, **5.155A** and **5.155B**;

1.3 take into account any footnotes applicable to the proposed bands and the implications regarding compatibility;

2 that frequency adaptive systems shall automatically limit simultaneous use of frequencies to the minimum necessary for communication requirements;

3 that, with a view to avoiding harmful interference, frequency adaptive systems should evaluate the channel occupancy prior to and during operation;

4 that assignments for frequency adaptive systems shall be notified to the Bureau in accordance with the provisions of Article **11** and Appendix **4**.

RESOLUTION 731 (REV.WRC-23)

Consideration of sharing and adjacent-band compatibility between passive and active services above 71 GHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the changes made to the Table of Frequency Allocations by WRC-2000 in frequency bands above 71 GHz were based on the requirements known at the time of that conference;

b) that the passive service spectrum requirements above 71 GHz are based on physical phenomena and therefore are well known, and are reflected in the changes made to the Table of Frequency Allocations by that conference;

c) that several frequency bands above 71 GHz are already used by the Earth exploration-satellite service (EESS) (passive) and space research service (passive) because they are unique bands for the measurement of specific atmospheric parameters;

d) that frequency bands in the frequency range 275-1 000 GHz are identified for use by administrations for passive service applications in No. **5.565**, without precluding the use of this frequency range by active service applications, and urging administrations to take all practicable steps to protect the passive service applications from harmful interference;

e) that there is currently only limited knowledge of requirements and implementation plans for the active services that will operate in frequency bands above 71 GHz;

f) that, in the past, technological developments have led to viable communication systems operating at increasingly higher frequencies, and that this can be expected to continue so as to make communication technology available in the future in the frequency bands above 71 GHz;

g) that, in the future, alternative spectrum needs for the active and passive services should be accommodated when the new technologies become available;

h) that, following the revisions to the Table of Frequency Allocations by WRC-2000, sharing studies may still be required for services in some frequency bands above 71 GHz;

i) that interference criteria for passive sensors have been developed and are given in Recommendation ITU-R RS.2017;

j) that protection criteria for radio astronomy have been developed and are given in Recommendations ITU-R RA.769 and ITU-R RA.1513 and Report ITU-R RA.2189;

k) that several satellite downlink allocations have been made in frequency bands adjacent to those allocated to the radio astronomy service;

l) that sharing criteria for active and passive services in frequency bands above 71 GHz have not yet been fully developed within the ITU Radiocommunication Sector (ITU-R),

recognizing

a) that several frequency bands above 71 GHz are subject to No. **5.340**, and all emissions are prohibited in these bands;

b) that, to the extent practicable, the burden of sharing among active and passive services should be equitably distributed among the services to which allocations are made,

resolves

to invite a future competent world radiocommunication conference to consider the results of ITU-R studies referred to in *invites the ITU Radiocommunication Sector* below with a view to taking the necessary action, as appropriate, in order to accommodate the emerging requirements of active services, taking into account the requirements of the passive services, in frequency bands above 71 GHz,

urges administrations

to note the possibility of changes to Article **5** to accommodate emerging requirements for active services, as indicated in this Resolution, and to take this into account in the development of national policies and regulations,

invites the ITU Radiocommunication Sector

1 to continue its studies to determine if and under what conditions sharing is possible between active and passive services in the frequency bands above 71 GHz, such as, but not limited to, 116-122.25 GHz, 174.8-182 GHz, 185-190 GHz and 235-238 GHz;

2 to study under what conditions passive services operating in allocated frequency bands 100-102 GHz, 148.5-151.5 GHz, 182-185 GHz, 190-191.8 GHz and 226-231.5 GHz are compatible with active services allocated to adjacent bands;

3 to conduct studies to determine the specific conditions to be applied to the land-mobile and fixed-service applications to ensure the protection of EESS (passive) applications in the frequency bands 296-306 GHz, 313-318 GHz and 333-356 GHz;

4 to study means of avoiding adjacent-band interference from space services (downlinks) into radio astronomy frequency bands above 71 GHz;

5 to take into account the principles of burden-sharing to the extent practicable in their studies;

6 to complete the necessary studies when the technical characteristics of the active services in these frequency bands are known;

7 to develop Recommendations specifying sharing criteria for those frequency bands where sharing is feasible,

instructs the Secretary-General

to bring this Resolution to the attention of the international and regional organizations concerned.

RESOLUTION 732 (REV.WRC-12)

Consideration of sharing between active services above 71 GHz

The World Radiocommunication Conference (Geneva, 2012),

considering

a) that the World Radiocommunication Conference (Istanbul, 2000) has made changes to the Table of Frequency Allocations above 71 GHz, following consideration of science service issues;

b) that there are several co-primary active services in some bands above 71 GHz in the Table of Frequency Allocations as revised by the World Radiocommunication Conference (Istanbul, 2000);

c) that there is still limited knowledge of characteristics of active services that may be developed to operate in bands above 71 GHz;

d) that sharing criteria for sharing between active services in bands above 71 GHz have not yet been fully developed within ITU-R;

e) that sharing between multiple co-primary active services may hinder the development of each active service in bands above 71 GHz;

f) that the technology for some active services may be commercially available earlier than for some other active services;

g) that adequate spectrum should be available for the active services for which the technology is available at a later time,

noting

that sharing criteria need to be developed and included in ITU-R Recommendations, which may be used by a future competent conference, for determining to what extent sharing between multiple co-primary active services is possible in each of the bands,

resolves

1 that appropriate measures should be taken to meet the spectrum requirements for active services for which the technology will be commercially available at a later time;

2 that sharing criteria be developed for co-primary active services in bands above 71 GHz;

3 that the sharing criteria developed should form the basis for a review of active service allocations above 71 GHz at a future competent conference, if necessary,

urges administrations

to note the possibility of changes to Article **5** to accommodate emerging requirements for active services, as indicated in this Resolution, and to take this into account in the development of national policies and regulations,

invites ITU-R

to complete the necessary studies and develop ITU-R Recommendation(s) with a view to presenting, at the appropriate time, the technical information likely to be required as a basis for the work of a future competent conference,

instructs the Secretary-General

to bring this Resolution to the attention of the international and regional organizations concerned.

RESOLUTION 739 (REV.WRC-19)

Compatibility between the radio astronomy service and the active space services in certain adjacent and nearby frequency bands

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that adjacent or nearby primary service allocations have been made to the radio astronomy service (RAS), and to various space services, such as the fixed-satellite service (FSS), radionavigation-satellite service (RNSS), mobile-satellite service (MSS) and broadcasting-satellite service (BSS), hereafter referred to as "active space services";

b) that, in many cases, the frequencies used by the RAS are chosen to study natural phenomena producing radio emissions at frequencies fixed by the laws of nature, so shifting frequency to avoid or mitigate interference problems may not be possible;

c) that Report ITU-R SM.2091 provides a methodology for conducting, and a framework for documenting the results of, compatibility studies between active space service and RAS band pairs;

d) that Report ITU-R SM.2091 also provides the results of compatibility studies between the RAS and an active space service in certain adjacent and nearby frequency bands;

e) that appropriate consultation between administrations has the potential to lead to the development of innovative solutions and to the rapid deployment of systems;

f) that, for technical or operational reasons, more stringent spurious emission limits than the general limits in Appendix **3** may be required to protect the RAS from active services in specific frequency bands,

noting

a) that the additional burden of undertaking any technical examination should not be placed on the Radiocommunication Bureau (BR);

b) that a consultation procedure, as contained in this Resolution, would not place an additional burden on BR;

c) that Recommendation ITU-R M.1583 provides a methodology based on the equivalent power flux-density (epfd) concept for calculation of interference resulting from unwanted emissions from non-geostationary-satellite (non-GSO) systems of the MSS or RNSS into radio astronomy stations;

d) that Recommendation ITU-R S.1586 provides a methodology based on the epfd concept for calculation of interference resulting from unwanted emissions from non-GSO systems of the FSS into radio astronomy stations;

e) that the methodology described in these Recommendations may also be used to study the case of non-GSO systems in the BSS;

f) that Recommendation ITU-R RA.1631 provides antenna patterns to be used for compatibility analyses between non-GSO systems and RAS stations, based on the epfd concept;

g) that Recommendation ITU-R RA.1513 provides acceptable levels of data loss to radio astronomy observations, stating in particular that the percentage of data loss caused by any system should be lower than 2%;

h) that some of the results documented in Report ITU-R SM.2091 may be used as threshold levels to initiate the consultation procedure;

i) that the results of successful consultation between concerned administrations would ensure that the interests of both the active services and the RAS are considered;

j) that measures taken by active space services to protect radio astronomy stations from interference may result in increased costs and/or reduced capabilities for those services;

k) that, conversely, not taking such measures may result in additional operating costs and reduced operational effectiveness for the radio astronomy stations concerned;

l) that the implementation of additional interference mitigation measures at the radio astronomy station may increase operating costs and reduce observational effectiveness;

m) that, conversely, not implementing such measures may impose upon the active space services an additional cost burden and reduction in service capability,

recognizing

a) that unwanted emissions produced by stations of the active space services may cause unacceptable interference to stations of the RAS;

b) that, although some unwanted emissions from transmitters on space stations can be controlled through careful design methods and appropriate testing procedures, other unwanted emissions, such as narrowband spurious emissions, generated by uncontrollable and/or unpredictable physical mechanisms, may only be detected after the spacecraft is launched;

c) that there is an uncertainty in the pre-launch assessment of the levels of unwanted emissions;

d) that it is necessary to ensure equitable burden-sharing for achieving compatibility between the active space services and the RAS;

e) that, for those cases where difficulties are encountered in meeting the values in the Annex to this Resolution, a consultation procedure could be used to resolve the difficulties,

resolves

1 that an administration take all reasonable steps to ensure that any space station or satellite system being designed and constructed to operate in the frequency bands in the Annex to this Resolution meets the values given therein at any radio astronomy station operating in the corresponding frequency bands identified in that Annex;

2 that in the event that during construction and prior to launch it is determined that, after having considered all reasonable means, the unwanted emissions from the space station or satellite system cannot meet the values given in the Annex, the administration that notified the space station or satellite system contact, as soon as possible, the administration operating the radio astronomy station to confirm that *resolves* 1 has been fulfilled, and the concerned administrations enter into a consultation process in order to achieve a mutually acceptable solution;

3 that in the event that, following the space station launch, an administration operating a radio astronomy station determines that, due to unexpected circumstances, a space station or satellite system does not meet the values for unwanted emissions given in the Annex at that radio astronomy station, it contact the administration that notified the space station or satellite system for the latter administration to confirm that *resolves* 1 has been fulfilled, and the concerned administrations enter into a consultation process in order to identify further steps with a view to achieving a mutually acceptable solution;

4 that the radio astronomy stations to be taken into account in applying *resolves* 1, 2 and 3 are those which are operating in the frequency band(s) identified in the Annex and which are notified before the date of receipt of the advance publication information (API) of the space station or satellite system to which this Resolution applies;

5 that the space stations or satellite systems to be considered in the application of *resolves* 1 to 4 above are those designed to operate in the space service frequency bands listed in the tables in the Annex for which API is received by BR following the entry into force of the Final Acts of the appropriate conference, as specified in those tables;

6 that the objective of the consultation process in *resolves* 1, 2 and 3 is to achieve a mutually acceptable solution, using as guidance Report ITU-R SM.2091 and any other ITU Radiocommunication Sector Recommendations deemed relevant by the concerned administrations;

7 that BR shall make no examination or finding with respect to this Resolution under either Article **9** or **11**,

invites administrations

1 to take all appropriate and practicable steps, from the design phase onward, to ensure that unwanted emissions are minimized from space stations that are planned to operate in one or more space service allocations, in order to avoid exceeding the threshold levels of unwanted emissions identified in the Annex at any radio astronomy station;

2 to take all practicable steps, from the design phase onward, to minimize the sensitivity of radio astronomy stations to interference and to take into account the need to implement interference mitigation measures.

ANNEX TO RESOLUTION 739 (REV.WRC-19)

Unwanted emission threshold levels

The unwanted emission threshold levels applicable to geostationary space stations are given in Table 1 in terms of power flux-density (pfd) in a reference bandwidth produced at a radio astronomy station.

In Table 1, the unwanted emission threshold levels given in the fourth, sixth and eighth columns (associated with the reference bandwidth contained in the adjacent columns) should be met by any GSO space station operating in the frequency bands indicated in the second column at the radio astronomy station operating in the frequency band mentioned in the third column.

The unwanted emission threshold levels applicable to space stations of a non-geostationary-satellite (non-GSO) system are given in Table 2 in terms of the equivalent power flux-density (epfd) produced at a radio astronomy station in a reference bandwidth by all the space stations in a non-GSO system that are visible to the radio astronomy station considered, not to be exceeded during a given percentage of time, over the whole sky.

In Table 2, the epfd value given in the fourth, sixth and eighth columns (associated with the reference bandwidths contained in the adjacent column) should be met by all the space stations of a non-GSO system operating in the frequency bands indicated in the second column at the radio astronomy station operating in the frequency band mentioned in the third column. The epfd value at a given radio astronomy station shall be evaluated by using the antenna pattern and the radio astronomy service maximum antenna gain given in Recommendation ITU-R RA.1631-0. Guidance on the calculation of epfd can be found in Recommendations ITU-R S.1586 and ITU-R M.1583. The elevation angles of the radio astronomy stations to be taken into account in the epfd calculation are those higher than the minimum elevation angle θ_{min} of the radio telescope. In the absence of such information, a value of 5° shall be taken. The percentage of time during which the epfd level shall not be exceeded is mentioned in Note (1) to Table 2.

Some sections of Report ITU-R SM.2091 indicate levels of unwanted emissions in radio astronomy frequency bands that certain satellite systems, by design, do not exceed.

TABLE 1

pfd thresholds for unwanted emissions from any GSO space station at a radio astronomy station

Space service	Space service frequency band	Radio astronomy frequency band	Single dish, continuum observations		Single dish, spectral line observations		VLBI		Condition of application: the API is received by BR following the entry into force of the Final Acts of:
			pfd(1)	Reference bandwidth	pfd(1)	Reference bandwidth	pfd(1)	Reference bandwidth	
	(MHz)	(MHz)	(dB(W/m²))	(MHz)	(dB(W/m²))	(kHz)	(dB(W/m²))	(kHz)	
MSS (space-to-Earth)	387-390	322-328.6	−189	6.6	−204	10	−177	10	WRC-07
BSS MSS (space-to-Earth)	1 452-1 492 1 525-1 559	1 400-1 427	−180	27	−196	20	−166	20	WRC-03
MSS (space-to-Earth) MSS (space-to-Earth)	1 525-1 559 1 613.8-1 626.5	1 610.6-1 613.8	NA	NA	−194	20	−166	20	WRC-03
RNSS (space-to-Earth)	1 559-1 610	1 610.6-1 613.8	NA	NA	−194	20	−166	20	WRC-07
BSS FSS (space-to-Earth)	2 655-2 670	2 690-2 700	−177	10	NA	NA	−161	20	WRC-03
FSS (space-to-Earth)	2 670-2 690	2 690-2 700 (in Regions 1 and 3)	−177	10	NA	NA	−161	20	WRC-03
	(GHz)	(GHz)	–	–	–	–	–	–	
BSS	21.4-22.0	22.21-22.5	−146	290	−162	250	−128	250	WRC-03 for VLBI, and WRC-07 for other types of observation

NA: Not applicable, measurements of this type are not made in this frequency band.

(1) Integrated over the reference bandwidth with an integration time of 2 000 s.

TABLE 2

epfd thresholds[1] for unwanted emissions from all space stations of a non-GSO satellite system at a radio astronomy station

Space service	Space service frequency band	Radio astronomy frequency band	Single dish, continuum observations		Single dish, spectral line observations		VLBI		Condition of application: the API is received by BR following the entry into force of the Final Acts of:
			epfd[2]	Reference bandwidth	epfd[2]	Reference bandwidth	epfd[2]	Reference bandwidth	
	(MHz)	(MHz)	(dB(W/m²))	(MHz)	(dB(W/m²))	(kHz)	(dB(W/m²))	(kHz)	
MSS (space-to-Earth)	137-138	150.05-153	−238	2.95	NA	NA	NA	NA	WRC-07
MMSS (space-to-Earth)	157.1875-157.3375 161.7875-161.9375	150.05-153	−238	2.95	NA	NA	NA	NA	WRC-19
MMSS (space-to-Earth)	157.1875-157.3375 161.7875-161.9375	322-328.6	−240	6.6	−255	10	−228	10	WRC-19
MSS (space-to-Earth)	387-390	322-328.6	−240	6.6	−255	10	−228	10	WRC-07
MSS (space-to-Earth)	400.15-401	406.1-410	−242	3.9	NA	NA	NA	NA	WRC-07
MSS (space-to-Earth)	1 525-1 559	1 400-1 427	−243	27	−259	20	−229	20	WRC-07
RNSS (space-to-Earth)[3]	1 559-1 610	1 610.6-1 613.8	NA	NA	−258	20	−230	20	WRC-07
MSS (space-to-Earth)	1 525-1 559	1 610.6-1 613.8	NA	NA	−258	20	−230	20	WRC-07

NA: Not applicable, measurements of this type are not made in this frequency band.

(1) These epfd thresholds should not be exceeded for more than 2% of time.

(2) Integrated over the reference bandwidth with an integration time of 2 000 s.

(3) This Resolution does not apply to current and future assignments of the radionavigation-satellite system GLONASS/GLONASS-M in the frequency band 1 559-1 610 MHz, irrespective of the date of receipt of the related coordination or notification information, as appropriate. The protection of the radio astronomy service in the frequency band 1 610.6-1 613.8 MHz is ensured and will continue to be in accordance with the bilateral agreement between the Russian Federation, the notifying administration of the GLONASS/GLONASS-M system, and IUCAF, and with subsequent bilateral agreements with other administrations.

RESOLUTION 741 (REV.WRC-15)

Protection of the radio astronomy service in the frequency band 4 990-5 000 MHz from unwanted emissions of the radionavigation-satellite service (space-to-Earth) operating in the frequency band 5 010-5 030 MHz

The World Radiocommunication Conference (Geneva, 2015),

considering

a) that unwanted emissions from space stations of the radionavigation-satellite service (RNSS) operating in the frequency band 5 010-5 030 MHz may cause interference to the radio astronomy service (RAS) in the frequency band 4 990-5 000 MHz;

b) that WRC-2000 decided to introduce a provisional power flux-density (pfd) limit in the frequency band 4 990-5 000 MHz to protect the RAS, and invited ITU-R to conduct studies to review this limit;

c) that protection requirements for the RAS are given in Recommendations ITU-R RA.769 and ITU-R RA.1513, and are different for geostationary (GSO) and non-GSO satellite systems,

noting

a) that Recommendation ITU-R M.1583 provides a methodology based on the equivalent pfd (epfd) concept for calculation of interference resulting from unwanted emissions from non-GSO systems of the mobile-satellite service or RNSS into radio astronomy stations;

b) that Recommendation ITU-R RA.1631 provides antenna patterns and maximum antenna gain to be used for compatibility analyses between non-GSO systems and RAS stations based on the epfd concept;

c) that Recommendation ITU-R RA.1513 recommends acceptable levels of data loss to radio astronomy observations, stating in particular that the percentage of data loss caused by any system should be lower than 2%;

d) that as from the end of WRC-03, the Radiocommunication Bureau reviewed all RNSS systems for which complete coordination or notification information, as appropriate, had been received for the frequency band 5 010-5 030 MHz, and revised its findings regarding compliance with No. **5.443B**, taking into account additional information received under *resolves* 4,

resolves

1 that in order not to cause harmful interference to the RAS in the frequency band 4 990-5 000 MHz, the pfd produced in this frequency band by any GSO RNSS network operating in the 5 010-5 030 MHz frequency band shall not exceed −171 dB(W/m^2) in a 10 MHz frequency band at any radio astronomy station;

2 that in order not to cause harmful interference to the RAS in the frequency band 4 990-5 000 MHz, over the whole sky, for elevations higher than the minimum operating elevation angle θ_{min}[1] specified for the radio telescope, the epfd produced in this frequency band by all space stations within any non-GSO RNSS system operating in the 5 010-5 030 MHz frequency band shall not exceed −245 dB(W/m^2) in a 10 MHz frequency band at any radio astronomy station for more than 2% of the time, using the methodology in Recommendation ITU-R M.1583-1 and a reference antenna with a radiation pattern and maximum antenna gain given in Recommendation ITU-R RA.1631-0;

3 that the limits referred to in *resolves* 1 and 2 shall apply to RNSS systems as from 3 June 2000;

4 that administrations planning to operate a GSO or a non-GSO RNSS system in the frequency band 5 010-5 030 MHz, for which complete coordination or notification information, as appropriate, has been received by the Bureau after 2 June 2000, shall send to the Bureau the value of the maximum level of pfd as referred to in *resolves* 1 or the value of the maximum level of epfd as referred to in *resolves* 2, as appropriate.

[1] Until adoption of a definition of θ_{min} by ITU-R, and publication of notified radio astronomy observatory data, a value of 5° should be assumed in appropriate calculations.

RESOLUTION 743 (WRC-03)

Protection of single-dish radio astronomy stations in Region 2 in the 42.5-43.5 GHz band

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that the band 42.5-43.5 GHz is allocated to the radio astronomy service (RAS) on a primary basis, and that both continuum and spectral line observations are conducted in this band;

b) that there are primary allocations to the fixed-satellite service (FSS) (space-to-Earth) and to the broadcasting-satellite service (BSS) in the 42-42.5 GHz band;

c) that a geostationary (GSO) FSS or BSS satellite operating in the 42-42.5 GHz band could encounter great difficulty in meeting the values given in No. **5.551I** for single-dish radio telescope observations in the 42.5-43.5 GHz band for 100% of the time;

d) that an FSS or BSS satellite or system operating in the 42-42.5 GHz band would encounter great difficulty in meeting the power flux-density (pfd) level of −153 dB(W/m^2) in any 500 kHz for GSO satellites or the equivalent pfd (epfd) level of −246 dB(W/m^2) in any 500 kHz for any non-GSO system for single-dish radio telescope spectral-line observations near the 42.5 GHz band edge of the 42.5-43.5 GHz band, even when all practicable technical or operational measures to reduce the potential for interference detrimental to the RAS stations are employed;

e) that because there are relatively few RAS stations operating single-dish telescopes in the band 42.5-43.5 GHz, and because there are expected to be relatively few FSS or BSS earth stations operating in the 42-42.5 GHz band, it may be feasible for both services to employ technical or operational measures, including but not limited to such interference mitigation techniques as geographical isolation, time sharing, etc., in order to reduce the potential for interference detrimental to the RAS stations operating in this band;

f) that, taking into account the above *considerings*, it should be feasible to rely on arrangements between concerned RAS and FSS/BSS administrations to ensure that the unwanted emissions from FSS or BSS satellites and systems in the 42-42.5 GHz band do not cause interference detrimental to RAS stations in Region 2 conducting spectral-line observations in the 42.5-42.77 GHz band,

resolves

1 that a GSO FSS or BSS satellite in the band 42-42.5 GHz shall not exceed the values given in No. **5.551I** for more than 2% of the time at any radio astronomy station in Region 2 registered as a single-dish radio telescope in the 42.5-43.5 GHz band;

2 that an administration that plans to operate a GSO FSS or BSS satellite or a non-GSO FSS or BSS system in the 42-42.5 GHz band shall take all practicable steps to avoid exceeding the pfd value of −153 dB(W/m^2) in any 500 kHz for a GSO satellite, and the epfd value of −246 dB(W/m^2) in any 500 kHz for any non-GSO system in the 42.5-42.77 GHz band, for more than 2% of the time, at the site of a radio astronomy station registered as a single-dish radio telescope in Region 2;

3 that in the event that an administration planning to operate a GSO FSS or BSS satellite or a non-GSO FSS or BSS system in the band 42-42.5 GHz has taken all practicable steps to avoid exceeding the values and percentage of time criterion in *resolves* 2 in the 42.5-42.77 GHz band, but that nevertheless would not meet them, the administration planning to operate such a satellite or systems shall enter into discussions with the administration operating the affected radio astronomy station in Region 2 to arrive at a mutually satisfactory arrangement with respect to the unwanted emissions produced into the band 42.5-42.77 GHz;

4 that *resolves* 1, 2 and 3 shall apply with respect to any radio astronomy station in Region 2 registered as a single-dish radio telescope in the band 42.5-43.5 GHz that was in operation prior to 5 July 2003 and that has been notified to the Radiocommunication Bureau before 4 January 2004, or that was notified before the date of receipt of the complete Appendix **4** information for coordination or notification, as appropriate, for an FSS or BSS satellite or system to which this Resolution applies (see Note 1);

5 that an administration notifying a radio astronomy station in Region 2 as a single-dish radio telescope after the dates provided in *resolves* 4 may seek an agreement with administrations that have authorized FSS or BSS satellites or systems to which this Resolution applies,

invites ITU-R

to conduct studies and develop Recommendations to establish the appropriate balance between the percentage of time that GSO satellites operating in the 42-42.5 GHz band exceed the single-dish values in No. **5.551I** at the site of a radio astronomy station and the associated impact on radio astronomy observations.

NOTE 1 − For purposes of No. **5.551H**, No. **5.551I** and *resolves* 4 of this Resolution, the radio astronomy stations currently under construction in Sierra Negra, Mexico, 18° 59′ N/97° 18′ W (station Volcan Sierra Negra) and San Pedro de Atacama, Chile, 23° 20′ S/67° 44′ W (station Atacama Large Millimeter Array) to conduct observations in the 42.5-43.5 GHz band, shall be considered to have been in operation prior to 5 July 2003 if they are notified to the Radiocommunication Bureau before 1 January 2005.

RESOLUTION 744 (REV.WRC-23)

Sharing between the mobile-satellite service (Earth-to-space) and the fixed and mobile services in the frequency band 1 668.4-1 675 MHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that WRC-03 made a global allocation to the mobile-satellite service (MSS) (Earth-to-space) in the band 1 668-1 675 MHz and a global allocation to the MSS (space-to-Earth) in the band 1 518-1 525 MHz;

b) that the band 1 668.4-1 675 MHz is also allocated to the fixed and mobile services;

c) that due to sharing conditions between MSS (space-to-Earth) and the aeronautical mobile service for telemetry in the band 1 518-1 525 MHz (see No. **5.348B**), MSS operation in the United States of America is unlikely to be feasible;

d) that the above constraints on the MSS in the band 1 518-1 525 MHz therefore limit the possible use of the band 1 668-1 675 MHz by the MSS in the United States of America;

e) that the band 1 670-1 675 MHz is used in Canada and the United States of America for the fixed and mobile services;

f) that some administrations operate transportable radio-relay systems in the band 1 668.4-1 675 MHz which could operate as part of the fixed or mobile service allocations;

g) that sharing between the mobile service and the mobile-satellite service (Earth-to-space) in the band 1 668.4-1 675 MHz has been studied in Recommendation ITU-R M.1799,

resolves

1 that the use of the band 1 668.4-1 675 MHz by systems in the mobile service is limited to transportable radio-relay systems;

2 that administrations operating transportable radio-relay systems should take into account the most recent version of Recommendation ITU-R M.1799, which states that, to adequately protect MSS networks, the e.i.r.p. of transportable radio-relay stations should not exceed −27 dB(W/4 kHz) in the frequency band 1 668.4-1 675 MHz in the direction of the geostationary orbit;

3 that from 1 January 2015 administrations operating such systems in the mobile service shall limit the e.i.r.p. spectral density radiated in the direction of the geostationary orbit by these systems to −27 dB(W/4 kHz) in the band 1 668.4-1 675 MHz;

4 that, in the band 1 670-1 675 MHz, stations in the MSS shall not claim protection from stations in the fixed and mobile services operating in Canada and the United States of America;

5 that *resolves* 1, 2 and 3 do not apply to stations in the fixed and mobile services operating in Canada and the United States of America.

RESOLUTION 748 (REV.WRC-19)

Compatibility between the aeronautical mobile (R) service and the fixed-satellite service (Earth-to-space) in the frequency band 5 091-5 150 MHz

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that the allocation of the frequency band 5 091-5 150 MHz to the fixed-satellite service (FSS) (Earth-to-space) is limited to feeder links of non-geostationary-satellite (non-GSO) systems in the mobile-satellite service (MSS);

b) that the frequency band 5 000-5 150 MHz is currently allocated to the aeronautical mobile-satellite (R) service (AMS(R)S), subject to agreement obtained under No. **9.21**, and to the aeronautical radionavigation service (ARNS);

c) that WRC-07 allocated the frequency band 5 091-5 150 MHz to the aeronautical mobile service (AMS) on a primary basis subject to No. **5.444B**;

d) that the International Civil Aviation Organization (ICAO) is in the process of identifying the technical and operating characteristics of new systems operating in the AM(R)S in the frequency band 5 091-5 150 MHz;

e) that the compatibility of one AM(R)S system, to be used by aircraft operating on the airport surface, and the FSS has been demonstrated in the frequency band 5 091-5 150 MHz;

f) that ITU Radiocommunication Sector (ITU-R) studies have examined potential sharing among the separate AMS applications and the FSS in the frequency band 5 091-5 150 MHz;

g) that the frequency band 117.975-137 MHz currently allocated to the AM(R)S is reaching saturation in certain areas of the world, and therefore that frequency band would not be available to support additional surface applications at airports;

h) that this new allocation is intended to support the introduction of applications and concepts in air traffic management which are data intensive, and which will support data links that carry safety-critical aeronautical data,

recognizing

a) that in the frequency band 5 030-5 091 MHz priority is to be given to the microwave landing system (MLS) in accordance with No. **5.444**;

b) that ICAO publishes recognized international aeronautical standards and recommended practices (SARPs) for AM(R)S systems;

c) that Resolution **114 (Rev.WRC-15)** applies to the sharing conditions between the FSS and ARNS in the frequency band 5 091-5 150 MHz,

noting

a) that the number of FSS transmitting earth stations required may be limited;

b) that the use of the frequency band 5 091-5 150 MHz by the AM(R)S needs to ensure protection of the current or planned use of this frequency band by the FSS (Earth-to-space);

c) that ITU-R studies describe methods for ensuring compatibility between the AM(R)S and FSS operating in the frequency band 5 091-5 150 MHz, and compatibility has been demonstrated for the AM(R)S system referred to in *considering e)*,

resolves

1 that any AM(R)S systems operating in the frequency band 5 091-5 150 MHz shall not cause harmful interference to, nor claim protection from, systems operating in the ARNS;

2 that any AM(R)S systems operating in the frequency band 5 091-5 150 MHz shall meet the SARPs requirements published in Annex 10 of the ICAO Convention on International Civil Aviation and the requirements of Recommendation ITU-R M.1827-1, to ensure compatibility with FSS systems operating in that frequency band;

3 that, in part to meet the provisions of No. **4.10**, the coordination distance with respect to stations in the FSS operating in the frequency band 5 091-5 150 MHz shall be based on ensuring that the signal received at the AM(R)S station from the FSS transmitter does not exceed −143 dB(W/MHz), where the required basic transmission loss shall be determined using the methods described in Recommendations ITU-R P.525-4 and ITU-R P.526-15,

invites

1 administrations to supply technical and operational criteria necessary for sharing studies for the AM(R)S, and to participate actively in such studies;

2 ICAO and other organizations to participate actively in such studies,

instructs the Secretary-General

to bring this Resolution to the attention of ICAO.

RESOLUTION 749 (REV.WRC-23)

Use of the frequency band 790-862 MHz in countries of Region 1 and the Islamic Republic of Iran by mobile applications and by other services

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the favourable propagation characteristics of the frequency band 470-862 MHz are beneficial in providing cost-effective solutions for coverage, including of large areas of low population density;

b) that the operation of broadcasting stations and base stations of the mobile service in the same geographical area may create incompatibility issues;

c) that many communities are particularly underserved compared to urban centres;

d) that applications ancillary to broadcasting are sharing the frequency band 470-862 MHz with the broadcasting service in all three Regions, and are expected to continue their operations in this frequency band;

e) that it is necessary to adequately protect, *inter alia*, terrestrial television broadcasting and other systems in this frequency band,

recognizing

a) that, in Article **5**, the frequency band 790-862 MHz, or parts thereof, is allocated, and is used on a primary basis, for various services including broadcasting;

b) that the GE06 Agreement applies in all Region 1 countries except Mongolia and in the Islamic Republic of Iran in the frequency bands 174-230/470-862 MHz;

c) that the transition from analogue to digital television is expected to result in situations where the frequency band 790-862 MHz will be used for both analogue and digital terrestrial transmission; and the demand for spectrum during the transition period may be even greater than the standalone usage of analogue broadcasting systems;

d) that the switchover to digital may result in spectrum opportunities for new applications;

e) that the timing of the switchover to digital is likely to vary from country to country;

f) that the use of spectrum for different services should take into account the need for sharing studies;

g) that the Radio Regulations provide that the identification of a given frequency band for International Mobile Telecommunications (IMT) does not preclude the use of that frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations;

h) that the GE06 Agreement contains provisions for the terrestrial broadcasting service and other terrestrial services, a Plan for digital TV, and the List of other primary terrestrial services;

i) that the GE06 Agreement established, for the frequency band 470-862 MHz, 16 June 2015 as the date when the transition period ended, meaning that the assignments that were in the analogue Plan are no longer protected and shall not cause unacceptable interference in countries which are Contracting Members to the Agreement;

j) that the studies carried out by the ITU Radiocommunication Sector (ITU-R) pursuant to Resolution **749 (WRC-07)**[*, 1] showed that the potential impact of the cumulative effect of interference from base stations, which individually did not trigger the need for coordination with broadcasting, could be significant; on the other hand, the potential impact of cumulative interference might be less significant in practice;

k) that ITU-R initiated studies with a view to developing and completing comprehensive Recommendations and Reports, in accordance with Resolution **224 (Rev.WRC-19)**[**], which need to take into account the cumulative effect of interference,

recognizing further

a) that the frequency band 790-862 MHz, as part of a wider frequency band, has been allocated to the mobile service in Region 3 (including the Islamic Republic of Iran) since 1971 (prior to WRC-07);

b) that the GE06 Agreement, in its relevant Annexes, establishes the relationship between digital terrestrial broadcasting, on the one hand, and other primary terrestrial services, including the aeronautical radionavigation service (ARNS) in the countries mentioned in No. **5.312**, on the other;

c) that WRC-07, under No. **5.316B**, allocated the frequency band 790-862 MHz in Region 1 to the mobile, except aeronautical mobile, service on a primary basis, and that this allocation shall come into effect as of 17 June 2015 and shall be subject to agreement obtained under No. **9.21** with respect to the ARNS in countries mentioned in No. **5.312**;

d) that the frequency band 790-862 MHz in Region 1 and the frequency band 790-806 MHz in Region 3 were identified by WRC-07 for use by administrations wishing to implement IMT, whereas the frequency band 806-960 MHz in Region 3 was identified for IMT in WRC-2000;

e) that for Contracting Members to the GE06 Agreement, the use of stations of the mobile service in relation to the broadcasting service is also subject to successful application of the procedures of the GE06 Agreement;

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[*] *Note by the Secretariat:* This Resolution was revised by WRC-12, WRC-15, WRC-19 and WRC-23.

[1] Reference to Resolution **749 (WRC-07)** is provided as background information.

[**] *Note by the Secretariat:* This Resolution was revised by WRC-23.

f) that the coordination between terrestrial services (fixed, mobile and broadcasting) in the frequency band 790-862 MHz between the Islamic Republic of Iran, on the one hand, and the other countries of Region 3, on the other, is a matter to be left to the administrations concerned, based on bilateral or multilateral negotiations, if it is mutually agreed by those administrations,

noting

a) that Resolution ITU-R 57 provides principles for the process of development of IMT-Advanced and that this process had already started after WRC-07;

b) that in the frequency band 790-862 MHz, Resolution **224 (Rev.WRC-23)** applies,

emphasizing

a) that the use of the frequency band 470-862 MHz by broadcasting and other primary services is also covered by the GE06 Agreement;

b) that the requirements of the different services to which the frequency band is allocated, including the mobile service, the ARNS (in accordance with No. **5.312**), the fixed service and the broadcasting service, shall be taken into account,

taking into account

that the results of the studies carried out by ITU-R pursuant to Resolution **749 (WRC-07)**[*, 2] indicate that there is a need to protect other primary terrestrial services from the mobile service in Region 1,

resolves

1 that, in Region 1:

in accordance with No. **5.316B**, and based on the criteria contained in the Annex to this Resolution, administrations implementing the mobile service in Region 1 shall seek agreement under No. **9.21** with respect to the ARNS in the countries mentioned in No. **5.312**;

2 that for Region 1 and the Islamic Republic of Iran:

2.1 when coordination between administrations is being effected, the protection ratios applicable to the generic case NB contained in the GE06 Agreement for the protection of the broadcasting service shall be used only for mobile systems with a bandwidth of 25 kHz; if another bandwidth is used, the relevant protection ratios are to be found in the most recent version of Recommendations ITU-R BT.1368 and ITU-R BT.2033;

2.2 administrations are invited to take into account, *inter alia*, the results of the sharing studies conducted by ITU-R in response to Resolution **749 (WRC-07)**[*, 2];

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[*] *Note by the Secretariat:* This Resolution was revised by WRC-12, WRC-15, WRC-19 and WRC-23.

[2] Reference to Resolution **749 (WRC-07)** is provided as background information.

3 that, with respect to adjacent channel interference within the frequency band 790-862 MHz:

3.1 adjacent channel interference within a given country is a national matter and needs to be dealt with by each administration as a national matter;

3.2 adjacent channel interference should be treated among administrations concerned, using mutually agreed criteria or those contained in relevant ITU-R Recommendations (see also the most recent versions of Recommendations ITU-R BT.1368, ITU-R BT.1895 and ITU-R BT.2033 when sharing with the broadcasting service is concerned), as appropriate,

invites administrations

to contribute further to the studies conducted by ITU-R in accordance with *recognizing k)* above,

instructs the Director of the Radiocommunication Bureau

to implement this Resolution and to take appropriate actions.

ANNEX TO RESOLUTION 749 (REV.WRC-23)

Criteria for identifying potentially affected administrations with respect to the aeronautical radionavigation service in countries listed in No. 5.312

To identify potentially affected administrations when applying the procedure for seeking agreement under No. **9.21** by the mobile service with respect to the aeronautical radionavigation service (ARNS) operating in countries mentioned in No. **5.312**, as stipulated in No. **5.316B**, the coordination distances (between a base station in the mobile service and a potentially affected ARNS station) indicated below should be used.

When applying No. **5.316B**, notifying administrations may indicate in the notice sent to the Radiocommunication Bureau (BR) the list of administrations with which bilateral agreement has already been reached. BR shall take this into account in determining the administrations with which coordination under No. **9.21** is required.

1 Case where the mobile service is operated according to the frequency arrangement where the base stations transmit only in the frequency band 791-821 MHz and receive only in the frequency band 832-862 MHz

ARNS station	System type code	Coordination distances for receiving MS base stations (km)	Coordination distances for transmitting MS base stations (km)
RSBN (ground receiver)	AA8	–	70/125/175**
RLS 2 (Type 2) (aircraft receiver)	BC	70/150*	–
RLS 1 (Types 1 and 2) (ground receiver)	AB	70/125/175**	–

* The first value should be used when the notifying administration indicates in the notice form that the aggregate equivalent isotropically radiated power (e.i.r.p.) value of all user equipment operating simultaneously with the notified base station is assumed not to exceed 21 dBm in 1 MHz. The second value should be used in other cases.

** 90% ≤ land path ≤ 100% / 50% ≤ land path < 90% / 0% ≤ land path < 50%.

2 Other cases

ARNS station	System type code	Coordination distances for MS receiving base stations (km)	Coordination distances for MS transmitting base stations (km)
RSBN	AA8	50	125/175*
RLS 2 (Type 1) (aircraft receiver)	BD	410	432
RLS 2 (Type 1) (ground receiver)	BA	50	250/275*
RLS 2 (Type 2) (aircraft receiver)	BC	150	432
RLS 2 (Type 2) (ground receiver)	AA2	50/75*	300/325*
RLS 1 (Types 1 and 2) (ground receiver)	AB	125/175*	400/450*
Other types of ARNS terrestrial station	Not applicable	125/175*	400/450*
Other types of ARNS airborne station	Not applicable	410	432

* 50% ≤ land path ≤ 100% / 0% ≤ land path < 50%.

RESOLUTION 750 (REV.WRC-19)

Compatibility between the Earth exploration-satellite service (passive) and relevant active services

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that primary allocations have been made to various space services such as the fixed-satellite service (Earth-to-space), the space operation service (Earth-to-space) and the inter-satellite service and/or to terrestrial services such as the fixed service, the mobile service and the radiolocation service, hereinafter referred to as "active services", in frequency bands adjacent or nearby to frequency bands allocated to the Earth exploration-satellite service (EESS) (passive), subject to No. **5.340**;

b) that unwanted emissions from active services have the potential to cause unacceptable interference to EESS (passive) sensors;

c) that, for technical or operational reasons, the general limits in Appendix **3** may be insufficient in protecting the EESS (passive) in specific frequency bands;

d) that, in many cases, the frequencies used by EESS (passive) sensors are chosen to study natural phenomena producing radio emissions at frequencies fixed by the laws of nature, and therefore shifting frequency to avoid or mitigate interference problems is not possible;

e) that the frequency band 1 400-1 427 MHz is used for measuring soil moisture, and also for measuring sea-surface salinity and vegetation biomass;

f) that long-term protection of the EESS in the frequency bands 23.6-24 GHz, 31.3-31.5 GHz, 50.2-50.4 GHz, 52.6-54.25 GHz and 86-92 GHz is vital to weather prediction and disaster management, and measurements at several frequencies must be made simultaneously in order to isolate and retrieve each individual contribution;

g) that, in many cases, the frequency bands adjacent to or nearby passive service frequency bands are used and will continue to be used for various active service applications;

h) that it is necessary to ensure equitable burden-sharing for achieving compatibility between active and passive services operating in adjacent or nearby frequency bands,

noting

a) that some of the compatibility studies between relevant active and passive services operating in adjacent and nearby frequency bands are documented in Report ITU-R SM.2092 and in Report ITU-R S.2463;

b) that the compatibility studies between International Mobile Telecommunications (IMT) systems in the frequency bands 1 375-1 400 MHz and 1 427-1 452 MHz and EESS (passive) systems in the frequency band 1 400-1 427 MHz are documented in Report ITU-R RS.2336;

c) that Report ITU-R F.2239 provides the results of studies covering various scenarios between the fixed service, operating in the frequency bands 81-86 GHz and/or 92-94 GHz, and the EESS (passive), operating in the frequency band 86-92 GHz;

d) that Recommendation ITU-R RS.2017 provides the interference criteria for satellite passive remote sensing,

noting further

that, for the purpose of this Resolution:

– point-to-point communication is defined as radiocommunication provided by a link, for example a radio-relay link, between two stations located at specified fixed points;

– point-to-multipoint communication is defined as radiocommunication provided by links between a single station located at a specified fixed point (also called "hub station") and a number of stations located at specified fixed points (also called "customer stations"),

recognizing

a) that studies documented in Report ITU-R SM.2092 do not consider point-to-multipoint communication links in the fixed service in the frequency bands 1 350-1 400 MHz and 1 427-1 452 MHz;

b) that, in the frequency band 1 427-1 452 MHz, mitigation measures, such as channel arrangements, improved filters and/or guardbands, may be necessary in order to meet the unwanted emission limits for IMT stations in the mobile service specified in Table 1 of this Resolution;

c) that, in the frequency band 1 427-1 452 MHz, IMT mobile stations typically perform better than the equipment specifications as stated by relevant standards organizations, which may be taken into account in meeting the limits specified in Table 1 (see also sections 4 and 5 of Report ITU-R RS.2336),

resolves

1 that unwanted emissions of stations brought into use in the frequency bands and services listed in Table 1 below shall not exceed the corresponding limits in that table, subject to the specified conditions;

2 to urge administrations to take all reasonable steps to ensure that unwanted emissions of active service stations in the frequency bands and services listed in Table 2 below do not exceed the recommended maximum levels contained in that table, noting that EESS (passive) sensors provide worldwide measurements that benefit all countries, even if these sensors are not operated by their country;

3 that the Radiocommunication Bureau shall not make any examination or finding with respect to compliance with this Resolution under either Article **9** or **11**.

TABLE 1

EESS (passive) frequency band	Active service frequency band	Active service	Limits of unwanted emission power from active service stations in a specified bandwidth within the EESS (passive) frequency band[1]
1 400- 1 427 MHz	1 427- 1 452 MHz	Mobile	−72 dBW in the 27 MHz of the EESS (passive) band for IMT base stations −62 dBW in the 27 MHz of the EESS (passive) band for IMT mobile stations[2, 3]
23.6-24.0 GHz	22.55-23.55 GHz	Inter-satellite	−36 dBW in any 200 MHz of the EESS (passive) band for non-GSO inter-satellite service (ISS) systems for which complete advance publication information (API) is received by BR before 1 January 2020, and −46 dBW in any 200 MHz of the EESS (passive) band for non-GSO ISS systems for which complete API is received by BR on or after 1 January 2020
	24.25-27.5 GHz	Mobile	−33 dBW[a] in any 200 MHz of the EESS (passive) band for IMT base stations[5] −29 dBW[b] in any 200 MHz of the EESS (passive) band for IMT mobile stations[5]
31.3-31.5 GHz	31-31.3 GHz	Fixed (excluding HAPS)	For stations brought into use after 1 January 2012: −38 dBW in any 100 MHz of the EESS (passive) band. This limit does not apply to stations that have been authorized prior to 1 January 2012
50.2-50.4 GHz	49.7-50.2 GHz	Fixed-satellite (E-to-s)[4]	For GSO earth stations brought into use after the date of entry into force of the Final Acts of WRC-07 and prior to 1 January 2024: −10 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain greater than or equal to 57 dBi −20 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain less than 57 dBi For GSO earth stations with antenna gain greater than or equal to 57 dBi brought into use on or after 1 January 2024: −25 dBW into the 200 MHz of the EESS (passive) band for earth stations having an elevation angle below 80° −45 dBW into the 200 MHz of the EESS (passive) band for earth stations having an elevation angle equal or above 80° For GSO earth stations with antenna gain less than 57 dBi brought into use on or after 1 January 2024: −30 dBW into the 200 MHz of the EESS (passive) band for earth stations having an elevation angle below 80° −45 dBW into the 200 MHz of the EESS (passive) band for earth stations having an elevation angle equal or above 80°

EESS (passive) frequency band	Active service frequency band	Active service	Limits of unwanted emission power from active service stations in a specified bandwidth within the EESS (passive) frequency band[1]
			For non-GSO earth stations brought into use after the date of entry into force of the Final Acts of WRC-07 and before the date of entry into force of the Final Acts of WRC-19: −10 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain greater than or equal to 57 dBi −20 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain less than 57 dBi For non-GSO earth stations brought into use after the date of entry into force of the Final Acts of WRC-19[6]: −42 dBW into the 200 MHz of the EESS (passive) band for earth stations not employing uplink power control −42 dBW into the 200 MHz of the EESS (passive) band at zenith increasing to a maximum level of −35 dBW into the 200 MHz of the EESS (passive) band at a minimum elevation angle of 15° for earth stations employing uplink power control
50.2-50.4 GHz	50.4-50.9 GHz	Fixed-satellite (E-to-s)[4]	For GSO earth stations brought into use after the date of entry into force of the Final Acts of WRC-07 and prior to 1 January 2024: −10 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain greater than or equal to 57 dBi −20 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain less than 57 dBi For GSO earth stations with antenna gain greater than or equal to 57 dBi brought into use on or after 1 January 2024: −25 dBW into the 200 MHz of the EESS (passive) band for earth stations having an elevation angle below 80° −45 dBW into the 200 MHz of the EESS (passive) band for earth stations having an elevation angle equal or above 80° For GSO earth stations with antenna gain less than 57 dBi brought into use on or after 1 January 2024: –30 dBW into the 200 MHz of the EESS (passive) band for earth stations having an elevation angle below 80° −45 dBW into the 200 MHz of the EESS (passive) band for earth stations having an elevation angle equal or above 80°

EESS (passive) frequency band	Active service frequency band	Active service	Limits of unwanted emission power from active service stations in a specified bandwidth within the EESS (passive) frequency band[1]
			For non-GSO earth stations brought into use after the date of entry into force of the Final Acts of WRC-07 and before the date of entry into force of the Final Acts of WRC-19: −10 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain greater than or equal to 57 dBi −20 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain less than 57 dBi For non-GSO earth stations brought into use after the date of entry into force of the Final Acts of WRC-19[6]: −42 dBW into the 200 MHz of the EESS (passive) band for earth stations not employing uplink power control −42 dBW into the 200 MHz of the EESS (passive) band at zenith increasing to a maximum level of −35 dBW into the 200 MHz of the EESS (passive) band at a minimum elevation angle of 15° for earth stations employing uplink power control
52.6-54.25 GHz	51.4-52.4 GHz	Fixed-satellite (E-to-s)[4]	For earth stations operating in GSO FSS networks, in order to protect non-GSO EESS (passive) space stations: −37 dBW in any 100 MHz of the EESS (passive) band for FSS earth stations with elevation angles lower than 75° −52 dBW in any 100 MHz of the EESS (passive) band for FSS earth stations with elevation angles equal to or higher than 75° For earth stations operating with a GSO FSS space station whose nominal geocentric orbital separation Δ is equal to or smaller than 2.5° from any GSO EESS (passive) space station from the time of its notification in accordance with No. **11.44** with nominal orbital positions: 0°, 9.5° E, 76° E, 79° E, 99.5° E, 105° E, 123.5° E, 133° E, 165.8° E, 14.5° W and 137.2° W: $-84 + 200\,\Delta$ dBW for $0° \leq \Delta < 0.1°$ $-67 + 22.8\,\Delta$ dBW for $0.1° \leq \Delta < 0.5°$ $-61 + 11.3\,\Delta$ dBW for $0.5° \leq \Delta < 1.9°$ $-47 + 4\,\Delta$ dBW for $1.9° \leq \Delta \leq 2.5°$ in any 100 MHz of the EESS (passive) band
52.6-54.25 GHz	51.4-52.6 GHz	Fixed	For stations brought into use after the date of entry into force of the Final Acts of WRC-07: −33 dBW in any 100 MHz of the EESS (passive) band

Notes to Table 1:

[1] The unwanted emission power level is to be understood here as the level measured at the antenna port, unless it is specified in terms of total radiated power (TRP).

[2] This limit does not apply to mobile stations in the IMT systems for which the notification information has been received by BR by 28 November 2015. For those systems, −60 dBW/27 MHz applies as the recommended value.

[3] The unwanted emission power level is to be understood here as the level measured with the mobile station transmitting at an average output power of 15 dBm.

[4] The limits apply under clear-sky conditions. During fading conditions, the limits may be exceeded by earth stations when using uplink power control.

[5] The unwanted emission power level is considered in terms of TRP. The TRP is to be understood here as the integral of the power transmitted from all antenna elements in different directions over the entire radiation sphere.

[a] A limit of −39 dB(W/200 MHz) will apply to IMT base stations brought into use after 1 September 2027. This limit will not apply to IMT base stations which have been brought into use prior to this date. For those IMT base stations, the limit of −33 dB(W/200 MHz) will continue to apply after this date.

[b] A limit of −35 dB(W/200 MHz) will apply to IMT mobile stations brought into use after 1 September 2027. This limit will not apply to IMT mobile stations which have been brought into use prior to this date. For those IMT mobile stations, the limit of −29 dB(W/200 MHz) will continue to apply after this date.

[6] Compliance with these limits may include the consideration of additional mitigation techniques, which require further studies by ITU-R.

TABLE 2

EESS (passive) frequency band	Active service frequency band	Active service	Recommended maximum level of unwanted emission power from active service stations in a specified bandwidth within the EESS (passive) frequency band[1]
1 400-1 427 MHz	1 350-1 400 MHz	Radiolocation[2]	−29 dBW in the 27 MHz of the EESS (passive) band
		Fixed	−45 dBW in the 27 MHz of the EESS (passive) band for point-to-point
		Mobile	−60 dBW in the 27 MHz of the EESS (passive) band for mobile-service stations except transportable radio-relay stations −45 dBW in the 27 MHz of the EESS (passive) band for transportable radio-relay stations
	1 427-1 429 MHz	Space operation (E-to-s)	−36 dBW in the 27 MHz of the EESS (passive) band
	1 427-1 429 MHz	Mobile except aeronautical mobile	−60 dBW in the 27 MHz of the EESS (passive) band for mobile-service stations except IMT stations and transportable radio-relay stations[3] −45 dBW in the 27 MHz of the EESS (passive) band for transportable radio-relay stations
		Fixed	−45 dBW in the 27 MHz of the EESS (passive) band for point-to-point
	1 429-1 452 MHz	Mobile	−60 dBW in the 27 MHz of the EESS (passive) band for mobile-service stations except IMT stations, transportable radio-relay stations and aeronautical telemetry stations −45 dBW in the 27 MHz of the EESS (passive) band for transportable radio-relay stations −28 dBW in the 27 MHz of the EESS (passive) band for aeronautical telemetry stations[3]
		Fixed	−45 dBW in the 27 MHz of the EESS (passive) band for point-to-point
31.3-31.5 GHz	30.0-31.0 GHz	Fixed-satellite (E-to-s)[4]	−9 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain greater than or equal to 56 dBi −20 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain less than 56 dBi
86-92 GHz[5]	81-86 GHz	Fixed	$-41 - 14(f - 86)$ dBW/100 MHz for $86.05 \leq f \leq 87$ GHz −55 dBW/100 MHz for $87 \leq f \leq 91.95$ GHz where f is the centre frequency of the 100 MHz reference bandwidth expressed in GHz
	92-94 GHz	Fixed	$-41 - 14(92 - f)$ dBW/100 MHz for $91 \leq f \leq 91.95$ GHz −55 dBW/100 MHz for $86.05 \leq f \leq 91$ GHz where f is the centre frequency of the 100 MHz reference bandwidth expressed in GHz

Notes to Table 2:

[1] The unwanted emission power level is to be understood here as the level measured at the antenna port.

[2] The mean power is to be understood here as the total power measured at the antenna port (or an equivalent thereof) in the frequency band 1 400-1 427 MHz, averaged over a period of the order of 5 s.

[3] The frequency band 1 429-1 435 MHz is also allocated to the aeronautical mobile service in eight Region 1 administrations on a primary basis exclusively for the purposes of aeronautical telemetry within their national territory (No. **5.342**).

[4] The recommended maximum levels apply under clear-sky conditions. During fading conditions, these levels may be exceeded by earth stations when using uplink power control.

[5] Other maximum unwanted emission levels may be developed based on different scenarios provided in Report ITU-R F.2239 for the frequency band 86-92 GHz.

RESOLUTION 751 (WRC-07)

Use of the frequency band 10.6-10.68 GHz

The World Radiocommunication Conference (Geneva, 2007),

considering

a) that the frequency band 10.6-10.7 GHz is allocated to the Earth exploration-satellite service (EESS) (passive) and to the space research service (passive) on a primary basis;

b) that the band 10.6-10.7 GHz is of primary interest for the measurement of rain, snow, sea state, ocean wind and soil moisture;

c) that this frequency band is used by passive sensors to study natural phenomena producing radio emissions at frequencies fixed by the laws of nature, and therefore shifting frequency to avoid or mitigate interference problems may not be possible;

d) that any limitation of the operation of passive sensors in the band 10.68-10.7 GHz covered by No. **5.340** would degrade the sensitivity of those sensors;

e) that the frequency band 10.6-10.68 GHz is also allocated to the mobile, except aeronautical mobile, and the fixed services on a primary basis;

f) that experience has shown that EESS (passive) sensors currently operating in the band 10.6-10.68 GHz are facing high interference levels from the emissions of systems of active services in some parts of the world;

g) that studies have concluded that appropriate sharing criteria applicable to both passive and active services would reduce this interference to a level that would permit passive sensors to operate successfully, while allowing continuing operation of active services in the same band,

noting

that, for the purpose of this Resolution:

– point-to-point communication is defined as radiocommunication provided by a link, for example a radio-relay link, between two stations located at specified fixed points;

– point-to-multipoint communication is defined as radiocommunication provided by links between a single station located at a specified fixed point (also called “hub station”) and a number of stations located at specified fixed points (also called “customer stations”);

– automatic transmit-power control (ATPC) is a technique in which the output power of a microwave transmitter is automatically varied to compensate for path propagation conditions; in normal propagation conditions, ATPC maintains the transmitter output power at a reduced level; ATPC is characterized by its range, which is defined as the difference between the maximum and minimum values of transmitted power, and has no impact on the design of the related link,

resolves

1 to urge administrations to take all reasonable steps to comply with the sharing criteria in Tables 1 to 4 contained in Annex 1 to this Resolution when bringing into use stations in the Earth exploration-satellite service (passive), the fixed service and the mobile, except aeronautical mobile, service, noting that EESS (passive) sensors provide worldwide measurements that benefit all countries, even if these sensors are not operated by their country;

2 that the Radiocommunication Bureau shall not make any examination or finding with respect to compliance with this Resolution under either Article **9** or **11**.

ANNEX 1 TO RESOLUTION 751 (WRC-07)

Sharing criteria in the band 10.6-10.68 GHz

TABLE 1

Earth exploration-satellite service (passive)

Parameter	Value
Incidence angle (defined as the angle at the Earth's surface between the local vertical and the direction of the passive sensor)	≤ 60°
Spatial resolution (defined as the maximum cross-section of the passive sensor −3 dB contour on the Earth's surface)	≤ 50 km (See Note 1)
Main-beam efficiency (defined as the energy of main and cross-polarization components within 2.5 times the −3 dB beamwidth region, relative to the total energy within all angles)	≥ 85% (See Note 1)

NOTE 1 − These parameters only apply to real-aperture EESS (passive) systems.

TABLE 2

Stations of point-to-point systems in the fixed service

Parameter	Value
Maximum elevation angle	20°
Maximum transmitter power at the antenna port	−15 dBW (See Notes 2 and 3)

NOTE 2 − In the case of point-to-point systems using ATPC, the maximum transmitter power at the antenna port may be increased by a value corresponding to the ATPC range, up to a maximum of −3 dBW.

NOTE 3 − In the case of point-to-point fixed service used for unidirectional transmissions for broadcasting applications, the maximum transmitter power at the antenna port may be increased up to −3 dBW. For such applications, administrations are urged to limit the off-axis e.i.r.p. above 20° elevation to a level of −10 dBW.

TABLE 3

Stations of point-to-multipoint systems in the fixed service

Parameter	Value
Hub stations (See Note 4)	
Maximum transmitter power at the antenna port	−7 dBW
Maximum off-axis e.i.r.p. above 20° from the horizontal plane	−6 dBW
Maximum off-axis e.i.r.p. above 45° from the horizontal plane	−11 dBW
Maximum off-axis e.i.r.p. at 90° from the horizontal plane	−13 dBW
Customer stations (See Note 4)	
Maximum elevation angle	20°
Maximum transmitter power at the antenna port	−8 dBW
Maximum off-axis e.i.r.p. above 45° from the horizontal plane	−18 dBW (See Note 5)

NOTE 4 − Administrations planning point-to-multipoint deployment in the band 10.6-10.68 GHz, paired with another frequency band, are encouraged to only deploy return links (i.e. emissions from customer stations) in the 10.6-10.68 GHz band.

NOTE 5 − In the case of point-to-multipoint systems using ATPC, the maximum transmitter power at the antenna port may be increased by a value corresponding to the ATPC range, up to a maximum of −3 dBW.

TABLE 4

Stations in the mobile service

Parameter	Value
Maximum transmitter power at the antenna port	−17 dBW (See Note 6)

NOTE 6 − In the case of mobile service systems used for broadcasting applications, the maximum transmitter power at the antenna port may be increased up to −3 dBW. For such applications, administrations are urged to limit the off-axis e.i.r.p. above 20° elevation to a level of −10 dBW.

RESOLUTION 752 (WRC-07)

Use of the frequency band 36-37 GHz

The World Radiocommunication Conference (Geneva, 2007),

considering

a) that the frequency band 36-37 GHz is allocated to the Earth exploration-satellite service (EESS) (passive) and to the space research service (passive) on a primary basis;

b) that the band 36-37 GHz is of primary interest for the measurement of rain, snow, ocean ice and water vapour;

c) that this frequency band is used by passive sensors to study natural phenomena producing radio emissions at frequencies fixed by the laws of nature, and therefore shifting frequency to avoid or mitigate interference problems may not be possible;

d) that the frequency band 36-37 GHz is also allocated to the fixed service and to the mobile service on a primary basis;

e) that the EESS (passive) operating in the band 36-37 GHz may suffer from interference from the emissions of systems of active services;

f) that studies have concluded that appropriate sharing criteria applicable to both passive and active services would reduce this interference to a level that would permit passive sensors to operate successfully in this band, while allowing continuing operation of active services in the same band,

noting

that, for the purpose of this Resolution:

– point-to-point communication is defined as radiocommunication provided by a link, for example a radio-relay link, between two stations located at specified fixed points;

– point-to-multipoint communication is defined as radiocommunication provided by links between a single station located at a specified fixed point (also called “hub station”) and a number of stations located at specified fixed points (also called “customer stations”);

– automatic transmit-power control (ATPC) is a technique in which the output power of a microwave transmitter is automatically varied to compensate for path propagation conditions; in normal propagation conditions, ATPC maintains the transmitter output power at a reduced level; ATPC is characterized by its range, which is defined as the difference between the maximum and minimum values of transmitted power,

resolves

1 that, in order to facilitate sharing between active and passive services in the band 36-37 GHz, EESS (passive) stations brought into use after the date of entry into force of the Final Acts of WRC-07 shall comply with the sharing criteria contained in Table 1 of Annex 1 to this Resolution;

2 that, in order to facilitate sharing between active and passive services in the band 36-37 GHz, stations of point-to-point systems in the fixed service brought into use after 1 January 2012 shall comply with the sharing criteria contained in Table 2 of Annex 1 to this Resolution;

3 that, in order to facilitate sharing between active and passive services in the band 36-37 GHz, stations of point-to-multipoint systems in the fixed service brought into use after the date of entry into force of Final Acts of WRC-07 shall comply with the sharing criteria contained in Table 2 of Annex 1 to this Resolution;

4 that, in order to facilitate sharing between active and passive services in the band 36-37 GHz, stations in the mobile service brought into use after the date of entry into force of the Final Acts of WRC-07 shall comply with the sharing criteria contained in Table 3 of Annex 1 to this Resolution;

5 that the Radiocommunication Bureau shall not make any examination or finding with respect to compliance with this Resolution under either Article **9** or **11**.

ANNEX 1 TO RESOLUTION 752 (WRC-07)

Sharing criteria in the band 36-37 GHz

TABLE 1

Earth exploration-satellite service (passive)

Parameter	Value
Incidence angle (defined as the angle at the Earth's surface between the local vertical and the direction of the passive sensor)	≤ 60°
Spatial resolution (defined as the maximum cross-section of the passive sensor −3 dB contour on the Earth's surface)	≤ 50 km (See Note 1)
Main-beam efficiency (defined as the energy of main and cross-polarization components within 2.5 times the −3 dB beamwidth region, relative to the total energy within all angles)	≥ 92% (See Note 1)

NOTE 1 − These parameters only apply to real-aperture EESS (passive) systems.

TABLE 2

Fixed service

Parameter	Value
Maximum elevation angle	20°
Point-to-point systems Maximum transmitter power at the antenna port	 −10 dBW (See Note 2)
Point-to-multipoint systems Maximum transmitter power at the antenna port of hub stations Maximum transmitter power at the antenna port of customer stations	 −5 dBW −10 dBW (See Note 2)

NOTE 2 − In the case of fixed service systems using ATPC, the maximum transmitter power at the antenna port may be increased by a value corresponding to the ATPC range, up to a maximum of −7 dBW.

TABLE 3

Mobile service

Parameter	Value
Maximum transmitter power at the antenna port	−10 dBW (See Note 3)

NOTE 3 − The maximum transmitter power at the antenna port may be increased up to −3 dBW for stations used for public safety and disaster management.

RESOLUTION 759 (WRC-15)

Technical studies on the coexistence of the radiolocation service and the amateur, amateur-satellite and radio astronomy services in the frequency band 76-81 GHz

The World Radiocommunication Conference (Geneva, 2015),

considering

a) that the frequency band 77.5-78 GHz is allocated to the amateur and amateur-satellite services on a primary basis;

b) that the frequency band 77.5-78 GHz is allocated to the radio astronomy service (RAS) on a secondary basis;

c) that this conference has allocated the frequency band 77.5-78 GHz to the radiolocation service on a primary basis;

d) that under No. **5.149**, administrations, in making assignments to stations of services other than radio astronomy to which the frequency band 76-86 GHz is allocated, are urged to take all practicable steps to protect the RAS from harmful interference,

noting

a) that the allocation of the frequency band 76-81 GHz to the radiolocation service is used by radar applications and that a radar station may use the entire frequency band 76-81 GHz;

b) that technical parameters of radars for automotive applications are contained in Recommendation ITU-R M.2057;

c) that sharing studies between the amateur, amateur-satellite and radio astronomy services and the radiolocation service are limited to automotive radars as described in Report ITU-R M.2322,

recognizing

a) that administrations may benefit from the availability of studies and guidelines about the protection of the RAS in the frequency band 76-81 GHz;

b) that the protection of the RAS, in accordance with *considering d)*, may require additional measures in some countries, such as the definition of specific exclusion zones around RAS sites,

resolves to invite the ITU Radiocommunication Sector

to perform studies to assist administrations in ensuring compatibility between applications of the amateur, amateur-satellite and radio astronomy services and radiolocation service applications in the frequency band 76-81 GHz, taking into account those already completed in Report ITU-R M.2322, and develop ITU-R Recommendations and Reports, as appropriate.

RESOLUTION 760 (REV.WRC-23)

Provisions relating to the use of the frequency band 694-790 MHz in Region 1 by the mobile, except aeronautical mobile, service and by other services

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the favourable propagation characteristics of the frequency band 694-790 MHz are beneficial in providing cost-effective solutions for coverage;

b) that the ITU Radiocommunication Sector (ITU-R) carried out studies, in accordance with Resolution **232 (WRC-12)**[*, 1], on compatibility between the mobile service and other services currently allocated in the frequency band 694-790 MHz;

c) that it is necessary to adequately protect all primary services in the frequency band 694-790 MHz and in adjacent frequency bands;

d) that Report ITU-R BT.2339 provides elements on co-channel sharing and compatibility between digital terrestrial television broadcasting and International Mobile Telecommunications (IMT) in the frequency band 694-790 MHz in the GE06 planning area, which administrations can use in the development of their bilateral agreements;

e) that the frequency band 645-862 MHz is allocated on a primary basis to the aeronautical radionavigation service (ARNS) in the countries listed in No. **5.312**;

f) that, in some countries, applications ancillary to broadcasting and programme-making are operating in the frequency band 470-862 MHz or in parts of that frequency band and are expected to continue such operations;

g) that, in some countries, the implementation of IMT in the frequency band 694-790 MHz may affect the availability of frequencies for applications ancillary to broadcasting and programme-making,

recognizing

a) that, in Article **5**, the frequency band 694-790 MHz, or parts of that frequency band, is allocated, and is used on a primary basis, for various services;

b) that the GE06 Agreement applies in all Region 1 countries except Mongolia and in the Islamic Republic of Iran in the frequency bands 174-230/470-862 MHz;

c) that, in the frequency band 694-790 MHz, Resolution **224 (Rev.WRC-23)** applies;

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[*] *Note by the Secretariat:* This Resolution was abrogated by WRC-15.

[1] Reference to Resolution **232 (WRC-12)** is provided as background information.

d) that WRC-12, through Resolution **232 (WRC-12)**[*, 2], allocated the frequency band 694-790 MHz in Region 1 to the mobile, except aeronautical mobile, service on a primary basis, subject to agreement obtained under No. **9.21** with respect to the ARNS in countries listed in No. **5.312**, and requested WRC-15 to specify technical and regulatory conditions applicable to the mobile-service allocation, as appropriate, taking into account the ITU-R studies;

e) that the identification of a given frequency band for IMT in the Radio Regulations does not preclude the use of that band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations;

f) that interference generated and received within a given country is a national matter and needs to be dealt with by each administration as a national matter;

g) that adjacent-channel interference generated in one country and affecting a neighbouring country needs to be mutually considered;

h) that Recommendation ITU-R M.2090 provides specific unwanted emission limits of IMT mobile stations operating in the frequency band 694-790 MHz in order to facilitate protection of existing services in the frequency band 470-694 MHz in Region 1;

i) that Recommendation ITU-R M.1036 provides frequency arrangements for implementation of the terrestrial component of IMT in the frequency bands identified for IMT in the Radio Regulations, and provides frequency arrangements in the frequency band 694-960 MHz;

j) that the studies carried out by ITU-R pursuant to Resolution **232 (WRC-12)**[*, 2] showed that the potential impact of the cumulative effect of interference from base stations, which individually did not trigger the need for coordination with broadcasting, could be significant; on the other hand, the potential impact of cumulative interference might be less significant in practice;

k) that bilateral coordination agreements have already been reached and will be used by administrations as an agreement obtained under No. **9.21** with respect to ARNS in countries listed in No. **5.312**;

l) that, in Region 1, a number of countries have deployments of applications ancillary to broadcasting and programme-making which provide tools for daily content production for the broadcasting service,

noting

a) that, while some administrations may decide to use all or part of the frequency band 694-790 MHz for IMT, other countries may continue to operate other services to which the frequency band is also allocated;

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[*] *Note by the Secretariat:* This Resolution was abrogated by WRC-15.

[2] Reference to Resolution **232 (WRC-12)** is provided as background information.

b) that the timing of the deployment of IMT in the frequency band 694-790 MHz is likely to vary from country to country;

c) that parts of Region 1 have successfully completed or committed to completing modification of the GE06 Digital Plan in the frequency band 470-790 MHz in order to harmonize the use of the frequency band 694-790 MHz for IMT, while other parts of Region 1 have not started;

d) that a digital entry in the GE06 Plan may also be used for transmissions in the mobile service under the conditions set out in § 5.1.3 of the GE06 Agreement;

e) that, in some countries, applications ancillary to broadcasting and programme-making may be operated in parts of the frequency band 694-790 MHz;

f) that ITU-R studies regarding possible solutions for global/regional harmonization of frequency bands and tuning ranges for electronic news gathering (ENG)[3] are needed and Resolution ITU-R 59 provides the framework for such studies,

resolves

1 that use of the frequency band 694-790 MHz in Region 1 by the mobile, except aeronautical mobile, service is subject to agreement obtained under No. **9.21** with respect to ARNS in countries listed in No. **5.312**, in which regard the criteria for identifying affected administrations under No. **9.21** for the mobile service with respect to the ARNS in the frequency band 694-790 MHz are set out in the Annex to this Resolution;

2 that, for Region 1 and the Islamic Republic of Iran:

2.1 when coordination between administrations is being effected, the protection ratios applicable to the generic case NB contained in the GE06 Regional Agreement for the protection of the broadcasting service shall be used only for mobile systems with a bandwidth of 25 kHz; if another bandwidth is used, the relevant protection ratios are to be found in the most recent versions of Recommendations ITU-R BT.1368 and ITU-R BT.2033;

2.2 administrations are invited to take into account, *inter alia*, the results of the sharing studies conducted by ITU-R;

3 that, with respect to adjacent-channel interference between the mobile service in the frequency band 694-790 MHz and the broadcasting service in the frequency band 470-694 MHz:

3.1 adjacent-channel interference within a given country is a national matter and needs to be dealt with by each administration as a national matter;

3.2 adjacent-channel interference should be treated among administrations concerned, using mutually agreed criteria or those contained in relevant ITU-R Recommendations (see also the most recent versions of Recommendations ITU-R BT.1368, ITU-R BT.1895 and ITU-R BT.2033, as well as ITU-R M.2090 when sharing with the broadcasting service is concerned), as appropriate,

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[3] ENG within Resolution ITU-R 59 represents all applications ancillary to broadcasting, such as terrestrial electronic news gathering, electronic field production, TV outside broadcast, wireless radio microphones and radio outside production and broadcast.

invites the ITU Radiocommunication Sector

1 to consider the information received about the implementation of IMT in the frequency band 694-790 MHz and develop ITU-R Reports, as appropriate;

2 to pursue studies on the implementation of applications ancillary to broadcasting and programme-making on the basis of Resolution ITU-R 59,

invites the Director of the Radiocommunication Bureau

to work, in cooperation with the Director of the Telecommunication Development Bureau, to bring assistance to developing countries wishing to implement the new mobile allocation in order to help these administrations to determine the modifications of the GE06 entries according to their needs,

invites administrations

1 to provide information to ITU-R about the implementation of IMT in the frequency band 694-790 MHz, including, for example, implementation of measures for interference mitigation;

2 to communicate on a bilateral basis in order to eliminate possible cumulative interference, as appropriate;

3 to consider the use of applications ancillary to broadcasting and programme-making in those parts of the frequency band 694-790 MHz that are not used for other applications in the mobile service or other primary services,

instructs the Director of the Radiocommunication Bureau

to implement this Resolution and to take appropriate actions.

ANNEX TO RESOLUTION 760 (REV.WRC-23)

Criteria for identifying potentially affected administrations in the frequency band 694-790 MHz with respect to the aeronautical radionavigation service for countries listed in No. 5.312

To identify affected administrations when applying the procedure for seeking agreement under No. **9.21** by the mobile service with respect to the aeronautical radionavigation service (ARNS) operating in countries mentioned in No. **5.312**, the coordination distances (between a base station in the mobile service and a potentially affected ARNS station) indicated below should be used.

Notifying administrations may indicate in the notice sent to the Radiocommunication Bureau (BR) the list of administrations with which bilateral agreement has already been reached. BR shall take this into account in determining the administrations with which coordination under No. **9.21** is required.

1 Case of mobile-service usage under the frequency allocation plans when base stations transmit only in the frequency band 758-788 MHz and receive signals only in the frequency band 703-733 MHz

TABLE 1

ARNS station	System type code	Coordination distances for the receiving MS base stations (km)	Coordination distances for the transmitting MS base stations (km)
RSBN (ground receiver)	AA8	-	70/125/175*

* 90% ≤ land path ≤ 100% / 50% ≤ land path < 90% / 0% ≤ land path < 50%.

2 Other cases

TABLE 2

ARNS station	System type code	Coordination distances for the receiving MS base stations (km)**	Coordination distances for the transmitting MS base stations (km)
RSBN	AA8	50	125/175*
RLS 2 (type 1) (airborne receiver)	BD	410	432
RLS 2 (type 1) (ground receiver)	BA	50	250/275*
RLS 2 (type 2) (airborne receiver)	BC	150	432
RLS 2 (type 2) (ground receiver)	AA2	50/75*	300/325*
RLS 1 (types 1 and 2) (ground receiver)	AB	125/175*	400/450*
Other ARNS ground stations	Not applied	125/175*	400/450*
Other ARNS airborne stations	Not applied	410	432

* 50% ≤ land path ≤ 100% / 0% ≤ land path < 50%.

** Coordination distances for the receiving MS base stations are based on protection of ARNS stations from the stations in the mobile service and do not ensure protection for receiving MS base stations from ARNS stations.

RESOLUTION 761 (REV.WRC-19)

Coexistence of International Mobile Telecommunications and the broadcasting-satellite service (sound) in the frequency band 1 452-1 492 MHz in Regions 1 and 3

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

noting

a) Recommendation ITU-R M.1459, on protection criteria for telemetry systems in the aeronautical mobile service and mitigation techniques to facilitate sharing with geostationary broadcasting-satellite (BSS) and mobile-satellite services in the frequency bands 1 452-1 525 MHz and 2 310-2 360 MHz;

b) that ITU Radiocommunication Sector (ITU-R) studies provide useful information on the power flux-density (pfd) level to protect BSS earth stations that could be used for coordination purposes,

recognizing

a) that the frequency band 1 452-1 492 MHz is allocated to the BSS (sound) and the mobile service on a primary basis;

b) that both the mobile service and the BSS (sound) have already been deployed or are being considered for deployment within the frequency band 1 452-1 492 MHz in Regions 1 and 3,

resolves

taking into account Nos. **5.346** and **5.346A**,

1 that the pfd at the Earth's surface produced by emissions from a geostationary space station in the BSS (sound) in the frequency band 1 452-1 492 MHz shall not exceed -107 dB(W/(m^2 · MHz)) on the territory of any other country in Regions 1 and 3 (except for the territories of the countries listed in No. **5.342**);

2 that the limit in *resolves* 1 may be exceeded on the territory of any country in Region 1 or 3 whose administration has so agreed;

3 that the pfd limit defined in *resolves* 1 does not apply to frequency assignments to the BSS (sound) in the frequency band 1 452-1 492 MHz for which complete Appendix **4** coordination or notification information was received prior to 28 October 2019 and for which the date of bringing into use or bringing back into use is prior to 1 January 2024 or the regulatory time-limit as specified in Nos. **11.44** and **11.49**, as appropriate, whichever comes earlier;

4 that, in the territories of countries listed in No. **5.342**, the pfd limit defined in *resolves* 1 and pfd coordination threshold in *resolves* 5 do not apply and the BSS (sound) is subject to coordination under No. **9.11**;

5 that, as an exception to No. **9.6.3**, No. **9.11** shall apply, in addition to the pfd limit set forth in *resolves* 1, with respect to the territories of those countries of Region 3 and those listed in No. **5.346** which use frequency assignments with the nature of service "IM", and the following pfd coordination threshold values shall be used:

-131.3 dB(W/m^2) in 1 MHz for angles of arrival $0° \leq \delta \leq 5°$ above the horizontal plane;

$-131.3 + 16/20(\delta - 5)$ dB(W/m^2) in 1 MHz for angles of arrival $5° \leq \delta \leq 25°$ above the horizontal plane;

-115.3 dB(W/m^2) in 1 MHz for angles of arrival $25° \leq \delta \leq 90°$ above the horizontal plane;

6 that the Radiocommunication Bureau (BR) shall apply the coordination threshold identified in *resolves* 5 above in the application of No. **9.11** to identify potentially affected administrations for frequency assignments to stations in the BSS (sound) in the frequency band 1 452-1 492 MHz in Regions 1 and 3 for which complete Appendix **4** coordination information is considered as having been received after 23 November 2019;

7 that, before an administration in Region 1 or 3 brings into use an International Mobile Telecommunications (IMT) system in the frequency band 1 452-1 492 MHz, the administration shall ensure that the pfd produced by any IMT transmitting station which uses frequency assignments with the nature of service "IM" at 3 m above the ground for any point at the border of the territory of the notifying administration of a BSS (sound) network in this frequency band does not exceed -154 dB(W/(m$^2 \cdot$ 4 kHz)) for more than 20 per cent of the time, unless otherwise agreed between the administrations, No. **9.19** also applies;

8 that, for the territories of the countries listed in No. **5.342**, the pfd limit defined in *resolves* 7 does not apply and the frequency assignments with the nature of service "IM" are subject to coordination under No. **9.21**,

instructs the Director of the Radiocommunication Bureau

1 not to examine the pfd limit set forth in *resolves* 1 under No. **9.35** and issue a qualified favourable finding with respect to No. **9.35**, but to perform the full regulatory examination under No. **11.31**, including the review of any qualified favourable findings;

2 in applying *resolves* 5 at the coordination stage, to check conformity with the pfd value contained herein during the examination under No. **9.36**:

– if the value is met on the territory of countries which use frequency assignments with the nature of service "IM", BR shall not identify such administrations with which coordination may need to be effected;

– if the value is exceeded, BR shall identify such administrations with which coordination may need to be effected and in such cases publish the administrations with an additional remark "IM" under No. **9.11**;

3 to assist administrations notifying frequency assignments to the BSS (sound) by informing each administration where coordination is required and to inform them that coordination is requested under No. **9.11** and that No. **9.52C** applies in the application of *resolves* 5;

4 to investigate under No. **13.6** the technical characteristics and operational parameters of assignments to the BSS (sound) in the frequency band 1 452-1 492 MHz for which the notification information was submitted before 23 November 2019 and which were brought into use by that date;

5 to investigate under No. **13.6** the technical characteristics and operational parameters of assignments to base stations in the frequency band 1 452-1 492 MHz identified for IMT in the country submitting the notice with the nature of service "IM" in Regions 1 and 3 for which the notification information was submitted and which were brought into use before 23 November 2019.

RESOLUTION 762 (WRC-15)

Application of power flux-density criteria to assess the potential for harmful interference under No. 11.32A for fixed-satellite and broadcasting-satellite service networks in the 6 GHz and 10/11/12/14 GHz frequency bands not subject to a Plan

The World Radiocommunication Conference (Geneva, 2015),

considering

a) that the 6 GHz and 10/11/12/14 GHz frequency bands, not subject to a Plan, are extensively used with operational satellites about every 2-3° around the geostationary-satellite orbit;

b) that there are currently a very large number of satellite networks submitted to the ITU Radiocommunication Sector for these frequency bands;

c) that the above factors have led to significant difficulties for administrations to introduce new satellite networks;

d) that more precise criteria to assess the probability of harmful interference under No. **11.32A** have the potential to reduce undue protection requirements for assignments in respect of incoming assignments;

e) that due to the congestion in these frequency bands as well as advances in technology and applications in these frequency bands, practical satellite implementations are seen in practice to use relatively homogeneous technical parameters;

f) that use of more homogeneous technical parameters will facilitate efficient spectrum usage and support the introduction of new networks;

g) that the use of power flux-density (pfd) thresholds will encourage use of more homogeneous technical parameters and support efficient spectrum usage,

resolves

1 that, for satellite networks operating in the frequency bands 5 725-5 850 MHz (Region 1), 5 850-6 725 MHz and 7 025-7 075 MHz (Earth-to-space) having a nominal orbital separation in the geostationary-satellite orbit of more than 7°, assignments for a fixed-satellite service (FSS) satellite network with respect to other FSS networks do not have the potential to cause harmful interference if the pfd produced at the location in the geostationary-satellite orbit of the other FSS network under assumed free-space propagation conditions does not exceed −204.0 dB(W/(m^2 · Hz))*;

2 that, in the frequency bands 10.95-11.2 GHz, 11.45-11.7 GHz, 11.7-12.2 GHz (Region 2), 12.2-12.5 GHz (Region 3), 12.5-12.7 GHz (Regions 1 and 3) and 12.7-12.75 GHz (space-to-Earth), assignments for an FSS or broadcasting-satellite service (BSS) satellite network not subject to a Plan with respect to other FSS or BSS networks not subject to a Plan having a nominal orbital separation in the geostationary-satellite orbit of more than 6° do not have the potential to cause harmful interference if the pfd produced under assumed free-space propagation conditions does not exceed the threshold values shown below*, anywhere within the service area of the potentially affected assignment:

$$5.8° < \theta \leq 20.9° \qquad -187.2 + 25\log(\theta/5) \quad \text{dB(W/(m}^2 \cdot \text{Hz))}$$
$$20.9° < \theta \qquad -171.67 \quad \text{dB(W/(m}^2 \cdot \text{Hz))}$$

where θ is the minimum orbital separation in the geostationary-satellite orbit, in degrees, between the wanted and interfering space stations, taking into account the longitudinal station-keeping tolerance;

* NOTE – The pfd thresholds were derived from the parameters shown below.

Downlink		**10/11/12 GHz**
Earth station antenna diameter	N/A	0.45-11 m
Earth station antenna diagram	N/A	Main lobe: According to Appendix **8**, Section III Sidelobes: 29–25logθ dBi (Recommendation ITU-R BO.1213, which implements these main and sidelobe characteristics, was used in deriving the pfd threshold)
Earth station noise temperature	N/A	125 K
Earth station antenna efficiency	N/A	70%
Equivalent $\Delta T/T$	N/A	6%
Uplink	**6 GHz**	**14 GHz**
Maximum satellite G/T	0 dB/K	11 dB/K
Equivalent $\Delta T/T$	6%	6%

3 that, for satellite networks operating in the frequency band 13.75-14.5 GHz (Earth-to-space) having a nominal orbital separation in the geostationary-satellite orbit of more than 6°, assignments for an FSS satellite network with respect to other FSS satellite networks do not have the potential to cause harmful interference if the pfd produced at the location in the geostationary-satellite orbit of the other FSS satellite network under assumed free-space propagation conditions does not exceed −208 dB(W/(m^2 · Hz))*,

4 that as of 1 January 2017 the Bureau and administrations shall apply this Resolution,

instructs the Director of the Radiocommunication Bureau

to include in his report, for consideration by WRC-19, the results and any potential difficulties relating to the implementation of this Resolution.

RESOLUTION 768 (WRC-19)

Need for coordination of Region 2 fixed-satellite service networks in the frequency band 11.7-12.2 GHz with respect to the Region 1 broadcasting-satellite service assignments located further west than 37.2° W and of Region 1 fixed-satellite service networks in the frequency band 12.5-12.7 GHz with respect to the Region 2 broadcasting-satellite service assignments located further east than 54° W

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that WRC-15 decided to conduct studies on, review, and identify possible revisions to, if necessary, the limitations mentioned in Annex 7 to Appendix **30 (Rev.WRC-15)**, while ensuring the protection of, and without imposing additional constraints on, assignments in the Plan and in the List and the future of broadcasting-satellite service (BSS) networks and existing fixed-satellite service (FSS) networks;

b) that the provisions applying to the BSS frequency assignments in the frequency bands 11.7-12.5 GHz in Region 1 and 12.2-12.7 GHz in Region 2 are contained in Appendix **30**;

c) that the FSS has primary allocations in the frequency bands 12.5-12.75 GHz in Region 1 and 11.7-12.2 GHz in Region 2;

d) that the BSS has primary allocations in the frequency bands 11.7-12.5 GHz in Region 1 and 12.2-12.7 GHz in Region 2;

e) that this conference has suppressed the limitation in Annex 7 to Appendix **30 (Rev.WRC-15)** that prevented broadcasting satellites serving an area in Region 1 and using frequency assignments in the frequency band 11.7-12.2 GHz at orbital positions further west than 37.2° W;

f) that this conference has suppressed the limitation in Annex 7 to Appendix **30 (Rev.WRC-15)** that prevented broadcasting satellites serving an area in Region 2 and using frequency assignments in the frequency band 12.5-12.7 GHz at orbital positions further east than 54° W;

g) that the result of those suppressions shall ensure the protection of, and cannot impose additional constraints on, assignments in the Plan and the List and the future development of the BSS within the Plan, and existing and planned FSS networks,

recognizing

a) that existing FSS networks operating in the frequency bands mentioned in *considering c)* and BSS frequency assignments in the Plan and List implemented in accordance with the provisions of Annex 7 to Appendix **30 (Rev.WRC-15)** prior to this conference shall continue to be protected;

b) that the frequency bands 11.7-12.5 GHz in Region 1 and 12.2-12.7 GHz in Region 2 are widely used by BSS networks, subject to the provisions of Annex 7 to Appendix **30 (Rev.WRC-15)** prior to this conference;

c) that the frequency bands 12.5-12.75 GHz in Region 1 and 11.7-12.2 GHz in Region 2 are widely used by FSS networks,

resolves

1 that, in the frequency band 11.7-12.2 GHz, with respect to §§ 7.1 *a)*, 7.2.1 *a),* 7.2.1 *b)* and 7.2.1 *c)* of Article 7 of Appendix **30**, in determining the need for coordination of a transmitting space station in the FSS in Region 2 with a transmitting space station in the BSS in Region 1 at an orbital position further west than 37.2° W, and with minimum geocentric orbital separation of less than 4.2 degrees between the FSS and BSS space stations, the conditions in Annex 1 to this Resolution apply instead of those contained in Annex 4 to Appendix **30**;

2 that, in the frequency band 12.5-12.7 GHz, with respect to §§ 7.1 *a)*, 7.2.1 *a)* and 7.2.1 *c)* of Article 7 of Appendix **30**, in determining the need for coordination of a transmitting space station in the FSS in Region 1 with a transmitting space station in the BSS in Region 2 at an orbital position further east than 54° W and not within its clusters in the Region 2 Plan of Appendix **30**, and with a minimum geocentric orbital separation less than 4.2 degrees between FSS and BSS space stations, the conditions in Annex 2 to this Resolution apply instead of those contained in Annex 4 to Appendix **30**;

3 that, except the cases specified in *resolves* 1 and 2, the conditions in Annex 4 to Appendix **30** continue to apply.

ANNEX 1 TO RESOLUTION 768 (WRC-19)

With respect to §§ 7.1 *a)*, 7.2.1 *a),* 7.2.1 *b)* and 7.2.1 *c)* of Article 7 of Appendix **30**, coordination of a transmitting space station in the fixed-satellite service (FSS) (space-to-Earth) in Region 2 is required with a broadcasting-satellite (BSS) station serving an area in Region 1 and using a frequency assignment in the frequency band 11.7-12.2 GHz with a nominal orbital position further west than 37.2° W when, under assumed free-space propagation conditions, the power flux-density at any test point within the service area of the overlapping frequency assignments in the BSS exceeds the following values:

-147	dB(W/(m^2 · 27 MHz))	for	$0° \le \theta < 0.23°$
$-135.7 + 17.74 \log \theta$	dB(W/(m^2 · 27 MHz))	for	$0.23° \le \theta < 2.0°$
$-136.7 + 1.66\, \theta^2$	dB(W/(m^2 · 27 MHz))	for	$2.0° \le \theta < 3.59°$
$-129.2 + 25 \log \theta$	dB(W/(m^2 · 27 MHz))	for	$3.59° \le \theta < 4.2°$

where θ is the minimum geocentric orbital separation in degrees between the wanted and interfering space stations, taking into account the respective east-west station-keeping accuracies.

ANNEX 2 TO RESOLUTION 768 (WRC-19)

With respect to §§ 7.1 *a)*, 7.2.1 *a)* and 7.2.1 *c)* of Article 7 of Appendix **30**, coordination of a transmitting space station in the fixed-satellite service (FSS) (space-to-Earth) in Region 1 is required with a broadcasting-satellite (BSS) station serving an area in Region 2 and using a frequency assignment in the frequency band 12.5-12.7 GHz with a nominal orbital position further east than 54° W and not within its clusters in the Region 2 Plan of Appendix **30** when, under assumed free-space propagation conditions, the power flux-density at any test point within the service area of the overlapping frequency assignments in the BSS exceeds the following values:

-147	dB(W/(m^2 · 27 MHz))	for	$0° \leq \theta < 0.23°$
$-135.7 + 17.74 \log \theta$	dB(W/(m^2 · 27 MHz))	for	$0.23° \leq \theta < 1.8°$
$-134.0 + 0.89\ \theta^2$	dB(W/(m^2 · 27 MHz))	for	$1.8° \leq \theta < 4.2°$

where θ is the minimum geocentric orbital separation in degrees between the wanted and interfering space stations, taking into account the respective east-west station-keeping accuracies.

RESOLUTION 769 (WRC-19)

Protection of geostationary fixed-satellite service, broadcasting-satellite service and mobile-satellite service networks from the aggregate interference produced by multiple non-geostationary fixed-satellite service systems in the frequency bands 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz and 50.4-51.4 GHz

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space) are allocated, *inter alia*, on a primary basis to the fixed-satellite service (FSS);

b) that the frequency bands 40.5-41 GHz and 41-42.5 GHz are allocated on a primary basis to the broadcasting-satellite service (BSS);

c) that the frequency bands 39.5-40 GHz (space-to-Earth) and 40-40.5 GHz (space-to-Earth) are allocated on a primary basis to the mobile-satellite service (MSS);

d) that Article **22** contains regulatory and technical provisions on sharing between geostationary-satellite (GSO) and non-geostationary-satellite (non-GSO) FSS systems in the frequency bands referred to in *considering a)*;

e) that, in accordance with No. **22.2**, non-GSO systems shall not cause unacceptable interference to GSO FSS and GSO BSS networks and, unless otherwise specified in the Radio Regulations, shall not claim protection from GSO FSS and GSO BSS networks;

f) that administrations planning to operate non-GSO FSS systems require quantification of the technical regulatory measures required for protection of GSO FSS, GSO MSS and GSO BSS networks operating in the frequency bands referred to in *considering a)*, *b)* and *c)* above;

g) that the operating parameters and orbital characteristics of non-GSO FSS systems are usually inhomogeneous;

h) that the time allowance for the *C*/*N* value specified in the short-term performance objective associated with the shortest percentage of time (lowest *C*/*N*) or decrease of the long-term throughput (spectral efficiency) caused to reference GSO FSS, GSO MSS and GSO BSS links by non-GSO FSS systems is likely to vary according to the parameters of such systems;

i) that the aggregate interference from multiple non-GSO FSS systems will be related to the actual number of systems sharing a frequency band based on the single-entry operational use of each system;

j) that, to protect GSO FSS, GSO MSS and GSO BSS networks in the frequency bands listed in *considering a)*, *b)* and *c)* from unacceptable interference, the aggregate impact of interference caused by all co-frequency non-GSO FSS systems shall not exceed the aggregate impact limit specified in No. **22.5M**;

k) that the aggregate levels are likely to be the summation of worst-case single-entry levels of interference caused by non-GSO FSS systems,

noting

a) that Resolution **770 (WRC-19)*** contains the methodology for determining conformity to the single-entry limits to protect the GSO networks;

b) that Recommendation ITU-R S.1503 provides guidance on how to compute the equivalent power flux-density (epfd) levels from a non-GSO system into GSO earth stations and satellites;

c) that Resolution **770 (WRC-19)*** contains GSO system characteristics to be used in non-GSO/GSO frequency sharing analyses in the frequency bands 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz and 50.4-51.4 GHz,

recognizing

a) that non-GSO FSS systems may need to implement interference mitigation techniques, such as avoidance angles, Earth station site diversity and GSO arc avoidance, to facilitate sharing frequencies among non-GSO FSS systems and to protect GSO FSS, GSO MSS and GSO BSS networks;

b) that administrations operating or planning to operate non-GSO FSS systems will need to agree cooperatively through consultation meetings to share the aggregate interference allowance for all non-GSO FSS systems sharing the frequency bands listed in *considering a)* in order to achieve the desired level of protection for GSO FSS, GSO MSS and GSO BSS networks that is stated in No. **22.5M**;

c) that administrations operating or planning to operate GSO FSS, GSO MSS or GSO BSS networks are invited to participate and be involved in the consultation meetings mentioned in *recognizing b)* above, especially as the aggregate interference level approaches the limits specified in No. **22.5M**;

d) that, taking into account the single-entry allowance in No. **22.5L**, the aggregated worst-case impact of all non-GSO FSS systems can be computed without the need for specialized software tools, based on the results of the assessment of single-entry levels of interference caused by each system;

e) that, in the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space), signals experience high levels of attenuation due to atmospheric effects such as rain, cloud cover and gaseous absorption;

f) that, given these expected high levels of fading, it is desirable for GSO networks and non-GSO FSS systems to implement fade countermeasures such as automatic level control, power control and adaptive coding and modulation,

resolves

1 that administrations operating or planning to operate non-GSO FSS systems in the frequency bands referred to in *considering a)* above shall jointly take all necessary steps, including, if necessary, appropriate modifications to the operational characteristics of their systems or networks, to ensure that the aggregate interference impact to GSO FSS, GSO MSS and GSO BSS networks caused by such systems operating co-frequency in these frequency bands does not exceed the aggregate limits specified in No. **22.5M**;

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* *Note by the Secretariat:* This Resolution was revised by WRC-23.

2 that, to carry out the obligations in *resolves* 1 above, administrations operating or planning to operate non-GSO FSS systems shall agree cooperatively through the regular consultation discussions referred to in *recognizing b)* to ensure that operations of all non-GSO FSS networks do not exceed the aggregate level of protection for GSO networks;

3 that, taking into account *resolves* 2, failure by a responsible administration operating or planning to operate non-GSO FSS systems to participate in the consultation process does not relieve that administration of obligations under *resolves* 1 above, nor does it remove their systems from consideration in any aggregate calculations by the consultation group;

4 that *resolves* 2 and 3 above begin to apply when a second non-GSO FSS system with frequency assignments in the frequency bands referred to in *considering a)* meets the criteria listed in Annex 2 to this Resolution;

5 that, to carry out the obligations in *resolves* 1 above, administrations shall use the generic GSO reference links listed in Resolution **770 (WRC-19)*** and validated supplemental GSO links associated with notified and brought-into-use frequency assignments submitted to the Radiocommunication Bureau (BR) by administrations to determine the results of the aggregate impact on GSO networks;

6 that administrations (including representatives of administrations operating GSO FSS, GSO MSS and GSO BSS networks) participating in a consultation meeting are allowed to use their own software in conjunction with any software tools used by BR for the calculation and verification of the aggregate limits, subject to the agreement of the consultation meeting;

7 that administrations, in carrying out their obligations under *resolves* 1 above, shall take into account only those non-GSO FSS systems with frequency assignments in the frequency bands referred to in *considering a)* above that have met the criteria listed in Annex 2 to this Resolution through appropriate information provided in the course of the consultation discussions referred to in *resolves* 2;

8 that administrations, in developing agreements to carry out their obligations under *resolves* 1, shall establish mechanisms to ensure that all notifying administrations and operators that are planning to operate FSS, BSS and MSS systems and networks are given full visibility of, and the opportunity to participate in, the consultation process, either in person or remotely, regardless of the stage of development and deployment of these systems and networks;

9 that, taking into account *resolves* 2, a responsible administration operating or planning to operate non-GSO FSS systems that is unable to participate in the consultation process, either in person or remotely, is still responsible for meeting its obligations under *resolves* 1 above and for providing information on its systems so that they may be included in the aggregate calculations by the consultation group;

10 that each administration, in the absence of an agreement reached at consultation meetings referred to in *resolves* 2, shall ensure that each of its non-GSO FSS systems subject to this Resolution are operated in accordance with reduced single-entry interference impact allowances, calculated by an amount proportional to their single-entry contribution to the aggregate, so as to ensure that the aggregate allowance in No. **22.5M** is not exceeded;

11 that the administrations participating in the consultation discussion referred to in *resolves* 2 shall designate one convener to be responsible for communicating to BR the results of the aggregate non-GSO system operational calculation and sharing determinations made in application of *resolves* 1, 3 and 9 above, without regard to whether such determinations result in any modifications to the published characteristics of their respective systems, providing a draft record of each consultation meeting, and providing BR with the approved record, as specified in Annex 1 to this Resolution,

invites administrations

to submit to BR, as necessary, supplemental GSO links, in a format consistent with the generic links in Annex 1 to Resolution **770 (WRC-19)***, and in the frequency bands listed in *considering a)*, that are associated with GSO networks,

invites the Radiocommunication Bureau

to participate in the consultation meetings in *resolves* 2 as an observer,

invites the ITU Radiocommunication Sector

1 to carry out studies and develop, as a matter of urgency, a suitable methodology, considering a range of input values and assumptions, including both best and worst case, for calculating the aggregate interference produced by all non-GSO FSS and as appropriate non-GSO MSS systems operating or planning to operate in the frequency bands referred to above co-frequency with GSO FSS, GSO MSS and GSO BSS networks, which may be used to determine whether the systems are in compliance with the aggregate limits specified in No. **22.5M**;

2 to carry out studies and develop, as a matter of urgency a methodology to validate supplemental GSO links;

3 to study the selection and use of *C*/*N* objectives, and the necessity of specifying one or more *C*/*N* objective points at associated percentages of time, with regard to the GSO link performance;

4 to report back to a future world radiocommunication conference, as appropriate, under Resolution **86 (Rev.WRC-07)**,

instructs the Radiocommunication Bureau

1 to collect and, once a methodology is available, evaluate for validation purposes and provide for information the supplemental GSO links submitted by administrations for frequency assignments associated with GSO networks;

2 to provide the consultation meeting, for use in the aggregate calculations, with the validated supplemental GSO links associated with networks brought into use;

3 to make available on the ITU website within one month from the closing date of any consultation meeting all information, such as that in Annex 2, referred to in *resolves* 11;

4 to exclude the aggregate calculations given in No. **22.5M** as part of a satellite network examination under No. **11.31**.

ANNEX 1 TO RESOLUTION 769 (WRC-19)

List of geostationary-satellite network characteristics and format of the result of the aggregate calculation to be provided to the Radiocommunication Bureau for publication for information

I GSO FSS and GSO BSS network characteristics to be used in the calculation of aggregate emissions from non-GSO FSS systems

I-1 GSO FSS, GSO MSS and GSO BSS network characteristics

The GSO network characteristics to be considered in the aggregate calculation are the:

– generic links contained in Annex 1 to Resolution **770 (WRC-19)***.

I-2 Non-GSO FSS system constellation parameters

For each non-GSO system, the following parameters should be provided to BR for publication in the aggregate calculation:

– notifying administration;

– number of space stations used in aggregate calculations;

– single-entry contribution to the aggregate of each non-GSO FSS system.

II Results of the aggregate epfd calculation

– summary record of the meeting;

– single-entry contribution of each non-GSO FSS system;

– detailed description of methodology used to calculate the aggregate interference;

– the aggregate assessment of the non-GSO systems on the generic and validated supplemental GSO links, if any;

– all input materials submitted to the meeting; and

– studies conducted prior to or at the meeting as well as any other materials deemed necessary for demonstrating compliance with No. **22.5M**.

* *Note by the Secretariat:* This Resolution was revised by WRC-23.

ANNEX 2 TO RESOLUTION 769 (WRC-19)

List of criteria for the application of *resolves* 7

1 Submission of appropriate coordination and/or notification information for non-GSO FSS systems.

2 Entry into satellite manufacturing or procurement agreement, and entry into satellite launch agreement.

The non-geostationary FSS system operator should possess:

i) evidence of a binding agreement for the manufacture or procurement of its satellites; and

ii) evidence of a binding agreement to launch its satellites.

The manufacturing or procurement agreement should identify the contract milestones leading to the completion of manufacture or procurement of satellites required for the service provision, and the launch agreement should identify the launch date, launch site and launch service provider. The notifying administration is responsible for authenticating the evidence of an agreement.

The information required under this criterion may be submitted in the form of a written commitment by the responsible administration.

3 As an alternative to satellite manufacturing or procurement and launch agreements, evidence of guaranteed funding arrangements for the implementation of the project would be accepted. The notifying administration is responsible for authenticating the evidence of these arrangements and for providing such evidence to other interested administrations in furtherance of its obligations under this Resolution.

RESOLUTION 770 (REV.WRC-23)

Application of Article 22 of the Radio Regulations to the protection of geostationary fixed-satellite service and broadcasting-satellite service networks from non-geostationary fixed-satellite service systems in the frequency bands 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz and 50.4-51.4 GHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that geostationary-satellite (GSO) and non-geostationary-satellite (non-GSO) fixed-satellite service (FSS) networks may operate in the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space);

b) that WRC-19 adopted Nos. **22.5L** and **22.5M**, which contain single-entry and aggregate limits for non-GSO FSS systems in the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space) to protect GSO networks operating in the same frequency bands;

c) that the ITU Radiocommunication Sector (ITU-R) has developed a methodology, contained in Recommendation ITU-R S.1503, that results in the equivalent power flux-density (epfd) generated by any one non-GSO FSS system considered and a GSO location that corresponds to the worst-case geometry that generates the highest levels of epfd into potentially affected GSO earth stations and satellites,

recognizing

a) that, in accordance with calculations utilizing Recommendation ITU-R S.1503, verification of the worldwide epfd interference of any one non-GSO system can be carried out by a set of generic GSO reference link budgets having characteristics that encompass global GSO network deployments that are independent of any specific geographical locations;

b) that Resolution **769 (WRC-19)** addresses the protection of GSO networks from aggregate emissions from non-GSO systems,

resolves

1 that, during the examination under Nos. **9.35** and **11.31**, as applicable, of a non-GSO FSS satellite system with frequency assignments in the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space), compliance with No. **22.5L** shall be verified using the technical characteristics of generic GSO reference links contained in Annex 1 to this Resolution and Recommendation ITU-R S.2157-0;

2 that frequency assignments to non-GSO FSS systems referred to in *resolves* 1 shall receive a favourable finding with respect to the single-entry provision given in No. **22.5L** if compliance with No. **22.5L** is established under *resolves* 1, otherwise the assignments shall receive an unfavourable finding;

3 that, if the Radiocommunication Bureau (BR) is unable to examine non-GSO FSS systems subject to the single-entry provision given in No. **22.5L** due to a lack of available software, the notifying administration shall provide all necessary information sufficient to demonstrate compliance with No. **22.5L** and send BR a commitment that the non-GSO FSS system complies with the limits given in No. **22.5L**;

4 that frequency assignments to non-GSO FSS systems that cannot be assessed under *resolves* 1 shall receive a qualified favourable finding under Nos. **9.35** and **11.31** with respect to No. **22.5L** if *resolves* 3 is satisfied, otherwise the assignments shall receive an unfavourable finding;

5 that, if an administration believes that a non-GSO FSS system for which the commitment referred to in *resolves* 3 was sent has the potential to exceed the limits given in No. **22.5L**, it may request additional information from the notifying administration with regard to compliance with these limits and No. **22.2**, and both administrations shall cooperate to resolve any difficulties, with the assistance of BR, if so requested by either of the parties;

6 that *resolves* 3, 4 and 5 shall no longer be applied after BR has communicated to all administrations via a circular letter that validation software is available and BR is able to verify compliance with the limits in No. **22.5L**,

invites the ITU Radiocommunication Sector

1 to study and, as appropriate, develop a functional description that could be used to develop software for the procedures outlined in *resolves* 1 above;

2 to review and, as appropriate, provide updates to the generic GSO reference links in Annex 1 to this Resolution under Resolution **86 (Rev.WRC-07)**,

instructs the Director of the Radiocommunication Bureau

1 to take all necessary measures to facilitate the implementation of this Resolution, in particular to accelerate the development of the validation software;

2 to send, once the validation software as described in *resolves* 3 above is available, a letter to administrations having submitted coordination requests and/or notification information for frequency assignments to non-GSO FSS satellite systems for which a qualified favourable finding has been issued under *resolves* 4, to offer the possibility to modify, within 90 days following publication of the circular letter referred to in *resolves* 6, their associated Appendix **4** parameters, limited to items listed under A.4.b.6*bis*, A.4.b.6.a, A.4.b.7 and A.14, and to retain the protection date of the initial frequency assignments, provided that the modified frequency assignments receive a favourable finding under No. **9.35** or No. **11.31**, as applicable, with respect to No. **22.5L**;

3 to review, once the validation software referred to in *resolves* 3 is available, BR's findings made in accordance with Nos. **9.35** and **11.31** under *resolves* 4.

ANNEX 1 TO RESOLUTION 770 (REV.WRC-23)

Generic GSO reference links for evaluation of compliance with single-entry requirements for non-GSO systems

The data in this Annex are to be regarded as a generic range of representative technical characteristics of geostationary-satellite (GSO) network deployments that are independent of any specific geographical location, to be used only for establishing the interference impact of a non-geostationary-satellite (non-GSO) system into GSO networks and not as a basis for coordination between satellite networks.

TABLE 1

Parameters of generic GSO reference links to be used in examination of the downlink (space-to-Earth) impact from any one non-GSO system

1	**Generic GSO reference link parameters - service**					**Parameters**
	Link type	User #1	User #2	User #3	Gateway	
1.1	E.i.r.p. density (dBW/MHz)	44	44	40	36	*eirp*
1.2	Equivalent antenna diameter (m)	0.45	0.6	2	9	D_m
1.3	Bandwidth (MHz)	1	1	1	1	B_{MHz}
1.4	ES antenna gain pattern	S.1428	S.1428	S.1428	S.1428	

1	Generic GSO reference link parameters - service					Parameters
1.5	Additional link losses (dB) This field includes non-precipitation impairments	3	3	3	3	L_o
1.6	Additional noise contribution including margin for inter-system interference (dB)	2	2	2	2	M_{0inter}
1.7	Additional noise contribution including margin for intra-system interference (dB) and non-time varying sources	1	1	1	1	M_{0intra}

2	Generic GSO reference link parameters - parametric analysis	Parametric cases for evaluation						
2.1	E.i.r.p. density variation	−3, 0, +3 dB from value in 1.1						$\Delta eirp$
2.2	Elevation angle (deg)	20			55		90	ε
2.3	Rain height (m) for specified latitude in item 2.4	5 000	3 950	1 650	5 000	3 950	5 000	h_{rain}
2.4	Latitude* (deg. *N*)	0	±30	±61.8	0	±30	0	Lat
2.5	ES noise temperature (K)	340						T
2.6	0.01% rain rate (mm/hr)	10, 50, 100						$R_{0.01}$
2.7	Height of ES above mean sea level (m)	0, 500, 1 000						h_{ES}
2.8	Threshold *C*/*N* (dB)	−2.5, 2.5, 5, 10						$\left(\frac{C}{N}\right)_{Thr,i}$
2.9	Probability of non-zero rain attenuation	10						p_{max} (%)

NOTE – For items 2.2, 2.3 and 2.4, these three groups of data are be considered as unique sets of data to be used in the larger, overall set of total possible permutations. For example, 20 degrees of elevation angle will consider three different latitudes of 0, 30 and 61.8 degrees while 90 degrees of elevation will only consider a latitude of 0 degrees and one possible rain height 5 km. The above parameters are chosen as representative propagation parameters for purposes of calculations of precipitation fade statistics. These precipitation fades are representative of other geographic locations.

* Latitude is evaluated as a single value representing the absolute value of the latitude

TABLE 2

Parameters of generic GSO reference links to be used in examination of the uplink (Earth-to-space) impact from any one non-GSO system

1	**Generic GSO reference link parameters - service**					
	Link type	Link #1	Link #2	Link #3	Gateway	
1.1	ES e.i.r.p. density (dBW/MHz)	49	49	49	60	*eirp*
1.2	Bandwidth (MHz)	1	1	1	1	B_{MHz}
1.3	Half-power beamwidth (deg)	0.2	0.3	1.5	0.3	
1.4	ITU-R S.672 sidelobe level (dB)	−25	−25	−25	−25	
1.5	Satellite antenna peak gain (dBi)	58.5	54.9	38.5	54.9	G_{max}
1.6	Additional link losses (dB) This field includes non-precipitation impairments	4.5	4.5	4.5	4.5	L_o
1.7	Additional noise contribution including margin for inter-system interference (dB)	2	2	2	2	M_{0inter}
1.8	Additional noise contribution including margin for intra-system interference (dB) and non-time varying sources	1	1	1	1	M_{0intra}

2	**Generic GSO reference link parameters - parametric analysis**	**Parametric cases for evaluation**						
2.1	E.i.r.p. density variation	−6, 0, +6 dB from value in 1.1						$\Delta eirp$
2.2	Elevation angle (deg)	20			55		90	ε
2.3	Rain height (m) for specified latitude in item 2.4	5 000	3 950	1 650	5 000	3 950	5 000	h_{rain}
2.4	Latitude* (deg. *N*)	0	± 30	± 61.8	0	± 30	0	Lat
2.5	0.01% rain rate (mm/hr)	10, 50, 100						$R_{0.01}$

2	Generic GSO reference link parameters - parametric analysis	Parametric cases for evaluation	
2.6	Height of ES above mean sea level (m)	0, 500, 1 000	h_{ES}
2.7	Satellite noise temperature (K)	500, 1 600	T
2.8	Threshold C/N (dB)	−2.5, 2.5, 5, 10	$\left(\frac{C}{N}\right)_{Thr,i}$
2.9	Probability of non-zero rain attenuation	10	p_{max} (%)

NOTE – For items 2.2, 2.3 and 2.4, these three groups of data are be considered as unique sets of data to be used in the larger, overall set of total possible permutations. For example, 20 degrees of elevation angle will consider three different latitudes of 0, 30 and 61.8 degrees while 90 degrees of elevation will only consider a latitude of 0 degrees and one possible rain height 5 km. The above parameters are chosen as representative propagation parameters for purposes of calculations of precipitation fade statistics. These precipitation fades are representative of other geographic locations.

* Latitude is evaluated as a single value representing the absolute value of the latitude

RESOLUTION 771 (WRC-19)

Use of the frequency bands 37.5-42.5 GHz (space-to-Earth) and 47.2-48.9 GHz, 48.9-50.2 GHz and 50.4-51.4 GHz (Earth-to-space) by non-geostationary-satellite systems in the fixed-satellite service and 39.5-40.5 GHz (space-to-Earth) by non-geostationary-satellite systems in the mobile-satellite service

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that this conference has adopted regulatory provisions for the operation of non-geostationary-satellite (non-GSO) fixed-satellite service (FSS) systems in the frequency bands 37.5-42.5 GHz (space-to-Earth) and 47.2-48.9 GHz, 48.9-50.2 GHz and 50.4-51.4 GHz (Earth-to-space) and non-GSO mobile-satellite service (MSS) systems in the frequency bands 39.5-40.5 GHz (space-to-Earth);

b) that this conference has introduced a new coordination procedure associated with the use of these frequency bands by these space services;

c) that there are already several frequency assignments to non-GSO FSS/MSS satellite systems that have been notified or recorded in the Master International Frequency Register prior to 23 November 2019,

resolves

1 that frequency assignments to non-GSO networks or systems for which the complete notification information has been received by the Radiocommunication Bureau before 23 November 2019 shall be brought into use before 23 November 2022 or the end of the regulatory period set forth in No. **11.44**, whichever date comes earlier;

2 that frequency assignments to which *resolves* 1 applies and that are not brought into use before 23 November 2022 or the end of the regulatory period set forth in No. **11.44**, whichever date comes earlier, shall be suppressed,

instructs the Radiocommunication Bureau

to take the necessary actions to implement this Resolution.

RESOLUTION 775 (REV.WRC-23)

Power flux-density and equivalent isotropically radiated power limits for inclusion in Article 21 for the fixed-satellite, mobile-satellite and broadcasting-satellite services to protect the fixed and mobile services in the frequency bands 71-76 GHz and 81-86 GHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that WRC-2000 made a number of different allocation changes to the frequency bands 71-76 GHz and 81-86 GHz based on the requirements known at the time;

b) that sharing conditions between the fixed service, mobile service and satellite services in the frequency bands 71-76 GHz and 81-86 GHz could not be fully developed at WRC-2000 due to lack of available information on these services at the time;

c) that, in the last two decades, there have been a number of significant technology advances and changes in network requirements in the fixed and mobile services, and the frequency bands 71-76 GHz and 81-86 GHz have become strategically important frequency bands for high-capacity fixed-service links, including backhaul for future mobile networks;

d) that there is now much more information available in the ITU Radiocommunication Sector (ITU-R) on the characteristics and deployment of fixed-service systems;

e) that there are an increasing number of satellite filings in the frequency bands 71-76 GHz and 81-86 GHz and some satellites are equipped with payload ready to utilize these bands,

noting

a) that the frequency band 81-86 GHz is allocated to the radio astronomy service on a primary basis, and that No. **5.149** applies;

b) that WRC-12 already addressed sharing and compatibility issues between the fixed and passive services in the frequency bands 71-76 GHz and 81-86 GHz and relevant adjacent frequency bands,

recognizing

a) that the frequency bands 71-76 GHz and 81-86 GHz are also allocated to other radiocommunication services and that those allocations are used by a variety of incumbent systems in many administrations, and that the protection of these services should be studied;

b) that for the determination of the incumbent services, the relevant provisions of the Radio Regulations in force apply;

c) that Article **21** and other provisions of the Radio Regulations currently do not contain the necessary technical and regulatory provisions to protect fixed and mobile service use in the frequency bands 71-76 GHz and 81-86 GHz;

d) that Resolution **750 (Rev.WRC-19)** already contains necessary provisions to protect passive services in the frequency bands and adjacent frequency bands from emissions of the fixed service in the frequency bands 71-76 GHz and 81-86 GHz, and there is no intention to change these provisions;

e) that there is no intention to remove the existing allocations or change the primary status of those allocations in Article **5** for the frequency bands 71-76 GHz and 81-86 GHz,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

the appropriate studies to determine power flux-density (pfd) and equivalent isotropically radiated power (e.i.r.p.) limits to be included in Article **21** for satellite services (fixed-satellite service (FSS), mobile-satellite service (MSS) and broadcasting-satellite service (BSS)) to protect the current and planned fixed and mobile services in the frequency bands 71-76 GHz and 81-86 GHz,

invites administrations

to participate actively in the studies by submitting contributions to ITU-R,

invites the 2027 world radiocommunication conference

to consider, based on the results of studies, the inclusion of pfd and e.i.r.p. limits in Article **21** for the FSS, MSS and BSS to protect the current and planned fixed and mobile services in the frequency bands 71-76 GHz and 81-86 GHz.

RESOLUTION 804 (REV.WRC-23)

Principles for establishing agendas for world radiocommunication conferences

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that, in accordance with No. 118 of the ITU Convention, the general scope of the agendas for world radiocommunication conferences (WRCs) should be established four to six years in advance;

b) Article 13 of the ITU Constitution relating to the competence and scheduling of WRCs and Article 7 of the Convention relating to their agendas;

c) that No. 92 of the Constitution and Nos. 488 and 489 of the Convention require conferences to be fiscally responsible;

d) that, in Resolution 71 (Rev. Marrakesh, 2002), concerning the strategic plan of the Union, the Plenipotentiary Conference noted the increasingly complex and lengthy agendas for WRCs;

e) that Resolution 80 (Rev. Marrakesh, 2002) of the Plenipotentiary Conference and Resolution **72 (Rev.WRC-19)** recognize the positive contribution of regional telecommunication organizations and informal groups and the need for improved efficiency and fiscal prudence;

f) the relevant Resolutions of previous WRCs;

g) that Resolution ITU-R 2-8 describes the principles of the organization of the work of the Conference Preparatory Meeting (CPM), including the reporting of contributions concerning future agenda items for information,

recognizing

a) that the number of issues addressed in agendas for future WRCs has been growing, and that, in the past, several issues could not be addressed adequately in the time allotted to WRCs, including WRC preparations;

b) that some agenda items may have a greater impact on the future of radiocommunications than others;

c) that the human and financial resources of administrations, Sector Members and ITU are limited;

d) that agendas of future WRCs include standing items, some of which could be addressed under more than one regular agenda item;

e) that there is a need to limit the agenda of WRCs and the amount of preparatory work to a manageable level for administrations and the ITU Radiocommunication Sector (ITU-R), taking account of the needs of developing countries, in a manner that allows the issues to be dealt with equitably and efficiently;

f) that, in accordance with No. 90 of the Constitution, the interval between WRCs should normally be three to four years, to ensure that changes in technology and requirements of Member States are adequately reflected in WRC agendas;

g) that administrations and regional telecommunication organizations need sufficient time to coordinate, evaluate and examine the potential consequences of proposed new items for inclusion in the agendas of future WRCs;

h) that during the study cycle for preparation of a WRC, the ITU-R studies identified in Resolutions associated with the agenda of that WRC should be carried out within ITU-R, and not by other international organizations,

resolves

1 that recommended agendas for future WRCs shall include a standing agenda item for the establishment of preliminary agendas for subsequent WRCs;

2 that the course of action outlined in this Resolution needs to be taken into account in the preparation of and decision on the agenda of future WRCs;

3 that the principles in Annex 1 to this Resolution need to be taken into account when developing agendas for future WRCs;

4 that the guidance given in Annex 2 to this Resolution needs to be used in developing agenda items for future WRCs and their supporting resolutions;

5 to encourage administrations and regional telecommunication organizations to submit, to the extent practicable, information on possible items/topics for the agenda of future WRCs under the WRC standing agenda item mentioned in *resolves* 1 to the second session of CPM,

invites administrations

1 to use the guidance in Annex 2 to this Resolution in developing agenda items for future WRCs and their supporting resolutions;

2 to use the template in Annex 3 to this Resolution in proposing agenda items for future WRCs,

further invites administrations

to participate in regional activities for the preparation of agendas for future WRCs,

invites the Radiocommunication Bureau

to review and provide feedback, to the extent possible, when consulted by administrations on the development of items for the agendas of future WRCs, seeking consistency with relevant provisions of the Radio Regulations and practices of the Bureau.

ANNEX 1 TO RESOLUTION 804 (REV.WRC-23)

Principles for establishing agendas for future radiocommunication conferences

1 An agenda of a world radiocommunication conference (WRC) shall include:

1.1 items assigned to it by the ITU Plenipotentiary Conference;

1.2 items on which the Director of the Radiocommunication Bureau (BR) has been requested to report;

1.3 items concerning instructions to the Radio Regulations Board and BR regarding their activities and concerning the review of those activities.

2 In general, a WRC may decide to include on the agenda of a future WRC an item proposed by a group of administrations or an administration, if all the following conditions are met:

2.1 it addresses issues of a worldwide or regional character;

2.2 it is expected that changes in the Radio Regulations, including WRC Resolutions and Recommendations, may be necessary;

2.3 it addresses issues that cannot be resolved through the regular activities of the ITU Radiocommunication Sector (ITU-R) or under WRC standing agenda items;

2.4 it is expected that required studies can be completed (e.g. that appropriate ITU-R Recommendations will be approved) prior to that WRC;

2.5 resources associated with the subject are kept within a range which is manageable for Member States and Sector Members, BR and ITU-R study groups and the Conference Preparatory Meeting;

3 Items that meet the requirements specified in section 2 of this Annex shall be included in the future WRC agenda as standalone items, and shall not be included as separate issues under the agenda item on which the Director of BR reports on ITU-R activities since the last WRC.

4 To the extent possible, agenda items arising from previous WRCs, normally reflected in Resolutions, and which have been considered by two successive WRCs, should not be considered, unless justified.

5 Inclusion of an identical topic on the agenda of two future subsequent WRCs shall strictly be avoided.

6 Issues that could be addressed through actions undertaken by a radiocommunication assembly, particularly those not involving amendments to the Radio Regulations, shall not be included in the agenda.

7 In developing agenda items for future WRCs, efforts need to be made to:

a) encourage regional and interregional coordination on the subjects to be considered in the preparatory process for WRCs, in accordance with Resolution **72 (Rev.WRC-19)** and Resolution 80 (Rev. Marrakesh, 2002) of the Plenipotentiary Conference, with a view to addressing potentially difficult issues well before a WRC;

b) include, to the extent possible, agenda items that are prepared within regional telecommunication organizations, taking into account the equal right of individual administrations to submit proposals for agenda items;

c) ensure that proposals are submitted with an indication of priority and any accompanying reasons for the indicated priority (see also Annex 3 to this Resolution);

d) include in proposals an assessment of their financial and other resource implications (with the assistance of BR) to ensure that they are within the agreed budgetary limits for ITU-R (see also Annex 3 to this Resolution);

e) ensure that the objectives and scope of proposed agenda items are complete and unambiguous (see guidance in Annex 2 to this Resolution);

f) take into account the status of ITU-R studies related to the potential agenda items before considering them as possible candidates for future agendas;

g) distinguish between items intended to result in changes to the Radio Regulations and those dealing solely with the progress of studies;

h) arrange items on the agenda by subject to the extent possible.

ANNEX 2 TO RESOLUTION 804 (REV.WRC-23)

Guidance for the development of Resolutions related to agenda items of world radiocommunication conferences

The guidance in this Annex is provided for developing the text of an agenda item of a future world radiocommunication conference (WRC) and a related supporting resolution which should contain the following sections:

– Preambular part (information/background)

- *considering*
- *noting*
- *recognizing*

– Operative part (actions/tasks)

- *resolves*
- *instructs*
- *invites.*

In developing the text of an agenda item of a future WRC and its supporting resolution, the following should be taken into account:

a) the text of the agenda item, the title of its supporting resolution and the operative part of that resolution should be unambiguous and consistent;

b) in selecting the terms and wording of the supporting resolution, in particular the operative part, efforts need to be made to be unambiguous, meaningful and clear;

c) in developing a supporting resolution, terms such as "constraints", "due constraints", "undue constraints", "additional constraints" and "regulatory actions" and the ambiguous use of "as appropriate", which are not quantifiable and have no regulatory consequence in the ITU Radio Regulations, should be avoided;

d) there needs to be conformity between the subject issue referred to in the preambular part of the supporting resolution and the actions required in the operative part of that resolution;

e) the preambular part of the supporting resolution needs to be kept to the minimum necessary to justify the operative part;

f) reference to the protection of incumbent services needs to be clearly specified in the supporting resolution;

g) repetition of text across different sections of the supporting resolution should be kept to a minimum, while references to existing provisions of the Radio Regulations and/or other sections of the supporting resolution should be used to the extent possible.

The below guidance in the form of a draft new Resolution provides an example addressing the study of the introduction of new service allocations and/or systems. In order to address different situations, variations of the guidance should be considered.

Below, guidance is provided in the form of NOTES for each section.

DRAFT NEW RESOLUTION [A10-Y.YY] (WRC-ZZ)

Title of the Resolution(NOTES 1 and 2)

The World Radiocommunication Conference (PLACE, YEAR),

considering(NOTES 3, 5 and 7)

(…),

considering further(NOTES 4, 5 and 7)

(…),

noting(NOTES 6, 7 and 9)

(…),

noting further(NOTES 7, 8 and 9)

(…),

recognizing(NOTES 7, 10 and 12)

a) that {the frequency bands/ranges under consideration} are also allocated to other radiocommunication services {on a primary basis} and that those allocations are used by a variety of incumbent systems in many administrations {throughout Region X}, {and that the protection of these services should be studied};

b) that for the determination of the incumbent services, the relevant provisions of the Radio Regulations in force apply;

c) (…),

recognizing further(NOTES 7, 11 and 12)

(…),

resolves to invite the ITU Radiocommunication Sector to complete in time for the ZZZZ world radiocommunication conference(NOTE 15)

1 studies on {relevant} spectrum requirements and technical and operational characteristics, for the {new entrant};

2 (…),(NOTES 13 and 14)

invites administrations

to participate actively in the studies and provide the information required for the studies listed under *resolves to invite the ITU Radiocommunication Sector to complete in time for the ZZZZ world radiocommunication conference* by submitting contributions to ITU-R,

invites the ZZZZ world radiocommunication conference(NOTE 16)

to …, based on results of studies, …,

invites relevant international organizations(NOTES 17 and 20)

to participate actively in the relevant ITU-R studies by providing information that should be taken into account in ITU-R studies,

instructs the Director of the Radiocommunication Bureau(NOTES 17, 18, 20 and 21)

(…),

instructs the Secretary-General(NOTES 17, 19, 20 and 21)

(…).(NOTE 22)

NOTE 1 The title of the Resolution related to an agenda item Y.YY should refer to the desired objective of that WRC-ZZ agenda item, with the same wording as listed in section Y.YY of the Resolution containing the agenda of that future WRC-ZZ.

NOTE 2 The title may start "Studies on/Consideration of ..." to bridge to the objective of the agenda item, emphasizing that the Resolution primarily relates to the studies to be provided by ITU-R to the competent WRC as a basis for the relevant decision.

NOTE 3 The content of the *considering* section should primarily aim to qualify the demand/objective under consideration and thus provide the baseline justification for approving a WRC agenda item and tasking ITU-R to perform the studies under *resolves to invite the ITU Radiocommunication Sector to complete in time for the ZZZZ world radiocommunication conference*. This may include an indication of the need for studies to support addressing the demand, the description of the {new entrant/revised service} or its applications. The section should also contain various general background information giving the reasons for the agenda item, including the allocations in the frequency band(s)/range(s) under consideration. Specific factual elements on current and planned usage may also be included here, as requested by the interested administrations.

NOTE 4 If there is a need to highlight any content of the *considering* section, that content could be listed in this section.

NOTE 5 Each *considering* should start with "that" and end with a semicolon ";" and be numbered *a*),…*z*), *aa*)…; the last *considering* ends with a comma ",".

NOTE 6 The content of the noting section should aim to provide factual/relevant regulatory information through statement of existing RR Article **5** frequency allocations, regulatory references (RR No., WRC Resolution, etc.), as well as ITU-R deliverables (Recommendation, Report, Question, etc.) of relevance to the topic, including information on any relevant sharing and compatibility studies so far carried out in previous cycles, to avoid repeating studies previously performed and specific usages and use cases (e.g. secondary services and/or identification/designations in RR footnotes) in the frequency bands/ranges under consideration, as requested by administrations.

NOTE 7 The information in this section cannot be expected to be exhaustive; an omission should not have an impact on proceedings.

NOTE 8 If there is a need to highlight any content of the *noting* section, that content could be listed in this section.

NOTE 9 Each *noting* should start with "that" and end with a semicolon ";" and be numbered *a*),…*z*), *aa*)…; the last *noting* ends with a comma ",".

NOTE 10 The content of the recognizing section should aim to set a framework for studies/future use, through recognizing assumptions or objectives for the studies to be performed by ITU-R under *resolves to invite the ITU Radiocommunication Sector to complete in time for the ZZZZ world radiocommunication conference*.

NOTE 11 If there is a need to highlight any content of the *recognizing* section, that content could be listed in this section.

NOTE 12 Each *recognizing* should start with "that" and end with a semicolon ";" and be numbered *a*),…*z*), *aa*)…; the last *recognizing* ends with a comma ",".

NOTE 13 This section should indicate study tasks for ITU-R – regulatory, technical, operational and/or procedural, including the necessary sharing and compatibility studies, as required, to ensure the protection of incumbent primary services. This section should be complete and provide the fundamental elements necessary for WRC action.

NOTE 14 The development of the Resolution should consider, on request by administrations, the following:
- passive services,
- secondary services,
- services and their specific conditions of use as outlined in footnotes to the Table of Frequency Allocations and/or designation of specific frequency bands for specific applications.

NOTE 15 Each *resolves to invite etc.* should end with a semicolon ";" and be numbered 1, 2, 3, etc.; the last *resolves to invite etc.* ends with a comma ",".

NOTE 16 The *invites the ZZZZ world radiocommunication conference* section shall express the desired objective of the relevant agenda item in concise and unambiguous wording – the same wording shall be listed in section Y.YY of the Resolution containing the agenda of WRC-ZZ.

NOTE 17 This section is optional.

NOTE 18 This section contains instructions for performing any further required ITU-R internal actions or steps or addressing non-self-standing issues for a WRC.

NOTE 19 This section may contain instructions on the presentation of the agenda item or a related topic in the framework of the United Nations principal organs, related organizations or specialized agencies, within the United Nations system, as necessary.

NOTE 20 The instructions should be limited to the minimum necessary and are considered an optional, non-standing part of the Resolution.

NOTE 21 Each item in this section should start with "to" and end with a semicolon ";" and be numbered 1, 2, 3, etc. the last item ends with a comma ",".

NOTE 22 The Resolution ends with a full stop ".".

ANNEX 3 TO RESOLUTION 804 (REV.WRC-23)

Template for the submission of proposals for agenda items of future world radiocommunication conferences

Subject: {The main purpose/objective/topic of the proposed new agenda item needs to be provided here with clear concise wording.}

Origin:

***Proposal*:** {The exact text of the proposed agenda item for future WRCs should be provided here in a clear and unambiguous wording with a reference to its supporting resolution(s).}

***Supporting resolution*:** {The title of the draft supporting resolution for the proposed agenda item needs to be provided here.}

***Background/reason*:**

{The reason and justification for the proposal should be clearly provided, taking into account 7*c)* of Annex 1 to this Resolution.}

***Radiocommunication services concerned*:**

***Indication of possible difficulties*:**

***Previous/ongoing studies on the issue*:**

***Studies to be carried out by*:**	***with the participation of*:**

***ITU-R study groups concerned*:**

***ITU resource implications, including financial implications (refer to CV126)*:**

***Common regional proposal*:** Yes/No	***Multicountry proposal*:** Yes/No ***Number of countries*:**

Remarks

RESOLUTION 813 (WRC-23)

Agenda for the 2027 world radiocommunication conference

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that, in accordance with No. 118 of the ITU Convention, the general scope of the agenda for a world radiocommunication conference (WRC) should be established four to six years in advance and that a final agenda shall be established by the ITU Council two years before the conference;

b) Article 13 of the ITU Constitution, relating to the competence and scheduling of WRCs, and Article 7 of the Convention, relating to their agendas;

c) the relevant resolutions and recommendations of previous world administrative radio conferences (WARCs) and WRCs,

recognizing

a) that this conference has identified a number of urgent issues requiring further examination by WRC-27;

b) that in preparing this agenda, some items proposed by administrations could not be included and have had to be deferred to future conference agendas,

resolves

to recommend to the Council that a WRC be held in 2027 for a period of four weeks, with the following agenda:

1 on the basis of proposals from administrations, taking into account of the results of WRC-23 and the Report of the Conference Preparatory Meeting, and with due regard to the requirements of existing and future services in the frequency bands under consideration, to consider and take appropriate action in respect of the following items:

1.1 to consider the technical and operational conditions for the use of the frequency bands 47.2-50.2 GHz and 50.4-51.4 GHz (Earth-to-space), or parts thereof, by aeronautical and maritime earth stations in motion communicating with space stations in the fixed-satellite service and develop regulatory measures, as appropriate, to facilitate the use of the frequency bands 47.2-50.2 GHz and 50.4-51.4 GHz (Earth-to-space), or parts thereof, by aeronautical and maritime earth stations in motion communicating with geostationary space stations and non-geostationary space stations in the fixed-satellite service, in accordance with Resolution **176 (Rev.WRC-23)**;

1.2 to consider possible revisions of sharing conditions in the frequency band 13.75-14 GHz to allow the use of uplink fixed-satellite service earth stations with smaller antenna sizes, in accordance with Resolution **129 (WRC-23)**;

1.3 to consider studies relating to the use of the frequency band 51.4-52.4 GHz to enable use by gateway earth stations transmitting to non-geostationary-satellite orbit systems in the fixed-satellite service (Earth-to-space), in accordance with Resolution **130 (WRC-23)**;

1.4 to consider a possible new primary allocation to the fixed-satellite service (space-to-Earth) in the frequency band 17.3-17.7 GHz and a possible new primary allocation to the broadcasting-satellite service (space-to-Earth) in the frequency band 17.3-17.8 GHz in Region 3, while ensuring the protection of existing primary allocations in the same and adjacent frequency bands, and to consider equivalent power flux-density limits to be applied in Regions 1 and 3 to non-geostationary-satellite systems in the fixed-satellite service (space-to-Earth) in the frequency band 17.3-17.7 GHz, in accordance with Resolution **726 (WRC-23)**;

1.5 to consider regulatory measures, and implementability thereof, to limit the unauthorized operations of non-geostationary-satellite orbit earth stations in the fixed-satellite and mobile-satellite services and associated issues related to the service area of non-geostationary-satellite orbit satellite systems in the fixed-satellite and mobile-satellite services, in accordance with Resolution **14 (WRC-23)**;

1.6 to consider technical and regulatory measures for fixed-satellite service satellite networks/systems in the frequency bands 37.5-42.5 GHz (space-to-Earth), 42.5-43.5 GHz (Earth-to-space), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space) for equitable access to these frequency bands, in accordance with Resolution **131 (WRC-23)**;

1.7 to consider studies on sharing and compatibility and develop technical conditions for the use of International Mobile Telecommunications (IMT) in the frequency bands 4 400-4 800 MHz and 7 125-8 400 MHz (or parts thereof), and 14.8-15.35 GHz taking into account existing primary services operating in these, and adjacent, frequency bands, in accordance with Resolution **256 (WRC-23)**;

1.8 to consider possible additional spectrum allocations to the radiolocation service on a primary basis in the frequency range 231.5-275 GHz and possible new identifications for radiolocation service applications in frequency bands within the frequency range 275-700 GHz for millimetric and sub-millimetric wave imaging systems, in accordance with Resolution **663 (Rev.WRC-23)**;

1.9 to consider appropriate regulatory actions to update Appendix **26** to the Radio Regulations in support of aeronautical mobile (OR) high frequency modernization, in accordance with Resolution **411 (WRC-23)**;

1.10 to consider developing power flux-density and equivalent isotropically radiated power limits for inclusion in Article **21** of the Radio Regulations for the fixed-satellite, mobile-satellite and broadcasting-satellite services to protect the fixed and mobile services in the frequency bands 71-76 GHz and 81-86 GHz, in accordance with Resolution **775 (Rev.WRC-23)**;

1.11 to consider the technical and operational issues, and regulatory provisions, for space-to-space links among non-geostationary and geostationary satellites in the frequency bands 1 518-1 544 MHz, 1 545-1 559 MHz, 1 610-1 645.5 MHz, 1 646.5-1 660 MHz, 1 670-1 675 MHz and 2 483.5-2 500 MHz allocated to the mobile-satellite service, in accordance with Resolution **249 (Rev.WRC-23)**;

1.12 to consider, based on the results of studies, possible new allocations to the mobile-satellite service and possible regulatory actions in the frequency bands 1 427-1 432 MHz (space-to-Earth), 1 645.5-1 646.5 MHz (space-to-Earth) (Earth-to-space), 1 880-1 920 MHz (space-to-Earth) (Earth-to-space) and 2 010-2 025 MHz (space-to-Earth) (Earth-to-space) required for the future development of low-data-rate non-geostationary mobile-satellite systems, in accordance with Resolution **252 (WRC-23)**;

1.13 to consider studies on possible new allocations to the mobile-satellite service for direct connectivity between space stations and International Mobile Telecommunications (IMT) user equipment to complement terrestrial IMT network coverage, in accordance with Resolution **253 (WRC-23)**;

1.14 to consider possible additional allocations to the mobile-satellite service, in accordance with Resolution **254 (WRC-23)**;

1.15 to consider studies on frequency-related matters, including possible new or modified space research service (space-to-space) allocations, for future development of communications on the lunar surface and between lunar orbit and the lunar surface, in accordance with Resolution **680 (WRC-23)**;

1.16 to consider studies on the technical and regulatory provisions necessary to protect radio astronomy operating in specific Radio Quiet Zones, and in frequency bands allocated to the radio astronomy service on a primary basis globally, from aggregate radio-frequency interference caused by non-geostationary-satellite orbit systems, in accordance with Resolution **681 (WRC-23)**;

1.17 to consider regulatory provisions for receive-only space weather sensors and their protection in the Radio Regulations, taking into account the results of ITU Radiocommunication Sector studies, in accordance with Resolution **682 (WRC-23)**;

1.18 to consider, based on the results of ITU Radiocommunication Sector studies, possible regulatory measures regarding the protection of the Earth exploration-satellite service (passive) and the radio astronomy service in certain frequency bands above 76 GHz from unwanted emissions of active services, in accordance with Resolution **712 (WRC-23)**;

1.19 to consider possible primary allocations in all Regions to the Earth exploration-satellite service (passive) in the frequency bands 4 200-4 400 MHz and 8 400-8 500 MHz, in accordance with Resolution **674 (WRC-23)**,

2 to examine the revised ITU Radiocommunication Sector Recommendations incorporated by reference in the Radio Regulations communicated by the Radiocommunication Assembly, in accordance with *further resolves* of Resolution **27 (Rev.WRC-19)**, and to decide whether or not to update the corresponding references in the Radio Regulations, in accordance with the principles contained in *resolves* of that Resolution;

3 to consider such consequential changes and amendments to the Radio Regulations as may be necessitated by the decisions of the conference;

4 in accordance with Resolution **95 (Rev.WRC-19)**, to review the resolutions and recommendations of previous conferences with a view to their possible revision, replacement or abrogation;

5 to review, and take appropriate action on, the Report from the Radiocommunication Assembly submitted in accordance with Nos. 135 and 136 of the ITU Convention;

6 to identify those items requiring urgent action by the radiocommunication study groups in preparation for the next world radiocommunication conference;

7 to consider possible changes, in response to Resolution 86 (Rev. Marrakesh, 2002) of the Plenipotentiary Conference, on advance publication, coordination, notification and recording procedures for frequency assignments pertaining to satellite networks, in accordance with Resolution **86 (Rev.WRC-07)**, in order to facilitate the rational, efficient and economical use of radio frequencies and any associated orbits, including the geostationary-satellite orbit;

8 to consider and take appropriate action on requests from administrations to delete their country footnotes or to have their country name deleted from footnotes, if no longer required, taking into account Resolution **26 (Rev.WRC-23)**;

9 to consider and approve the Report of the Director of the Radiocommunication Bureau, in accordance with Article 7 of the ITU Convention:

9.1 on the activities of the ITU Radiocommunication Sector since WRC-23[1];

9.2 on any difficulties or inconsistencies encountered in the application of the Radio Regulations[2]; and

---

[1] This WRC's standing agenda sub-item is strictly limited to the Report of the Director on ITU-R activities since the last WRC; and any topics outside 1.1-1.19 as listed above shall be strictly avoided, particularly those topics which require any changes/amendments to the Radio Regulations.

[2] This WRC's standing agenda sub-item is strictly limited to the Report of the Director on any difficulties or inconsistencies encountered in the application of the Radio Regulations and the comments from administrations. Administrations are invited to inform the Director of the Radiocommunication Bureau of any difficulties or inconsistencies encountered in the Radio Regulations.

9.3 on action in response to Resolution **80 (Rev.WRC-07)**;

10 to recommend to the ITU Council items for inclusion in the agenda for the next world radiocommunication conference, and items for the preliminary agenda of future conferences, in accordance with Article 7 of the ITU Convention and Resolution **804 (Rev.WRC-23)**,

further resolves

to activate the Conference Preparatory Meeting (CPM),

invites the ITU Council

to finalize the agenda and arrange for the convening of WRC-27, and to initiate as soon as possible the necessary consultations with Member States,

instructs the Director of the Radiocommunication Bureau

1 to make the necessary arrangements to convene meetings of the CPM and to prepare a report to WRC-27;

2 to submit a draft report on any difficulties or inconsistencies encountered in the application of the Radio Regulations, as referred to in agenda item 9.2, to the second session of the CPM and to submit the final report at least five months before the next WRC,

instructs the Secretary-General

to communicate this Resolution to international and regional organizations concerned.

RESOLUTION 814 (WRC-23)

Preliminary agenda for the 2031 world radiocommunication conference*

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that, in accordance with No. 118 of the ITU Convention, the general scope of the agenda for WRC-31 should be established four to six years in advance;

b) Article 13 of the ITU Constitution, relating to the competence and scheduling of world radiocommunication conferences (WRCs), and Article 7 of the Convention, relating to their agendas;

c) the relevant resolutions and recommendations of previous world administrative radio conferences (WARCs) and WRCs,

resolves to give the view

that the following items should be included in the preliminary agenda for WRC-31:

1 to take appropriate action in respect of those urgent issues that were specifically requested by WRC-27;

2 on the basis of proposals from administrations and the Report of the Conference Preparatory Meeting, and taking account of the results of WRC-27, to consider and take appropriate action in respect of the following items:

2.1 to consider potential new allocations to the fixed, mobile, radiolocation, amateur, amateur-satellite, radio astronomy, Earth exploration-satellite (passive and active) and space research (passive) services in the frequency range 275-325 GHz in the Table of Frequency Allocations of the Radio Regulations, with the consequential update of Nos. **5.149**, **5.340**, **5.564A** and **5.565**, in accordance with Resolution **721 (WRC-23)**;

2.2 [to consider the possible [frequency bands] for [non-beam and beam] wireless power transmission to avoid harmful interference to the radiocommunication services caused by wireless power transmission, in accordance with Resolution **910 (WRC-23)**];

2.3 to consider the use of aeronautical and maritime earth stations in motion communicating with non-geostationary space stations in the fixed-satellite service (Earth-to-space) in the frequency band 12.75-13.25 GHz, in accordance with Resolution **133 (WRC-23)**;

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* For further consideration at WRC-27, given the divergent views regarding the frequency bands to be studied and the means to ensure the full protection of all incumbent services concerned.

2.4 to consider, based on the results of ITU Radiocommunication Sector studies, support for inter-satellite service allocations in the frequency bands 3 700-4 200 MHz and 5 925-6 425 MHz, and associated regulatory provisions, to enable links between non-geostationary orbit satellites and geostationary orbit satellites, in accordance with Resolution **683 (WRC-23)**;

2.5 to consider a possible primary allocation in the frequency bands [694-960 MHz, or parts thereof, in Region 1], 890-942 MHz, or parts thereof, in Region 2, and [3 400-3 700 MHz, or parts thereof, in Region 3] to the aeronautical mobile service for the use of International Mobile Telecommunications (IMT) user equipment in terrestrial IMT networks by non-safety applications, in accordance with Resolution **251 (Rev.WRC-23)**;

2.6 to consider the identification of the frequency bands [102-109.5 GHz, 151.5-164 GHz, 167-174.8 GHz, 209-226 GHz and 252-275 GHz] for International Mobile Telecommunications, in accordance with Resolution **255 (WRC-23)**;

2.7 to consider improving the utilization of VHF maritime radiocommunication, in accordance with Resolution **363 (Rev.WRC-23)**;

2.8 to consider improving the utilization and channelization of maritime radiocommunication in the MF and HF bands, including potential revisions of Article **52** and Appendix **17**, in accordance with Resolution **366 (WRC-23)**;

2.9 to consider possible new allocations to the radionavigation-satellite service (space-to-Earth) in the frequency bands [5 030-5 150 MHz and 5 150-5 250 MHz] or parts thereof, in accordance with Resolution **684 (WRC-23)**;

2.10 to consider a possible new primary allocation to the Earth exploration-satellite service (Earth-to-space) in the frequency band 22.55-23.15 GHz, in accordance with Resolution **664 (Rev.WRC-23)**;

2.11 to consider an upgrade of the secondary allocation to the Earth exploration-satellite service (space-to-Earth) in the frequency band [37.5-40.5 GHz] or possible new worldwide frequency allocations on a primary basis to the Earth exploration-satellite service (space-to-Earth) in certain frequency bands within the frequency range [40.5-52.4 GHz], in accordance with Resolution **685 (WRC-23)**;

2.12 to consider possible new allocations to the Earth exploration-satellite service (active) in the frequency bands [3 000-3 100 MHz] and [3 300-3 400 MHz] on a secondary basis, in accordance with Resolution **686 (WRC-23)**;

2.13 to consider studies on coexistence between spaceborne synthetic aperture radars operating in the Earth exploration-satellite service (active) and the radiodetermination service in the frequency band 9 200-10 400 MHz, with possible actions as appropriate, in accordance with Resolution **722 (WRC-23)**;

2.14 to review spectrum use and needs of applications of broadcasting and mobile services and consider possible regulatory actions in the frequency band 470-694 MHz or parts thereof, in accordance with Resolution **235 (Rev.WRC-23)**;

3 to examine the revised ITU Radiocommunication Sector Recommendations incorporated by reference in the Radio Regulations communicated by the Radiocommunication Assembly, in accordance with *further resolves* of Resolution **27 (Rev.WRC-19)**, and to decide whether or not to update the corresponding references in the Radio Regulations, in accordance with the principles contained in *resolves* of that Resolution;

4 to consider such consequential changes and amendments to the Radio Regulations as may be necessitated by the decisions of the conference;

5 in accordance with Resolution **95 (Rev.WRC-19)**, to review the Resolutions and Recommendations of previous conferences with a view to their possible revision, replacement or abrogation;

6 to review, and take appropriate action on, the Report from the Radiocommunication Assembly submitted in accordance with Nos. 135 and 136 of the ITU Convention;

7 to identify those items requiring urgent action by the radiocommunication study groups;

8 to consider possible changes, in response to Resolution 86 (Rev. Marrakesh, 2002) of the Plenipotentiary Conference, on advance publication, coordination, notification and recording procedures for frequency assignments pertaining to satellite networks, in accordance with Resolution **86 (Rev.WRC-07)**, in order to facilitate the rational, efficient and economical use of radio frequencies and any associated orbits, including the geostationary-satellite orbit;

9 to consider and take appropriate action on requests from administrations to delete their country footnotes or to have their country name deleted from footnotes, if no longer required, taking into account Resolution **26 (Rev.WRC-23)**;

10 to consider and approve the Report of the Director of the Radiocommunication Bureau, in accordance with Article 7 of the ITU Convention:

10.1 on the activities of the Radiocommunication Sector since WRC-27[1];

10.2 on any difficulties or inconsistencies encountered in the application of the Radio Regulations[2]; and

10.3 on action in response to Resolution **80 (Rev.WRC-07)**;

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[1] This WRC's standing sub-item is strictly limited to the Report of the Director on ITU-R activities since the last WRC; and any topics outside 2.1-2.14 as listed above shall be strictly avoided, particularly those topics which require any changes/amendments to the Radio Regulations.

[2] This agenda sub-item is strictly limited to the Report of the Director on any difficulties or inconsistencies encountered in the application of the Radio Regulations and the comments from administrations. Administrations are invited to inform the Director of the Radiocommunication Bureau of any difficulties or inconsistencies encountered in the Radio Regulations.

11 to recommend to the ITU Council items for inclusion in the agenda for the next world radiocommunication conference, and items for the preliminary agenda of future conferences, in accordance with Article 7 of the ITU Convention and Resolution **804 (Rev.WRC-23)**,

invites the ITU Council

to finalize the agenda and arrange for the convening of WRC-31, and to initiate as soon as possible the necessary consultations with Member States,

instructs the Director of the Radiocommunication Bureau

1 to make the necessary arrangements to convene meetings of the Conference Preparatory Meeting (CPM) and to prepare a report to WRC-31;

2 to submit a draft Report on any difficulties or inconsistencies encountered in the application of the Radio Regulations, as referred to in agenda item 10.2, to the second session of the CPM and to submit the final Report at least five months before the next WRC,

instructs the Secretary-General

to communicate this Resolution to international and regional organizations concerned.

RESOLUTION 901 (REV.WRC-15)

Determination of the orbital arc separation for which coordination would be required between two satellite networks operating in a space service not subject to a Plan

The World Radiocommunication Conference (Geneva, 2015),

considering

a) that WRC-2000 adopted a coordination arc concept in Appendix **5** to simplify the coordination between fixed-satellite service (FSS) networks in certain frequency bands between 3.4 GHz and 30 GHz;

b) that in frequency bands below 3.4 GHz, mobile-satellite service (MSS) satellite networks normally have to coordinate with other networks with overlapping service areas operating anywhere in the visible arc;

c) that the application of such a concept was limited to the frequency ranges where very large numbers of FSS satellite filings had been received by ITU-R;

d) that many satellite networks and systems are now proposing to use higher frequency bands for which the coordination arc does not yet apply;

e) that the Radio Regulations Board (RRB) adopted a Rule of Procedure on No. **9.36** that extended the coordination arc concept to the FSS and broadcasting-satellite service (BSS), not subject to a Plan, and in all frequency bands above 3.4 GHz until a review by WRC-03;

f) that the use of the coordination arc considerably reduces the volume of data that needs to be supplied to the Radiocommunication Bureau under Section D of Annex 2 to Appendix **4**;

g) that application of the coordination arc concept has the potential to reduce the workload of the Bureau in identifying affected administrations;

h) that the coordination arc concept may be valid for all geostationary space stations operating in any space radiocommunication service above 3.4 GHz that is not subject to a Plan, but may require different values for different services and frequency bands;

i) that the ITU-R studies for other services and for frequency bands above 17.3 GHz, except for the 17.7-20.2 GHz and 29.5-30 GHz ranges for the FSS, have not been completed;

j) that application of the coordination arc concept could facilitate the introduction of satellite services above 17.3 GHz after the studies conclude on the appropriate value(s) of the coordination arc,

recognizing

that there have been no difficulties resulting from the application of the coordination arc concept in the frequency bands where it applies,

noting

Recommendation ITU-R S.1780 "Coordination between geostationary-satellite orbit fixed-satellite service networks and broadcasting-satellite service networks in the frequency band 17.3-17.8 GHz",

further noting

that WRC-07 incorporated part of the Rule of Procedure referred to in *considering e)* and extended the coordination arc of ±8° for the FSS in frequency bands above 17.3 GHz on a provisional basis, and has adopted an alternative value of ±16° on a provisional basis for the coordination arc applicable for the BSS in these frequency bands in Table 5-1 of Appendix **5**,

resolves

to recommend that a future competent conference review the results of ITU-R studies on the application of the coordination arc value(s) to other frequency bands and other services, as applicable, and consider their inclusion in Appendix **5**,

invites ITU-R

1 to conduct studies on the applicability of the coordination arc concept for space radiocommunication services not yet covered by these Regulations;

2 to recommend, as appropriate, the orbital separation required for triggering inter-service and intra-service coordination concerning the satellite services in frequency bands above 3.4 GHz for geostationary-satellite (GSO) networks not subject to a Plan and not already covered by the coordination arc concept specified in No. **9.7** (GSO/GSO) of Table 5-1 (Appendix **5**), under items 1) to 8) of the frequency band column, and subject to Section II of Article **9**,

instructs the Director of the Radiocommunication Bureau

to report the results of these studies to the RRB once Recommendations are approved, and to the next competent conference.

RESOLUTION 902 (REV.WRC-23)

Provisions relating to earth stations located on board vessels which operate in fixed-satellite service networks in the uplink frequency bands 5 925-6 425 MHz and 14-14.5 GHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that there is a demand for global wideband satellite communication services on vessels;

b) that the technology exists that enables earth stations on board vessels (ESVs) to use fixed-satellite service (FSS) networks operating in the uplink bands 5 925-6 425 MHz and 14-14.5 GHz;

c) that ESVs are currently operating through FSS networks in the frequency bands 3 700-4 200 MHz, 5 925-6 425 MHz, 10.7-12.75 GHz and 14-14.5 GHz under No. **4.4**;

d) that ESVs have the potential to cause unacceptable interference to other services in the frequency bands 5 925-6 425 MHz and 14-14.5 GHz;

e) that, with respect to the frequency bands considered in this Resolution, global coverage is only available in the frequency band 5 925-6 425 MHz and that only a limited number of geostationary FSS systems can provide such global coverage;

f) that, without special regulatory provisions, ESVs could place a heavy coordination burden on some administrations, especially those in developing countries;

g) that, in order to ensure the protection and future growth of other services, ESVs need to operate under certain technical and operational limitations;

h) that, within ITU-R studies, based on agreed technical assumptions, minimum distances from the low-water mark as officially recognized by the coastal State have been calculated, beyond which an ESV will not have the potential to cause unacceptable interference to other services in the frequency bands 5 925-6 425 MHz and 14-14.5 GHz;

i) that, in order to limit the interference into other networks in the FSS, it is necessary to establish maximum off-axis e.i.r.p. density limits on ESV emissions;

j) that establishing a minimum antenna diameter for ESVs has an impact on the number of ESVs that will ultimately be deployed, hence it will reduce interference into the fixed service,

noting

a) that ESVs may be assigned frequencies to operate in FSS networks in the frequency bands 3 700-4 200 MHz, 5 925-6 425 MHz, 10.7-12.75 GHz and 14-14.5 GHz pursuant to No. **4.4** and shall not claim protection from, or cause interference to, other services having allocations in these bands;

b) that the regulatory procedures of Article **9** apply for ESVs operating at specified fixed points,

resolves

that ESVs transmitting in the frequency bands 5 925-6 425 MHz and 14-14.5 GHz shall operate under the regulatory and operational provisions contained in Annex 1 and the technical limitations in Annex 2 of this Resolution,

encourages concerned administrations

to cooperate with administrations which license ESVs while seeking agreement under the above-mentioned provisions, taking into consideration the provisions of Recommendation **37 (Rev.WRC-23)**,

instructs the Secretary-General

to bring this Resolution to the attention of the Secretary-General of the International Maritime Organization.

ANNEX 1 TO RESOLUTION 902 (REV.WRC-23)

Regulatory and operational provisions for ESVs transmitting in the frequency bands 5 925-6 425 MHz and 14-14.5 GHz

1 The administration that issues the licence for the use of earth stations on board vessels (ESVs) in these frequency bands (licensing administration) shall ensure that such stations follow the provisions of this Annex and thus do not present any potential to cause unacceptable interference to the services of other concerned administrations.

2 ESV service providers shall comply with the technical limitations listed in Annex 2 and, when operating within the minimum distances as identified in § 4 below, with the additional limitations agreed by the licensing and other concerned administrations.

3 In the frequency band 3 700-4 200 MHz and frequency range 10.7-12.75 GHz range, ESVs in motion shall not claim protection from transmissions of terrestrial services operating in accordance with the Radio Regulations.

4 The minimum distances from the low-water mark as officially recognized by the coastal State beyond which ESVs can operate without the prior agreement of any administration are 300 km in the frequency band 5 925-6 425 MHz and 125 km in the frequency band 14-14.5 GHz, taking into account the technical limitations in Annex 2. Any transmissions from ESVs within the minimum distances shall be subject to the prior agreement of the concerned administration(s).

5 The potentially concerned administrations referred to in § 4 above are those where fixed or mobile services are allocated on a primary basis in the Table of Frequency Allocations of the Radio Regulations:

Frequency bands	Potentially concerned administrations
5 925-6 425 MHz	All three Regions
14-14.25 GHz	Countries listed in No. **5.505**, except those listed in No. **5.506B**
14.25-14.3 GHz	Countries listed in Nos. **5.505**, **5.508** and **5.509**, except those listed in No. **5.506B**
14.3-14.4 GHz	Regions 1 and 3, except countries listed in No. **5.506B**
14.4-14.5 GHz	All three Regions, except countries listed in No. **5.506B**

6 The ESV system shall include means of identification and mechanisms to immediately cease emissions, whenever the station does not operate in compliance with the provisions of §§ 2 and 4 above.

7 Cessation of emissions as referred to in § 6 above shall be implemented in such a way that the corresponding mechanisms cannot be bypassed on board the vessel, except under the provisions of No. **4.9**.

8 ESVs shall be equipped so as to:

– enable the licensing administration under the provisions of Article **18** to verify earth station performance; and

– enable the cessation of ESV emissions immediately upon request by an administration whose services may be affected.

9 Each licence-holder shall provide a point of contact to the administration with which agreements have been reached for the purpose of reporting unacceptable interference caused by the ESV.

10 When ESVs operating beyond the territorial sea but within the minimum distance (as referred to in § 4 above) fail to comply with the terms required by the concerned administration pursuant to §§ 2 and 4, then that administration may:

– request the ESV to comply with such terms or cease operation immediately; or

– request the licensing administration to require such compliance or immediate cessation of the operation.

ANNEX 2 TO RESOLUTION 902 (REV.WRC-23)

Technical limitations applicable to ESVs transmitting in the frequency bands 5 925-6 425 MHz and 14-14.5 GHz

	5 925-6 425 MHz	**14-14.5 GHz**
Minimum diameter of ESV antenna	2.4 m	1.2 m[1]
Tracking accuracy of ESV antenna	±0.2° (peak)	±0.2° (peak)
Maximum ESV e.i.r.p. spectral density towards the horizon	17 dB(W/MHz)	12.5 dB(W/MHz)
Maximum ESV e.i.r.p. towards the horizon	20.8 dBW	16.3 dBW
Maximum off-axis e.i.r.p. density[2]	See below	See below

[1] While operations within the minimum distances are subject to specific agreement with concerned administrations, licensing administrations may authorize the deployment of smaller antenna sizes down to 0.6 m at 14 GHz provided that the interference to the terrestrial services is no greater than that which would be caused with an antenna size of 1.2 m, taking into account the most recent version of Recommendation ITU-R SF.1650. In any case, the use of smaller antenna size shall be in compliance with the tracking accuracy of ESV antenna, maximum ESV e.i.r.p. spectral density towards the horizon, maximum ESV e.i.r.p. towards the horizon and maximum off-axis e.i.r.p. density limits in the Table above and the protection requirements of the FSS intersystem coordination agreements.

[2] In any case, the e.i.r.p. off-axis limits shall be compliant with the FSS intersystem coordination agreements that may agree to more stringent off-axis e.i.r.p. levels.

Off-axis limits

For earth stations on board vessels (ESVs) operating in the 5 925-6 425 MHz band, at any angle φ specified below, off the main-lobe axis of an earth-station antenna, the maximum equivalent isotropically radiated power (e.i.r.p.) in any direction within 3° of the geostationary-satellite orbit (GSO) shall not exceed the following values:

5 925-6 425 MHz

Angle off-axis	*Maximum e.i.r.p. per 4 kHz band*	
$2.5° \leq \varphi \leq 7°$	$(32 - 25 \log \varphi)$	dB(W/4 kHz)
$7° < \varphi \leq 9.2°$	11	dB(W/4 kHz)
$9.2° < \varphi \leq 48°$	$(35 - 25 \log \varphi)$	dB(W/4 kHz)
$48° < \varphi \leq 180°$	−7	dB(W/4 kHz)

For ESV operating in the 14-14.5 GHz band, at any angle φ specified below, off the main-lobe axis of an earth station antenna, the maximum e.i.r.p. in any direction within 3° of the GSO shall not exceed the following values:

14.0-14.5 GHz

Angle off-axis	*Maximum e.i.r.p. per 40 kHz band*	
$2° \leq \varphi \leq 7°$	$(33 - 25 \log \varphi)$	dB(W/40 kHz)
$7° < \varphi \leq 9.2°$	12	dB(W/40 kHz)
$9.2° < \varphi \leq 48°$	$(36 - 25 \log \varphi)$	dB(W/40 kHz)
$48° < \varphi \leq 180°$	−6	dB(W/40 kHz)

RESOLUTION 903 (REV.WRC-19)

Transitional measures for certain broadcasting-satellite/fixed-satellite service systems in the frequency band 2 500-2 690 MHz

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that WRC-07 revised the limits of power flux-density (pfd) from space stations in Article **21**, Table **21-4** for the frequency band 2 500-2 690 MHz;

b) that use of the frequency bands 2 500-2 690 MHz in Region 2 and 2 500-2 535 MHz and 2 655-2 690 MHz in Region 3 by the fixed-satellite service (FSS) is limited to national and regional systems, subject to agreement obtained under No. **9.21** (see Nos. **5.415** and No. **5.2.1**);

c) that in the frequency band 2 520-2 670 MHz, the broadcasting-satellite service (BSS) is limited to national and regional systems, subject to agreement obtained under No. **9.21** (see Nos. **5.416** and No. **5.2.1**);

d) that, in No. **5.384A**, the frequency band 2 500-2 690 MHz is identified as one of the frequency bands for use by administrations wishing to implement International Mobile Telecommunications (IMT) in accordance with Resolution **223 (Rev.WRC-19)***;

e) that, due to the specific national and regional allocation status applied to the space services mentioned above, and the identification for use by administrations wishing to implement IMT, it is advantageous to apply the revised Article **21**, Table **21-4** limits in the frequency band 2 500-2 690 MHz at an early date;

f) that agenda item 1.9 of WRC-07 mentioned a requirement to not place undue constraints on the services to which the frequency band is allocated,

resolves

1 that, in the frequency band 2 500-2 690 MHz, space stations of satellite networks listed in the Annex to this Resolution shall not exceed the following pfd values:

-152 dB(W/m^2)	for	$\delta < 5°$
$-152 + 0.75\,(\delta - 5)$ dB(W/m^2)	for	$5° \leq \delta \leq 25°$
-137 dB(W/m^2)	for	$\delta > 25°$

in any 4 kHz band, where δ is the angle of arrival above the horizontal plane; the limits in Table **21-4** do not apply;

* *Note by the Secretariat:* This Resolution was revised by WRC-23.

2 that, for systems other than those addressed in *resolves* 1, No. **5.418** and Resolution **539 (Rev.WRC-19)**, the Radiocommunication Bureau (BR) shall examine any coordination and notification information with respect to the provisions Nos. **9.35** and **11.31** (respectively) for frequency assignments in the FSS or BSS received by BR after 14 November 2007 using the pfd limits for the frequency band 2 500-2 690 MHz in Table **21-4** of Article **21**,

instructs the Radiocommunication Bureau

to implement *resolves* 1 and *resolves* 2.

ANNEX TO RESOLUTION 903 (REV.WRC-19)

Notifying administration	Name of space station	Orbital position	Coordination request Special Section	Date of receipt of Advance Publication Information
IND	INSAT-2(74)	74.00 E	CR/C/1311 and CR/C/1311 M1	07.08.85
IND	INSAT-2(83)	83.00 E	CR/C/1312 and CR/C/1312 M1	07.08.85
IND	INSAT-2(93.5)	93.50 E	CR/C/1313 and CR/C/1313 M1	07.08.85

RESOLUTION 906 (REV.WRC-15)

Electronic submission of notices for terrestrial services to the Radiocommunication Bureau and exchange of data between administrations

The World Radiocommunication Conference (Geneva, 2015),

considering

a) that the electronic format for submission of notifications concerning terrestrial services under Article **11** and Plans annexed to Regional Agreements has been used by the Radiocommunication Bureau since September 1994;

b) that, since 8 December 1998, submission of high-frequency broadcasting schedule requirements under Article **12** has been in electronic format only;

c) that, since 3 June 2001 for space services, all notices and related information submitted to the Radiocommunication Bureau pursuant to Articles **9** and **11** have been submitted in electronic format only;

d) that, since January 2009, the submission of notices for terrestrial services is done in electronic format only, using the secured ITU web interface WISFAT (Web Interface for the Submission of Frequency Assignments/Allotments to Terrestrial Services) in accordance with Circular Letter CR/297;

e) that RRC-06 decided that all submissions in the application of Articles 4 and 5 of the GE06 Regional Agreement shall be in electronic format only;

f) that preparation of notices for terrestrial services in electronic format allows administrations to validate the data prior to submission using Radiocommunication Bureau software tools;

g) that submission of notices for terrestrial services in electronic format removes the need for the Radiocommunication Bureau to transcribe the data, avoids the potential for the introduction of errors and reduces the data processing effort required by the Radiocommunication Bureau;

h) that the submission of notices for terrestrial services in electronic format only may require appropriate training on the Radiocommunication Bureau's software tools, especially in developing and least-developed countries;

i) that, for some administrations, the submission of notices for terrestrial services in electronic format only may require the adaptation of their national procedures and the development of appropriate electronic facilities;

j) that information in electronic format could be used to fulfil administrations' database requirements and facilitate the exchange of information between administrations and with the Radiocommunication Bureau;

k) that administrations have the sovereign right to establish bilateral agreements pertaining to cross-border coordination issues, including the definition of the format for the mutual exchange of information;

l) that administrations recognize the importance and requirement of electronic submission of notices for terrestrial services to the Radiocommunication Bureau,

further considering

a) that the use of an electronic format for the submission of notices for terrestrial services to the Radiocommunication Bureau tends to reduce its costs and allows a better publication of data;

b) that the Radiocommunication Bureau makes available free of charge to administrations terrestrial notification software (TerRaNotices) through the distribution of its BR International Frequency Information Circular (BR IFIC) for terrestrial services;

c) that in its Resolution 9 (Rev. Dubai, 2014), on the participation of countries, particularly developing countries, in spectrum management, the World Telecommunication Development Conference 2014 (WTDC-14) recognizes the importance of facilitating access to radiocommunication-related documentation in order to facilitate the task of radio-frequency spectrum managers;

d) that in its Decision 12 (Rev. Busan, 2014), on free online access to ITU publications, the Plenipotentiary Conference instructed the Secretary-General of ITU to prepare a report on an ongoing basis on sales of ITU software and databases, and to present this report to the Council, which will decide on further policies for improving access to ITU publications, software and databases;

e) that an automated spectrum management system would, among other things, facilitate national spectrum management and monitoring, coordination among administrations and notification to the Radiocommunication Bureau;

f) that Recommendation ITU-R SM.1370 provides design guidelines for developing automated spectrum management systems at the national level;

g) that data elements used in national spectrum management for international coordination and notification have been reflected in Appendix **4** of the Radio Regulations and in Recommendation ITU-R SM.1413;

h) that the Radiocommunication Advisory Group has established a task group to review the Radiocommunication Bureau's information systems used for the submission and treatment of notices for terrestrial and space services;

i) the difficulty faced by many countries, particularly developing and least-developed countries, in participating in the activities of ITU-R world radiocommunication seminars and study group meetings dealing with terrestrial services,

resolves

1 that administrations are encouraged to accelerate migration to the use of an electronic format and electronic facilities for the submission of notices to the Bureau and for the exchange of coordination data between administrations;

2 that the format established by ITU-R for electronic notices be considered by administrations for the exchange of information,

instructs the Director of the Radiocommunication Bureau

1 to refine, as required, the specification of the electronic format and related software to be used for the submission of notices for terrestrial services;

2 to provide assistance, as required, to any administration in the use of the electronic format for the submission of notices for terrestrial services;

3 to support developing and least-developed countries while deploying electronic facilities for the submission of electronic notices to the Bureau and for the exchange of coordination data between administrations;

4 to include in radiocommunication seminars and regional workshops appropriate training in the use of the electronic format and related software for the submission of notices for terrestrial services.

RESOLUTION 910 (WRC-23)

[Studies on the possible [frequency bands] for [non-beam and beam] wireless power transmission (WPT) to avoid harmful interference to the radiocommunication services caused by WPT][1]

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that wireless power transmission (WPT) is defined as the transmission of power from a power source to an electrical load wirelessly using an electromagnetic field, excluding transmission for radiocommunications;

b) that a wide variety of technologies and applications of WPT are evolving, planned, or have already been partly put on the market;

c) that such [beam and non-beam] WPT technologies may be useful in a variety of applications, including electric vehicles, Internet of Things (IoT) devices, and wireless charging of mobile or portable devices,

noting

a) that ITU Radiocommunication Sector (ITU-R) Study Group 1 is studying, based on Question ITU-R 210/1, the technical and operational requirements to ensure that radiocommunication services are protected from harmful interference caused by WPT operations, and what kind of applications and electric apparatus WPT are considered to be;

b) that ITU-R Recommendations on frequency ranges for WPT (Recommendations ITU-R SM.2110, ITU-R SM.2129, and ITU-R SM.2151) have been approved, and further studies on a variety of WPT applications and technologies are ongoing in ITU-R;

c) that, according to Nos. **15.12.1** and **15.13.1**, in order to provide protection to radiocommunication services called for in *recognizing c)* administrations should be guided by the latest relevant ITU-R Recommendations;

d) that ITU-R Recommendations provide guidance to administrations,

recognizing

a) that WPT is not a defined radio service in the Radio Regulations;

b) that there are no international regulations to regulate radiation from WPT;

[1] Further discussion is needed on the scope of this agenda item.

c) that, under Nos. **15.12** and **15.13**, administrations shall take all practicable and necessary steps to ensure that the operation of electrical apparatus or installations, including those for WPT, does not cause harmful interference to a radiocommunication service and, in particular, to a radionavigation or any other safety service;

d) that some administrations regard WPT as an industrial, scientific and medical (ISM) application defined by the Radio Regulations, and that they apply their current regulations to the ISM applications and equipment;

e) that some administrations regard WPT equipment as short-range radiocommunication Devices (SRD), and that they apply their current SRD regulations, although SRD is not defined by the Radio Regulations, but it is discussed in some ITU-R Recommendations and Reports;

f) that, in order not to cause harmful interference to the radiocommunication services, some administrations classify certain applications of WPT as a radio service that is not defined in the Radio Regulations,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2031 world radiocommunication conference

1 technical, operational and impact studies, taking into account the results of already available studies, to consider suitable frequency ranges for harmonized WPT operations;

2 consideration of spectrum matters necessary to ensure the protection of radiocommunication services and the radio astronomy service to which the frequency bands are allocated on a primary and secondary basis, as well as services in the adjacent bands, and those affected by the harmonics,

invites Member States, Sector Members, Academia, and Associates

to participate in the studies by submitting contributions to ITU-R,

invites the 2031 world radiocommunication conference

to consider, based on the results of ITU-R studies, the possible frequency bands for WPT on the basis of avoiding harmful interference to the radiocommunication services caused by WPT.

RECOMMENDATIONS

RECOMMENDATION 7 (REV.WRC-97)

Adoption of standard forms for ship station and ship earth station licences and aircraft station and aircraft earth station licences[1]

The World Radiocommunication Conference (Geneva, 1997),

considering

a) that the standardization of the licence forms issued to stations installed on board ships and aircraft making international voyages and flights would greatly facilitate the task of inspection of such stations;

b) that standard licence forms for ship stations and for aircraft stations would serve as a useful guide to those administrations desiring to improve their existing national licences;

c) that standard licence forms could be advantageously used by these administrations as the form of certification specified in No. **18.8**,

considering further

that the Administrative Radio Conference (Geneva, 1959), formulated:

a) a set of principles for the draft of a standard licence form (see Annex 1);

b) specimens of a ship station licence and of an aircraft station licence (see Annexes 2 and 3),

considering also

changes in radio systems and shipborne radiocommunication equipment introduced in connection with the implementation of the Global Maritime Distress and Safety System (GMDSS),

recommends

1 that administrations which find these forms practicable and acceptable should adopt them for international use;

2 that administrations should, as far as possible, endeavour to bring their national licence forms into line with these standard forms.

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[1] Throughout this Recommendation, references to ship stations may include references to ship earth stations and references to aircraft stations may include references to aircraft earth stations.

ANNEX 1 TO RECOMMENDATION 7 (REV.WRC-97)

Principles for the formulation of standard ship and aircraft station licences

The Administrative Radio Conference (Geneva, 1959), considered that, in formulating standard ship and aircraft station licences, the following set of principles should be applied:

1 The licence should, as far as possible, be prepared in tabular form, and each line and column of the table clearly numbered or lettered.

2 The licence for ship stations and the licences for aircraft stations should be as similar as possible.

3 The size of the licence should be international standard A4.

4 The licence should be designed in a form which facilitates its display on board a ship or an aircraft.

5 The licence should be printed in Latin characters in the national language of the country which issues it. Those countries whose national language cannot be written in Latin characters should use their national language and, in addition, English, Spanish or French.

6 The title “Ship Station Licence” or “Aircraft Station Licence” should appear at the top of the licence in the national language as well as in English, Spanish and French.

These principles were used in formulating the two standard forms which are given in Annexes 2 and 3.

ANNEX 2 TO RECOMMENDATION 7 (REV.WRC-97)

(Full name of the authority issuing the licence, in the national language)

.....*

SHIP STATION LICENCE
LICENCE DE STATION DE NAVIRE
LICENCIA DE ESTACIÓN DE BARCO

No. .....
Period of validity .....

In accordance with (*Title of the National Regulation*) and with the Radio Regulations which complement the Constitution and the Convention of the International Telecommunication Union now in force, this authorization is herewith issued for the installation and for the use of the radio equipment described below:

1	2			3	4
Name of ship	**Identification of the ship station**			Holder of licence	Accounting authority identification code, or additional information including accounting information if required
	Call sign	MMSI	Other identification *(optional)*		

	Equipment	Type or description of equipment	Frequencies
5	Transmitters		**
6	Other equipment *(optional)*		

For the Issuing Authority:

.....

Place Date Authentication

* The words "Ship Station Licence" written in the national language, if this is not English, Spanish or French.

** Specifically or by reference to List V, columns 8 and 9.

ANNEX 3 TO RECOMMENDATION 7 (REV.WRC-97)

(Full name of the authority issuing the licence, in the national language)

.....*

AIRCRAFT STATION LICENCE
LICENCE DE STATION D'AÉRONEF
LICENCIA DE ESTACIÓN DE AERONAVE

No. .....
Period of validity .....

In accordance with *(Title of the National Regulation)* and with the Radio Regulations which complement the Constitution and the Convention of the International Telecommunication Union now in force, this authorization is herewith issued for the installation and for the use of the radio equipment described below:

1	2	3	4
Nationality and registration mark of the aircraft	Call sign or other identification	Type of aircraft	Owner of aircraft

		a	b	c	d
	Equipment	**Type**	**Power (W)**	**Class of emission**	**Frequency bands or assigned frequencies**
5	Transmitters				**
6	Survival craft transmitters *(when applicable)*				**
7	Other equipment	*(Optional)*			

For the Issuing Authority:

.....

Place Date Authentication

* The words "Aircraft Station Licence" written in the national language, if this is not English, Spanish or French.

** Specifically or by reference.

RECOMMENDATION 8

Relating to automatic identification of stations

The World Administrative Radio Conference (Geneva, 1979),

considering

a) Article **19** which allows, where practicable, automatic identification of stations in appropriate services, and under certain circumstances;

b) that it is not always feasible or convenient to give manual identification;

c) that sources of harmful interference often remain unidentified for long periods, with consequential delay in measures that might be taken to minimize the interference;

d) that automatic identification procedures, where appropriate, may help overcome some of the disadvantages of manual identification;

e) that automatic transmission of a call sign or other signals may provide a means of identifying some stations for which identification is not always possible, e.g. radio relay and space systems;

f) the desirability of fostering a common automatic identification method to facilitate effective implementation of the provisions of Article **19**, as an alternative to the proliferation of many different systems and modulation techniques that might be used for this purpose,

recommends

that the ITU-R study the matter of automatic identification of stations with a view to recommending technical characteristics and methods of implementing a common universal system, including standard modulation techniques, for application in accordance with Article **19**, with due consideration to the needs of the different services and types of stations.

RECOMMENDATION 9

Relating to the measures to be taken to prevent the operation of broadcasting stations on board ships or aircraft outside national territories[1]

The World Administrative Radio Conference (Geneva, 1979),

considering

a) that the operation of broadcasting stations on board ships or aircraft outside national territories is in conflict with the provisions of Nos. **23.2** and **42.4**;

b) that such operation is contrary to the orderly use of the radio-frequency spectrum and may result in chaotic conditions;

c) that the operation of such broadcasting stations may take place outside the jurisdiction of Member States, thereby making the direct application of national laws difficult;

d) that a particularly difficult legal situation arises when such broadcasting stations are operated on board ships or aircraft not duly registered in any country,

recommends

1 that administrations ask their governments to study possible means, direct or indirect, to prevent or suspend such operations and, where appropriate, take the necessary action;

2 that administrations inform the Secretary-General of the results of these studies and submit any other information which may be of general interest, so that the Secretary-General can inform Member States accordingly.

[1] WRC-97 made editorial amendments to this Recommendation.

RECOMMENDATION 16 (REV.WRC-19)

Interference management for stations that may operate under more than one terrestrial radiocommunication service

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that radiocommunication services and spectrum allocation aim at achieving international uniformity in spectrum usage in order to simplify interference management rules and promote equitable spectrum access;

b) that the principles behind radiocommunication services and spectrum allocation have been adopted since the first Radio Telegraph Conference of Berlin in 1906, where frequency bands were allocated to the maritime service;

c) that technological, market and regulatory developments are resulting in significant changes to the radiocommunication environment, especially in bands below 6 GHz;

d) that these changes to the radiocommunication environment, and in particular the convergence of services, will make the classification of certain radio stations under existing radiocommunication services increasingly difficult;

e) that the issues raised by the convergence of services may not always be addressed through the redefinition of radiocommunication services;

f) that previous world radiocommunication conferences (WRCs) have considered the possibility of enhancing the international spectrum regulatory framework in the light of the changing radiocommunication environment;

g) that ITU-R studies to enhance the international spectrum management framework have so far been carried out under the traditional framework of radiocommunication services and spectrum allocation only;

h) that administrations have adopted, or are in the process of adopting, approaches to spectrum management on a national basis that are not based on the above traditional framework, with a view to improving flexibility and to catering for the changing radiocommunication environment;

i) that in order to obtain the required degree of flexibility at national level while not causing harmful interference at international level, these administrations may use No. **4.4** of the Radio Regulations;

j) that through the application of No. **4.4**, administrations having adopted national spectrum management that is not based on the above traditional framework and that is in derogation of the Table of Frequency Allocations and of the provisions of the Radio Regulations cannot claim protection for their radio stations from cross-border harmful interference, or cause harmful interference to stations operated in conformance with the Radio Regulations by other administrations,

recognizing

a) that improvement of the international spectrum management framework is a continuous process;

b) that Article 42 of the Constitution provides that administrations reserve for themselves the right to make special arrangements on telecommunications matters which do not concern Member States in general, so far as this is not in conflict with the provisions of the Constitution, the Convention or the Administrative Regulations, so far as concerns harmful interference which their operation might cause to the radio operations of other Member States,

recommends

that ITU-R study all aspects of interference management resulting from the impact of technical convergence on the radio regulatory environment, involving stations that may operate under more than one terrestrial radiocommunication service, particularly cross-border interference cases, to ensure harmful interference is not caused to stations of other Member States,

invites administrations

to participate actively in the studies by submitting contributions to ITU-R.

RECOMMENDATION 34 (REV.WRC-23)

Principles for the allocation of frequency bands

The World Radiocommunication Conference (Dubai,2023),

considering

a) that the Radio Regulations contain an international Table of Frequency Allocations covering the radio-frequency spectrum;

b) that it may be desirable, in certain cases, to allocate frequency bands to the most broadly defined services of Article **1** in order to improve flexibility of use but without detriment to other services;

c) that the development of common worldwide allocations is desirable in order to improve and harmonize utilization of the radio-frequency spectrum;

d) that adherence to these principles for the allocation of spectrum will allow the Table of Frequency Allocations to focus on matters of regulatory significance while enabling greater flexibility in national spectrum use;

e) that technological developments occur at a rapid pace and administrations desire to take advantage of such developments to increase spectrum efficiency and facilitate spectrum access;

f) that the needs of developing countries need to be taken into account;

g) that Recommendation ITU-R SM.1133 provides a guide to the use of broadly-defined services;

h) that radiocommunications play a significant role in achieving national, as well as regional and global, priorities, including those found in relevant resolutions of plenipotentiary conferences and world radiocommunication conferences (WRCs),

recognizing

that Resolution **26 (Rev.WRC-23)** provides guidelines for the use of footnotes, including additions, modifications or deletions,

recommends that future world radiocommunication conferences

1 should, wherever possible, allocate frequency bands to the most broadly defined services with a view to providing the maximum flexibility to administrations in spectrum use, taking into account safety, technical, operational, economic and other relevant factors;

2 should, wherever possible, allocate frequency bands on a worldwide basis (aligned services, categories of service and frequency band limits) taking into account safety, technical, operational, economic and other relevant factors;

3 should, wherever possible, keep the number of footnotes in Article **5** to a minimum when allocating frequency bands through footnotes, in line with Resolution **26 (Rev.WRC-23)**;

4 should take into account relevant studies by the ITU Radiocommunication Sector (ITU-R) and report(s) of the relevant Conference Preparatory Meeting(s) (CPM), as appropriate, considering also contributions by members, including technical and operational developments, forecasts and usages as per the agenda of the WRC,

recommends administrations

in making proposals to world radiocommunication conferences, to take into account *recommends that future world radiocommunication conferences* 1 to 4 and *considering a)* to *g)*,

invites administrations

to actively participate in ITU-R studies, providing their technical and operational developments, forecasts and usages,

instructs the Director of the Radiocommunication Bureau and requests the ITU Radiocommunication Sector study groups

1 when carrying out technical studies relating to a frequency band, to examine the compatibility of broadly defined services with the existing utilizations and the possibility of aligning allocations on a worldwide basis, having regard to *considering a)* to *g)* and *recommends that future world radiocommunication conferences* 1 to 4 above;

2 to conduct the studies with the participation of the International Civil Aviation Organization (ICAO), the International Maritime Organization (IMO), the World Meteorological Organization (WMO) and other international organizations concerned, where appropriate;

3 to submit a report to future world radiocommunication conferences containing the results of these studies,

invites the ITU Radiocommunication Sector

to identify areas for study and to undertake the studies necessary to determine the impact on existing services of those agenda items of future world radiocommunication conferences which involve broadening the scope of existing service allocations,

instructs the Secretary-General

to communicate this Recommendation to ICAO, IMO, WMO and other international organizations concerned, where appropriate,

invites the Director of the Radiocommunication Bureau

to bring this Recommendation to the attention of the ITU Telecommunication Standardization and Telecommunication Development Sectors.

RECOMMENDATION 36 (REV.WRC-19)

Role of international monitoring in reducing apparent congestion in the use of orbit and spectrum resources

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that the geostationary-satellite orbit and the radio-frequency spectrum are limited natural resources and are being increasingly utilized by space services;

b) the desirability of achieving a more effective use of the geostationary-satellite orbit and radio-frequency spectrum in order to assist administrations in satisfying their requirements and, to that end, the desirability of taking steps to make the Master International Frequency Register reflect more accurately the actual use being made of these resources;

c) that monitoring information should assist ITU-R in discharging this function;

d) that facilities for monitoring of emissions originating from space stations are expensive,

recognizing

that an international monitoring system cannot be fully effective unless it covers all areas of the world,

invites ITU-R

to study and make recommendations concerning the facilities required to provide adequate coverage of the world with a view to ensuring efficient use of resources,

invites administrations

1 to make every effort to provide monitoring facilities as envisaged in Article **16**;

2 to inform ITU-R of the extent to which they are prepared to cooperate in such monitoring programmes as may be requested by ITU-R;

3 to consider the various aspects of monitoring emissions originating from space stations to enable the provisions of Articles **21** and **22** to be applied.

RECOMMENDATION 37 (REV.WRC-23)

Operational procedures for earth stations on board vessels (ESVs) use

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that under the provisions of Resolution **902 (Rev.WRC-23)** transmissions from ESVs within the distances defined in item 4 of Annex 1 of Resolution **902 (Rev.WRC-23)** should be based upon prior agreement of concerned administrations;

b) that it is desirable to provide guidance on activities to achieve such prior agreement with concerned administrations;

c) that such guidance should include the operational procedures for ESV use,

recommends

that operation of ESVs follow the procedures set forth in the Annex.

ANNEX 1 TO RECOMMENDATION 37 (REV.WRC-23)

Operational procedures for earth stations on board vessels (ESV) use

A Initiation of contact

The ESV licensing administration or the licence-holder should contact, in advance of ESV operations within the minimum distances, the concerned administration(s) to obtain agreements that will establish the technical bases for avoiding unacceptable interference to the terrestrial facilities of the concerned administration or administrations.

The minimum distances and concerned administrations are defined in items 4 and 5 of Annex 1 of Resolution **902 (Rev.WRC-23)**, respectively.

B Recommended actions of licensing administrations, licence-holders and concerned administrations

– The licensing administration or the licence-holder should provide the technical and operational parameters required by the concerned administration, among them, if required, information on the movement of the ship(s) equipped with ESVs within the minimum distances.

– Concerned administrations that wish to permit the operation of ESVs should determine if they have terrestrial stations that could be affected by ESV operations with a view to identifying possible frequencies for ESV use that would avoid potential interference.

C Frequency use arrangements

National practices, as well as applicable Recommendations of ITU-R (such as ITU-R S.1587, ITU-R SF.1585, ITU-R SF.1648, ITU-R SF.1649, ITU-R SF.1650), may be used in reaching frequency usage arrangements.

D Avoidance of unacceptable interference

According to Annex 1 of Resolution **902 (Rev.WRC-23)** the ESV licensing administration shall ensure that such stations do not cause unacceptable interference to the services of other concerned administrations. In the event that unacceptable interference occurs, the licence-holder must eliminate the source of any interference from its station immediately upon being advised of such interference. Additionally, the licence-holder shall immediately terminate transmissions at the request of either the concerned administration or the ESV licensing administration if either administration determines that the ESV is causing unacceptable interference or is otherwise not being operated in compliance with the operating agreement.

RECOMMENDATION 63 (REV.WRC-19)

Relating to the provision of formulae and examples for the calculation of necessary bandwidths

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that Appendix **1**, Section I requires that the necessary bandwidth be part of the full designation of emissions;

b) that Recommendation ITU-R SM.1138, gives a partial list of examples and formulae for the calculation of the necessary bandwidth of some typical emissions;

c) that sufficient information is not available for the determination of the *K*-factors used throughout the table of examples of the necessary bandwidth in Recommendation ITU-R SM.1138;

d) that, especially with regard to the efficient utilization of the radio-frequency spectrum, monitoring and the notification of emissions, it is required that necessary bandwidths for the individual classes of emission be known;

e) that for reasons of simplification and international uniformity it is desirable that measurements for determining the necessary bandwidth be made as seldom as possible,

recommends that ITU-R

1 provide, from time to time, additional formulae for the determination of necessary bandwidth for common classes of emission, as well as examples to supplement those given in Recommendation ITU-R SM.1138;

2 study and provide values of supplementary *K*-factors required for the calculation of the necessary bandwidth for common classes of emission,

invites the Radiocommunication Bureau

to publish examples of such calculations in the Preface to the International Frequency Information Circular (BR IFIC).

RECOMMENDATION 71

Relating to the standardization of the technical and operational characteristics of radio equipment[1]

The World Administrative Radio Conference (Geneva, 1979),

considering

a) that administrations are confronted with the necessity of allocating increasing resources to the regulation of radio equipment performance;

b) that administrations, and in particular those in developing countries, often have difficulty in providing such resources;

c) that it would be of advantage to apply, as far as practicable, any mutually agreed standards and associated type approvals;

d) that a number of international bodies including the ITU-R, International Civil Aviation Organization (ICAO), International Maritime Organization (IMO), International Special Committee on Radio Interference (CISPR) and the International Electrotechnical Commission (IEC) already provide recommendations and standards for technical and operating characteristics applicable to equipment performance and its measurement;

e) that in this context the specific requirements of developing countries have not always been taken fully into account,

recommends

1 that administrations endeavour to cooperate with a view to establishing international performance specifications and associated measuring methods that could be used as models for domestic standards for radio equipment;

2 that such international performance specifications and associated measuring methods respond to widely representative conditions including specific requirements of developing countries;

3 that, when such international performance specifications for radio equipment exist, administrations, as far as practicable, adopt these specifications as a basis for their national standards;

4 that administrations consider as far as practicable mutual acceptance for the type approval of equipment which conforms to such performance specifications.

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[1] WRC-97 made editorial amendments to this Recommendation.

RECOMMENDATION 75 (REV.WRC-15)

Study of the boundary between the out-of-band and spurious domains of primary radars using magnetrons

The World Radiocommunication Conference (Geneva, 2015),

considering

a) that the principal objective of Appendix **3** is to specify the maximum permitted level of unwanted emissions in the spurious domain;

b) that the out-of-band and spurious domains of an emission are defined in Article **1**;

c) that Recommendation ITU-R SM.1541 specifies the boundary between the out-of-band and spurious domains for primary radars, and that the boundary is related to the emission mask based on the −40 dB bandwidth;

d) that Appendix **3** refers to Recommendation ITU-R SM.1541;

e) that Recommendation ITU-R M.1177 describes the techniques for measurement of unwanted emissions of radars,

recognizing

that there is a possibility that calculated values for the −40 dB bandwidth related to unwanted emissions of primary radars using magnetrons underestimate the actual bandwidth,

recommends

that ITU-R study calculation methods for the −40 dB bandwidth necessary for the determination of the boundary between the spurious and out-of-band domains of primary radars using magnetrons,

invites administrations

to participate actively in the above studies by submitting contributions to ITU-R.

RECOMMENDATION 76 (WRC-12)

Deployment and use of cognitive radio systems

The World Radiocommunication Conference (Geneva, 2012),

considering

a) that a cognitive radio system (CRS) is defined as *a radio system employing technology that allows the system to obtain knowledge of its operational and geographical environment, established policies and its internal state; to dynamically and autonomously adjust its operational parameters and protocols according to its obtained knowledge in order to achieve predefined objectives; and to learn from the results obtained* (Report ITU-R SM.2152);

b) that a method of spectrum management to be used for aiding frequency assignment for terrestrial services in border areas can be found in Recommendation ITU-R SM.1049;

c) that ITU-R is studying the implementation and use of CRS in accordance with Resolution ITU-R 58;

d) that studies on regulatory measures related to the implementation of CRS are outside the scope of Resolution ITU-R 58;

e) that there are plans to deploy CRS in some radiocommunication services,

recognizing

a) that any radio system implementing CRS technology needs to operate in accordance with the provisions of the Radio Regulations;

b) that the use of CRS does not exempt administrations from their obligations with regard to the protection of stations of other administrations operating in accordance with the Radio Regulations;

c) that CRSs are expected to provide flexibility and improved efficiency to overall spectrum use,

recommends

that administrations participate actively in the ITU-R studies conducted under Resolution ITU-R 58, taking into account *recognizing a)* and *b)*.

RECOMMENDATION 100 (REV.WRC-03)

Preferred frequency bands for systems using tropospheric scatter

The World Radiocommunication Conference (Geneva, 2003),

considering

a) the technical and operational difficulties pointed out by Recommendation ITU-R F.698 in the frequency bands shared by tropospheric scatter systems, space systems and other terrestrial systems;

b) the additional allocation of frequency bands made by WARC-79 and WARC-92 for the space services in view of their increasing development;

c) that the Radiocommunication Bureau requires administrations to supply specific information on systems using tropospheric scatter in order to verify compliance with certain provisions of the Radio Regulations (such as Nos. **5.410** and **21.16.3**),

recognizing nevertheless

that, to meet certain telecommunication requirements, administrations will wish to continue using tropospheric scatter systems,

noting

that the proliferation of such systems in all frequency bands and particularly in those shared with space systems is bound to aggravate an already difficult situation,

recommends that administrations

1 for the assignment of frequencies to new stations in systems using tropospheric scatter, take into account the latest information prepared by ITU-R to ensure that systems established in the future use a limited number of certain frequency bands;

2 in frequency assignment notifications to the Bureau, indicate expressly whether they relate to stations of tropospheric scatter systems.

RECOMMENDATION 206 (REV.WRC-23)

Studies on the possible use of integrated mobile-satellite service and ground component systems in the frequency bands 1 525-1 544 MHz, 1 545-1 559 MHz, 1 626.5-1 645.5 MHz and 1 646.5-1 660.5 MHz

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that mobile-satellite service (MSS) systems may provide service to a wide area;

b) that integrated MSS systems employ a satellite component and a ground component where the ground component is complementary to the satellite component and operates as, and is, an integral part of the MSS system. In such systems, the ground component is controlled by the satellite resource and network management system. Further, the ground component uses the same portions of MSS frequency bands as the associated operational mobile-satellite system;

c) that MSS systems have a limited capacity for providing reliable radiocommunication services in urban areas on account of natural or man-made obstacles and that the ground component of an integrated MSS system can mitigate blockage areas, as well as allow for indoor service coverage;

d) that MSS systems can improve coverage of rural areas, thus being one element that can bridge the digital divide in terms of geography;

e) that MSS systems are suitable for public protection and disaster relief communications, as stated in Resolution **646 (Rev.WRC-19)**;

f) that the frequency bands 1 525-1 544 MHz, 1 545-1 559 MHz, 1 626.5-1 645.5 MHz and 1 646.5-1 660.5 MHz are allocated on a primary basis to the mobile-satellite service and to other services but that none of these bands are allocated to the mobile service on a primary basis except by country footnote;

g) that within their territories in some of the frequency bands identified in *considering f)*, some administrations have authorized or plan to authorize integrated MSS systems;

h) that ITU-R has performed frequency sharing studies and has determined that the coexistence between independent systems in the MSS and systems in the mobile services in the same spectrum without harmful interference is not feasible in the same or adjacent geographical area,

recognizing

a) that ITU-R has not performed studies on sharing, technical or regulatory issues with regard to integrated MSS systems, but that some administrations have performed such studies;

b) that the radionavigation-satellite service in the 1 559-1 610 MHz band and the radio astronomy service in the frequency bands 1 610.6-1 613.8 MHz and 1 660-1 670 MHz need to be protected from harmful interference;

c) that the MSS in the 1 525-1 559 MHz and 1 626.5-1 660.5 MHz bands needs to be protected from harmful interference that may be caused due to co-channel and/or adjacent channel operation of the ground component of integrated MSS systems;

d) that Nos. **5.353A** and **5.357A** are applicable to MSS systems in different portions of the frequency bands 1 525-1 559 MHz and 1 626.5-1 660.5 MHz with respect to the spectrum requirements and prioritization of communications for the Global Maritime Distress and Safety System and the aeronautical mobile-satellite (R) service;

e) that, subject to satisfactory measures being taken to protect RNSS systems, integrated MSS systems may be deployed in the 1 980-2 010 MHz, 2 170-2 200 MHz, 2 483.5-2 500 MHz bands in all three Regions and also in the 2 010-2 025 MHz band in Region 2, all of which bands are allocated both to the MSS and MS services, without the need for ITU-R studies,

noting

a) that the combined wide-area and urban coverage capabilities of integrated MSS systems may contribute to meeting the particular needs of developing countries;

b) that some administrations that are planning to implement or are implementing integrated systems within their national territories have imposed limitations, in rules and authorization actions, on the e.i.r.p. density that the ground component of such systems may produce into bands allocated to the radionavigation-satellite service;

c) that there are a limited number of frequency bands allocated to the MSS, that these bands are already congested, and that the introduction of integrated ground components may in some instances make spectrum access for other MSS systems more difficult;

d) that administrations implementing integrated MSS systems may provide, in bilateral consultations of administrations, information on system characteristics of the ground component,

recommends

to invite ITU-R to conduct studies on the possible use of integrated MSS systems in the frequency bands 1 525-1 544 MHz, 1 545-1 559 MHz, 1 626.5-1 645.5 MHz and 1 646.5-1 660.5 MHz, as appropriate, taking into account the need to protect existing and planned systems, as well as the above *considering*, *recognizing* and *noting*, and in particular *recognizing a)*, *b)* and *c)*,

invites administrations

to participate as necessary in the ITU-R studies taking into account *recognizing a)*.

RECOMMENDATION 207 (REV.WRC-19)

Future IMT systems

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that the future development of IMT is being studied by ITU-R in accordance with Recommendations ITU-R M.1645 and ITU-R M.2083, and further Recommendations are to be developed for IMT;

b) that the future development of IMT for 2020 and beyond is foreseen to address the need for higher data rates, corresponding to user needs, as appropriate, than those of currently deployed IMT systems;

c) the need to define the requirements associated with ongoing enhancement of future IMT systems,

noting

a) the ongoing relevant studies by ITU-R on IMT-2020, in particular the outputs from Question ITU-R 229/5;

b) the need to take into consideration requirements of applications of other services,

recommends

to invite ITU-R to study as necessary technical, operational and spectrum related issues to meet the objectives of future development of IMT systems.

RECOMMENDATION 208 (WRC-19)

Harmonization of frequency bands for evolving Intelligent Transport Systems applications under mobile-service allocations

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that information and communication technologies are integrated in a vehicle system to provide evolving Intelligent Transport Systems (ITS) communication applications for the purpose of improving traffic management and assisting safer driving;

b) that there is a need for consideration of spectrum harmonization for evolving ITS applications, which are being used globally or regionally;

c) that there is a need to integrate various technologies, including radiocommunications, into land transportation systems;

d) that many new connected vehicles use intelligent technologies in the vehicles' combined advanced traffic-management, advanced traveller-information, advanced public transportation-management and/or advanced fleet-management systems to improve traffic management;

e) that future vehicular radiocommunication technologies and ITS broadcast systems are emerging;

f) that some frequency bands harmonized for ITS are also allocated to the fixed-satellite service (FSS) (Earth-to-space), which under certain circumstances may cause potential interference to ITS stations while in close proximity,

recognizing

a) that harmonized spectrum and international standards facilitate worldwide deployment of evolving ITS radiocommunications and provide for economies of scale in bringing evolving ITS equipment and services to the public;

b) that the use of frequency bands harmonized for evolving ITS, or parts thereof, does not preclude the use of these bands/frequencies by any other application of the services to which they are allocated and does not establish priority in the Radio Regulations;

c) that in those harmonized frequency bands or parts thereof for evolving ITS, there are existing services whose protection needs to be ensured;

d) that evolving ITS also becomes important in helping to reduce road traffic problems such as congestion and accidents;

e) that ITU-R studies on evolving ITS technologies are meant to address road safety and efficiency-related matters,

noting

a) that the ITU-R Recommendations on ITS are Recommendations ITU-R M.1452, M.1453, M.1890, M.2057, M.2084 and M.2121;

b) that the ITU-R Reports on ITS are Reports ITU-R M.2228, M.2322, M.2444 and M.2445;

c) that some administrations have deployed or are considering deployment of radiocommunication local area networks in some frequency bands recommended for evolving ITS,

recommends

1 that administrations consider using globally or regionally harmonized frequency bands, or parts thereof, as described in the most recent versions of Recommendations (e.g. ITU-R M.2121), when planning and deploying evolving ITS applications, taking into account *recognizing b)* above;

2 that administrations take into account, if necessary, coexistence issues between ITS stations and stations of existing services (e.g. FSS earth stations), taking into account *considering f)*,

invites Member States and Sector Members

to participate actively in and to contribute to ITU-R studies on aspects of ITS and evolving ITS (e.g. connected vehicles, autonomous vehicles, adaptive driver assistance systems), through the ITU-R study groups,

instructs the Secretary-General

to bring this Recommendation to the attention of relevant international and regional organizations, in particular standards development organizations, dealing with ITS.

RECOMMENDATION 316 (REV.WRC-19)

Use of ship earth stations within harbours and other waters under national jurisdiction

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

recognizing

that permitting the use of ship earth stations within harbours and other waters under national jurisdiction belongs to the sovereign right of countries concerned,

recalling

that a number of frequency bands have been allocated to the mobile-satellite service and maritime mobile-satellite service and can be used for maritime-related communications via ship earth stations,

considering

a) that the maritime mobile-satellite service, which is at present in operation worldwide, has improved maritime communications greatly and has contributed much to the safety and efficiency of ship navigation, and that fostering and developing the use of that service in future will contribute further to their improvement;

b) that the maritime mobile-satellite service plays an important role in the Global Maritime Distress and Safety System (GMDSS),

recommends

that all administrations should permit, to the extent possible, ship earth stations to operate within harbours and other waters under national jurisdiction, in the frequency bands used for the GMDSS.

RECOMMENDATION 401

Relating to the efficient use of aeronautical mobile (R) worldwide frequencies

The World Administrative Radio Conference (Geneva, 1979),

considering

that WARC-Aer2 allotted a limited number of worldwide frequencies for exercising control over regularity of flight and for safety of aircraft,

recommends to administrations

1 that the number of HF aeronautical stations on the worldwide channels should be kept to a minimum consistent with the economic and efficient use of frequencies;

2 that, if possible and practicable, one such station should serve aircraft operating agencies in adjacent countries and there should not normally be more than one station per country.

RECOMMENDATION 503 (REV.WRC-19)

High-frequency broadcasting

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) the congestion in the HF broadcasting bands;

b) the extent of co-channel and adjacent-channel interference;

c) that AM reception quality is relatively poor compared with FM broadcast or CD quality;

d) that new digital techniques have enabled significant improvements in reception quality to be obtained in other broadcasting bands;

e) that the introduction of digital modulation systems in the broadcasting bands below 30 MHz has been shown to be feasible using low bit-rate coding;

f) that Resolution **517 (Rev.WRC-19)** invites ITU-R to continue its studies on digital techniques in HF broadcasting, with a view to assisting the development of this technology for future use;

g) that studies on this subject are currently being carried out by ITU-R, with a view to issuing a relevant Recommendation,

recognizing

a) that the implementation of an ITU-recommended worldwide system for digital sound in the HF bands would be extremely beneficial, particularly for developing countries, since it allows for:

– mass-scale production resulting in receivers as economical as possible;

– more economical analogue-to-digital conversion of existing transmitting infrastructures;

b) that the above system would result in digital receivers having a number of advanced features such as assisted tuning, improved audio quality and robustness to co-channel and adjacent-channel interference, which would greatly contribute to a better spectrum utilization,

recommends administrations

1 to draw the attention of manufacturers to this matter, in order to ensure that future digital receivers take full advantage of the advanced technology while maintaining low cost;

2 to encourage manufacturers to monitor closely the development of the studies carried out by ITU-R, with a view to starting mass production of new low-cost digital receivers as soon as possible after the approval of relevant ITU-R Recommendation(s).

RECOMMENDATION 506

Relating to the harmonics of the fundamental frequency of broadcasting-satellite stations[1]

The World Administrative Radio Conference (Geneva, 1979),

considering

a) that the frequency band 23.6-24 GHz is allocated to the radio astronomy service on a primary basis;

b) that the second harmonic of the fundamental frequency of broadcasting-satellite stations operating within the band 11.8-12 GHz may seriously disturb radio astronomy observations in the band 23.6-24 GHz if effective steps are not taken to reduce the level of this harmonic,

in view of

the provisions of No. **3.8**,

recommends

that, when defining the characteristics of their space stations operating in the broadcasting-satellite service, particularly within the band 11.8-12 GHz, administrations take all necessary steps to reduce the level of the second harmonic below the values indicated in the relevant ITU-R Recommendations.

[1] WRC-97 made editorial amendments to this Recommendation.

RECOMMENDATION 520 (WARC-92)

Elimination of HF broadcasting on frequencies outside the HF bands allocated to the broadcasting service

The World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (Malaga-Torremolinos, 1992),

considering

a) that there is an increasing number of HF broadcasting stations operating on frequencies outside the bands allocated to the broadcasting service;

b) that the common use of the HF bands by the broadcasting and other services, without the relevant allocations or detailed regulations, results in inefficient use of the frequency spectrum;

c) that such use has led to harmful interference;

d) that this Conference has allocated additional spectrum to the broadcasting service in the HF bands,

recommends

that administrations shall take practicable steps to eliminate HF broadcasting outside the HF bands allocated to the broadcasting service.

RECOMMENDATION 522 (WRC-97)

Coordination of high-frequency broadcasting schedules in the bands allocated to the broadcasting service between 5 900 kHz and 26 100 kHz

The World Radiocommunication Conference (Geneva, 1997),

considering

a) that Article **12** establishes the principles and the procedure for use of the frequency bands allocated to the HF broadcasting service between 5 900 kHz and 26 100 kHz;

b) that the aforementioned principles stipulate, *inter alia*, that the procedure should promote the development of a voluntary coordination process among administrations to resolve incompatibilities;

c) that the procedure itself encourages administrations to coordinate their schedules with other administrations as far as possible prior to submission;

d) that the development of coordination among administrations with the assistance of the Radiocommunication Bureau, when requested, would result in better use of the spectrum allocated to the HF broadcasting service between 5 900 kHz and 26 100 kHz,

recognizing

a) that the participation of broadcasting organizations in this coordination process would make the task of resolving incompatibilities easier;

b) that multilateral coordination of the use of the HF broadcasting bands is already practised on an informal basis in various regional coordination groups[1],

recommends administrations

to promote, as far as possible, regular coordination of their broadcasting schedules within appropriate regional coordination groups of administrations or broadcasting organizations in order to resolve or reduce incompatibilities, through bilateral or multilateral meetings or by correspondence (telephone, facsimile, e-mail, etc.).

[1] Not related to the ITU Regions.

RECOMMENDATION 608 (REV.WRC-07)

Guidelines for consultation meetings established in Resolution 609 (Rev.WRC-07)

The World Radiocommunication Conference (Geneva, 2007),

considering

a) that in accordance with the Radio Regulations (RR), the band 960-1 215 MHz is allocated on a primary basis to the aeronautical radionavigation service (ARNS) in all the ITU Regions;

b) that WRC-2000 introduced a co-primary allocation for the radionavigation-satellite service (RNSS) in the frequency band 1 164-1 215 MHz (subject to the conditions specified under No. **5.328A**), with a provisional limit on the aggregate power flux-density (pfd) produced by all the space stations within all radionavigation-satellite systems at the Earth's surface of −115 dB(W/m^2) in any 1 MHz band for all angles of arrival;

c) that WRC-03 revised this provisional limit and decided that the level of −121.5 dB(W/m^2) in any 1 MHz for the aggregate equivalent pfd (epfd) applying for all the space stations within all RNSS systems, taking into account the reference worst-case ARNS system antenna characteristics described in Annex 2 of Recommendation ITU-R M.1642-2, is adequate to ensure the protection of the ARNS in the band 1 164-1 215 MHz;

d) that WRC-03 decided that to achieve the objectives in *resolves* 1 and 2 of Resolution **609 (Rev.WRC-07)**, administrations operating or planning to operate RNSS systems will need to agree cooperatively through consultation meetings to achieve the level of protection for ARNS systems, and shall establish mechanisms to ensure that all potential RNSS system operators are given full visibility of the process but that only real systems are taken into account in the calculation of the aggregate epfd,

recommends

1 that in the implementation of *resolves* 5 of Resolution **609 (Rev.WRC-07)**, in the frequency band 1 164-1 215 MHz, the maximum pfd produced at the surface of the Earth by emissions from a space station in the RNSS, for all angles of arrival, should not exceed −129 dB(W/m^2) in any 1 MHz band under free space propagation conditions;

2 that the RNSS characteristics listed in the Annex 1, used when applying the methodology contained in Recommendation ITU-R M.1642-2, as well as the calculated aggregate epfd in dB(W/m^2) in each 1 MHz in the range 1 164-1 215 MHz, should be made available in electronic format by the consultation meetings.

ANNEX 1 TO RECOMMENDATION 608 (REV.WRC-07)

List of RNSS system characteristics and format of the result of the aggregate epfd calculation to be provided to the Radiocommunication Bureau for publication for information

I RNSS systems characteristics

I-1 RNSS ITU publication reference

RNSS network name	Network ID	ITU Publication reference	IFIC
		AR11/A/....	
		API/A/....	
		AR11/C/....	
		CR/C/....	

I-2 Non-GSO satellite system constellation parameters

For each non-GSO satellite system, the following constellation parameters should be provided to the Bureau for publication for information:

N: number of space stations of the non-GSO system

K: number of orbital planes

h: satellite altitude above the Earth (km)

I: inclination angle of the orbital plane above the Equator (degrees).

Satellite index I	RAAN $\Omega_{i,0}$ (degrees)	Argument of latitude $E_{i,0}$ (degrees)
1	...	...
2	...	...
...	...	...
N	...	...

I-3 GSO satellite system longitude

For each GSO satellite network, the satellite longitude should be provided to the Bureau for publication for information, as follows:

$LonGSO_i$: longitude of each of the GSO satellites (degrees).

I-4 Maximum non-GSO space station pfd versus the elevation angle at the Earth's surface (worst 1 MHz)

For the non-GSO satellite system space stations, the maximum pfd in the worst 1 MHz versus elevation angle should be provided to the Bureau for publication for information in a table format as follows:

Elevation angle (each 1°)	**pfd (dB(W/(m^2 · MHz)))**
−4	pfd (−4°)
−3	pfd (−3°)
…	…
…	…
90	pfd (−90°)

I-5 Maximum GSO space station pfd versus latitude and longitude at the Earth's surface (worst 1 MHz)

For each GSO satellite network space station, the maximum pfd in the worst 1 MHz, defined as the 1 MHz in which the pfd of the signal is maximum versus latitude and longitude should be provided to the Bureau for publication for information in a table format as follows:

Longitude (each 1°)	0	1	…	360
Latitude (each 1°)	Maximum pfd dB(W/m^2) in worst 1 MHz			
−90	pfd (0, −90)	…	…	…
−89	…	…	…	…
…	…	…	…	…
…	…	…	…	…
90	…	…	…	pfd (360, 90)

I-6 Spectrum for GSO satellite networks or non-GSO satellite systems

For each GSO satellite network or non-GSO satellite system, the level of spectrum emission in each 1 MHz relative to the spectrum value at the worst 1 MHz of the whole band (1 164-1 215 MHz) should also be provided to the Bureau for publication for information.

II Results of the aggregate epfd calculation in the worst 1 MHz of the 1 164-1 215 MHz band

Maximum aggregate epfd in dB(W/m^2) in the worst-case megahertz in the range 1 164-1 215 MHz.

RECOMMENDATION 622 (WRC-97)

Use of the frequency bands 2 025-2 110 MHz and 2 200-2 290 MHz by the space research, space operation, Earth exploration-satellite, fixed and mobile services

The World Radiocommunication Conference (Geneva, 1997),

considering

a) that the bands 2 025-2 110 MHz and 2 200-2 290 MHz are allocated on a primary basis to the space research, space operation, Earth exploration-satellite, fixed and mobile services;

b) that, in response to Resolutions from the 1992 Conference (WARC-92), studies have resulted in a number of ITU-R Recommendations, which, when adhered to by the services, will result in a stable, long-term sharing environment (Recommendations ITU-R SA.364, ITU-R SA.1019, ITU-R F.1098, ITU-R SA.1154, ITU-R F.1247, ITU-R F.1248, ITU-R SA.1273, ITU-R SA.1274 and ITU-R SA.1275);

c) that this Conference adopted No. **5.391** which states that high-density mobile systems shall not be introduced in these frequency bands,

considering further

that enhancements in technology may enable the services mentioned in *considering a)* to minimize the total bandwidth requirement in these frequency bands,

noting

that WARC-92 considered that it is desirable to review the present and planned use of the frequency bands 2 025-2 110 MHz and 2 200-2 290 MHz, with the intent, where practicable, of satisfying some space mission requirements in bands above 20 GHz,

recognizing

that there are increasing requirements for emerging communication systems which need to be satisfied in the frequency range below 3 GHz,

recommends

that administrations planning to introduce new systems in the space research, space operation, earth exploration-satellite, fixed or mobile services in the bands 2 025-2 110 MHz and 2 200-2 290 MHz take into account the ITU-R Recommendations referred to in *considering b)* above when making assignments to these services, and implement enhancements in technology as early as practicable with a view to minimizing the total bandwidth required by systems of each service.

RECOMMENDATION 707 (REV.WRC-23)

Relating to the use of the frequency band 32.3-33 GHz shared between the inter-satellite service and the radionavigation service

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that the band 32.3-33 GHz is allocated to the inter-satellite service and the radionavigation service;

b) that there are safety aspects associated with the radionavigation service;

c) that No. **5.548** has been incorporated into Article **5**;

d) that Recommendation ITU-R S.1151 provides the criteria for sharing between the inter-satellite service and the radionavigation service at 33 GHz,

recommends

that a future competent world radiocommunication conference consider the result of the ITU-R studies referred to in *considering d)* above with a view to the inclusion of such sharing criteria in Article **21**.

RECOMMENDATION 724 (WRC-07)

Use by civil aviation of frequency allocations on a primary basis to the fixed-satellite service

The World Radiocommunication Conference (Geneva, 2007),

considering

a) that remote and rural areas often still lack a terrestrial communication infrastructure that meets the evolving requirements of modern civil aviation;

b) that the cost of providing and maintaining such an infrastructure could be expensive, particularly in remote regions;

c) that satellite communication systems operating in the fixed-satellite service (FSS) may be the only medium to satisfy the requirements of the International Civil Aviation Organization's (ICAO) communication, navigation, surveillance and air traffic management (CNS/ATM) systems, where an adequate terrestrial communication infrastructure is not available;

d) that the use of VSAT systems, operating in the FSS and being deployed on a large scale in aeronautical communications, has the potential to significantly enhance communications between air traffic control centres as well as with remote aeronautical stations;

e) that establishing and utilizing satellite communication systems for civil aviation would also bring benefits for developing countries and countries with remote and rural areas by enabling the use of VSAT systems for non-aeronautical communications;

f) that in the cases identified in *considering e)* it is necessary to draw attention to the importance of aeronautical communications as opposed to non-aeronautical communications,

noting

a) that the FSS is not a safety service;

b) that Resolution **20 (Rev.WRC-03)** *resolves to instruct the Secretary-General* "to encourage ICAO to continue its assistance to developing countries which are endeavouring to improve their aeronautical telecommunications ...",

recommends

1 that administrations, in particular in developing countries and in countries with remote and rural areas, recognize the importance of VSAT operations to the modernization of civil aviation telecommunications systems and encourage the implementation of VSAT systems that could support both aeronautical and other communication requirements;

2 that administrations in developing countries be encouraged, to the maximum extent possible and as necessary, to expedite the authorization process to enable aeronautical communications using VSAT technology;

3 that arrangements should be made to provide for urgent service restoration or alternative routing in case of a disruption of a VSAT link associated with the aeronautical communications;

4 that administrations implementing VSAT systems in accordance with *recommends* 1 to 3 should do so in satellite networks operating in frequency bands with a primary allocation to the satellite services;

5 to invite ICAO, noting Resolution **20 (Rev.WRC-03)**, to continue its assistance to developing countries to improve their aeronautical telecommunications, including interoperability of VSAT networks, and provide guidance to developing countries on how they could best use VSAT technology for this purpose,

requests the Secretary-General

to bring this Recommendation to the attention of ICAO.

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Radio Regulations

ITU-R Recommendations incorporated by reference

4

Edition of 2024

Radio Regulations

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4

Edition of 2024

Disclaimer

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Note by the Secretariat

This revision of the Radio Regulations, complementing the Constitution and the Convention of the International Telecommunication Union, incorporates the decisions of the World Radiocommunication Conferences of 1995 (WRC-95), 1997 (WRC-97), 2000 (WRC-2000), 2003 (WRC-03), 2007 (WRC-07), 2012 (WRC-12), 2015 (WRC-15), 2019 (WRC-19) and 2023 (WRC-23). The majority of the provisions of these Regulations shall enter into force as from 1 January 2025; the remaining provisions shall apply as from the special dates of application indicated in Article **59** of the revised Radio Regulations.

In preparing the Radio Regulations, Edition of 2024, the Secretariat corrected the typographical errors that were drawn to the attention of WRC-23 and which were approved by WRC-23.

This edition uses the same numbering scheme as the 2001 edition of the Radio Regulations, notably:

With respect to *Article numbers*, this edition follows the standard sequential numbering. The Article numbers are not followed by any abbreviation (such as "(WRC-97)", "(WRC-2000)", "(WRC-03)", "(WRC-07)", "(WRC-12)", "(WRC-15)", "(WRC-19)" or "(WRC-23)"). Consequently, any reference to an Article, in any of the provisions of these Radio Regulations (e.g. in No. **13.1** of Article **13**), in the texts of the Appendices as contained in Volume 2 of this edition (e.g. in § 1 of Appendix **2**), in the texts of the Resolutions included in Volume 3 of this edition (e.g. in Resolution **1 (Rev.WRC-97)**), and in the texts of the Recommendations included in Volume 3 of this edition (e.g. in Recommendation **8**), is considered as a reference to the text of the concerned Article which appears in this edition, unless otherwise specified.

With respect to *provision numbers in Articles*, this edition continues to use composite numbers indicating the number of the Article and the provision number within that Article (e.g. No. 9.2B means provision No. 2B of Article **9**). The abbreviation "(WRC-23)", "(WRC-19)", "(WRC-15)", "(WRC-12)", "(WRC-07)", "(WRC-03)", "(WRC-2000)" or "(WRC-97)" at the end of such a provision means that the relevant provision was modified or added by WRC-23, by WRC-19, by WRC-15, by WRC-12, by WRC-07, by WRC-03, by WRC-2000 or by WRC-97, as applicable. The absence of an abbreviation at the end of the provision means that the provision is identical with the provision of the simplified Radio Regulations as approved by WRC-95, and whose complete text was contained in Document 2 of WRC-97.

With respect to *Appendix numbers*, this edition follows the standard sequential numbering, with the addition of the appropriate abbreviation after the Appendix number (such as "(WRC-97)", "(WRC-2000)", "(WRC-03)", "(WRC-07)", "(WRC-12)", "(WRC-15)", "(WRC-19)" or "(WRC-23)"), where applicable. As a rule, any reference to an Appendix, in any of the provisions of these Radio Regulations, in the texts of the Appendices as contained in Volume 2 of this edition, in the texts of the Resolutions and of the Recommendations included in Volume 3 of this edition, is presented in the standard manner (e.g. "Appendix **30 (Rev.WRC-23)**") if not explicitly described in the text (e.g. Appendix **4** as modified by WRC-23). In the texts of Appendices that were partially modified by WRC-23, the provisions that were modified by WRC-23 are indicated with the abbreviation "(WRC-23)" at the end of the concerned text. If an Appendix is referenced without any abbreviation after the Appendix number, in the texts of this edition (e.g. in No. **13.1**), or without other description, such reference is considered as a reference to the text of the concerned Appendix which appears in this edition.

Within the text of the Radio Regulations, the symbol, ↑, has been used to represent quantities associated with an uplink. Similarly, the symbol, ↓, has been used to represent quantities associated with a downlink.

Abbreviations have generally been used for the names of world administrative radio conferences and world radiocommunication conferences. These abbreviations are shown below.

Abbreviation	Conference
WARC Mar	World Administrative Radio Conference to Deal with Matters Relating to the Maritime Mobile Service (Geneva, 1967)
WARC-71	World Administrative Radio Conference for Space Telecommunications (Geneva, 1971)
WMARC-74	World Maritime Administrative Radio Conference (Geneva, 1974)
WARC SAT-77	World Broadcasting-Satellite Administrative Radio Conference (Geneva, 1977)
WARC-Aer2	World Administrative Radio Conference on the Aeronautical Mobile (R) Service (Geneva, 1978)
WARC-79	World Administrative Radio Conference (Geneva, 1979)
WARC Mob-83	World Administrative Radio Conference for the Mobile Services (Geneva, 1983)
WARC HFBC-84	World Administrative Radio Conference for the Planning of the HF Bands Allocated to the Broadcasting Service (Geneva, 1984)
WARC Orb-85	World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilising It (First Session – Geneva, 1985)
WARC HFBC-87	World Administrative Radio Conference for the Planning of the HF Bands Allocated to the Broadcasting Service (Geneva, 1987)
WARC Mob-87	World Administrative Radio Conference for the Mobile Services (Geneva, 1987)
WARC Orb-88	World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilising It (Second Session – Geneva, 1988)
WARC-92	World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (Malaga-Torremolinos, 1992)
WRC-95	World Radiocommunication Conference (Geneva, 1995)
WRC-97	World Radiocommunication Conference (Geneva, 1997)
WRC-2000	World Radiocommunication Conference (Istanbul, 2000)
WRC-03	World Radiocommunication Conference (Geneva, 2003)
WRC-07	World Radiocommunication Conference (Geneva, 2007)
WRC-12	World Radiocommunication Conference (Geneva, 2012)
WRC-15	World Radiocommunication Conference (Geneva, 2015)
WRC-19	World Radiocommunication Conference (Sharm El-Sheikh, 2019)
WRC-23	World Radiocommunication Conference (Dubai, 2023)
WRC-27	World Radiocommunication Conference, 2027[1]

[1] The date of this conference has not been finalized.

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RECOMMENDATION ITU-R TF.460-6*

Standard-frequency and time-signal emissions

(Question ITU-R 102/7)

(1970-1974-1978-1982-1986-1997-2002)

The ITU Radiocommunication Assembly,

considering

a) that the World Administrative Radio Conference, Geneva, 1979, allocated the frequencies 20 kHz ± 0.05 kHz, 2.5 MHz ± 5 kHz (2.5 MHz ± 2 kHz in Region 1), 5 MHz ± 5 kHz, 10 MHz ± 5 kHz, 15 MHz ± 10 kHz, 20 MHz ± 10 kHz and 25 MHz ± 10 kHz to the standard-frequency and time-signal service;

b) that additional standard frequencies and time signals are emitted in other frequency bands;

c) the provisions of Article 26 of the Radio Regulations;

d) the continuing need for close cooperation between Radiocommunication Study Group 7 and the International Maritime Organization (IMO), the International Civil Aviation Organization (ICAO), the General Conference of Weights and Measures (CGPM), the Bureau International des Poids et Mesures (BIPM), the International Earth Rotation Service (IERS) and the concerned Unions of the International Council of Scientific Unions (ICSU);

e) the desirability of maintaining worldwide coordination of standard-frequency and time-signal emissions;

f) the need to disseminate standard frequencies and time signals in conformity with the second as defined by the 13th General Conference of Weights and Measures (1967);

g) the continuing need to make universal time (UT) immediately available to an uncertainty of one-tenth of a second,

recommends

1 that all standard-frequency and time-signal emissions conform as closely as possible to coordinated universal time (UTC) (see Annex 1); that the time signals should not deviate from UTC by more than 1 ms; that the standard frequencies should not deviate by more than 1 part in 10^{10}, and that the time signals emitted from each transmitting station should bear a known relation to the phase of the carrier;

2 that standard-frequency and time-signal emissions, and other time-signal emissions intended for scientific applications (with the possible exception of those dedicated to special systems) should contain information on UT1 – UTC and TAI – UTC (see Annex 1).

---

* This Recommendation should be brought to the attention of the IMO, the ICAO, the CGPM, the BIPM, the IERS, the International Union of Geodesy and Geophysics (IUGG), the International Union of Radio Science (URSI) and the International Astronomical Union (IAU).

ANNEX 1

Time scales

A Universal time (UT)

Universal time (UT) is the general designation of time scales based on the rotation of the Earth.

In applications in which an imprecision of a few hundredths of a second cannot be tolerated, it is necessary to specify the form of UT which should be used:

UT0 is the mean solar time of the prime meridian obtained from direct astronomical observation;

UT1 is UT0 corrected for the effects of small movements of the Earth relative to the axis of rotation (polar variation);

UT2 is UT1 corrected for the effects of a small seasonal fluctuation in the rate of rotation of the Earth;

UT1 is used in this Recommendation, since it corresponds directly with the angular position of the Earth around its axis of diurnal rotation.

Concise definitions of the above terms and the concepts involved are available in the publications of the IERS (Paris, France).

B International atomic time (TAI)

The international reference scale of atomic time (TAI), based on the second (SI), as realized on the rotating geoid, is formed by the BIPM on the basis of clock data supplied by cooperating establishments. It is in the form of a continuous scale, e.g. in days, hours, minutes and seconds from the origin 1 January 1958 (adopted by the CGPM 1971).

C Coordinated universal time (UTC)

UTC is the time-scale maintained by the BIPM, with assistance from the IERS, which forms the basis of a coordinated dissemination of standard frequencies and time signals. It corresponds exactly in rate with TAI but differs from it by an integer number of seconds.

The UTC scale is adjusted by the insertion or deletion of seconds (positive or negative leap-seconds) to ensure approximate agreement with UT1.

D DUT1

The value of the predicted difference UT1 – UTC, as disseminated with the time signals is denoted DUT1; thus DUT1 ≈ UT1 – UTC. DUT1 may be regarded as a correction to be added to UTC to obtain a better approximation to UT1.

The values of DUT1 are given by the IERS in multiples of 0.1 s.

The following operational rules apply:

1 Tolerances

1.1 The magnitude of DUT1 should not exceed 0.8 s.

1.2 The departure of UTC from UT1 should not exceed ±0.9 s (see Note 1).

1.3 The deviation of (UTC plus DUT1) should not exceed ±0.1 s.

NOTE 1 – The difference between the maximum value of DUT1 and the maximum departure of UTC from UT1 represents the allowable deviation of (UTC + DUT1) from UT1 and is a safeguard for the IERS against unpredictable changes in the rate of rotation of the Earth.

2 Leap-seconds

2.1 A positive or negative leap-second should be the last second of a UTC month, but first preference should be given to the end of December and June, and second preference to the end of March and September.

2.2 A positive leap-second begins at 23h 59m 60s and ends at 0h 0m 0s of the first day of the following month. In the case of a negative leap-second, 23h 59m 58s will be followed one second later by 0h 0m 0s of the first day of the following month (see Annex 3).

2.3 The IERS should decide upon and announce the introduction of a leap-second, such an announcement to be made at least eight weeks in advance.

3 Value of DUT1

3.1 The IERS is requested to decide upon the value of DUT1 and its date of introduction and to circulate this information one month in advance. In exceptional cases of sudden change in the rate of rotation of the Earth, the IERS may issue a correction not later than two weeks in advance of the date of its introduction.

3.2 Administrations and organizations should use the IERS value of DUT1 for standard-frequency and time-signal emissions, and are requested to circulate the information as widely as possible in periodicals, bulletins, etc.

3.3 Where DUT1 is disseminated by code, the code should be in accordance with the following principles (except § 3.4 below):

– the magnitude of DUT1 is specified by the number of emphasized second markers and the sign of DUT1 is specified by the position of the emphasized second markers with respect to the minute marker. The absence of emphasized markers indicates DUT1 = 0;

– the coded information should be emitted after each identified minute if this is compatible with the format of the emission. Alternatively the coded information should be emitted, as an absolute minimum, after each of the first five identified minutes in each hour.

Full details of the code are given in Annex 2.

3.4 DUT1 information primarily designed for, and used with, automatic decoding equipment may follow a different code but should be emitted after each identified minute if this is compatible with the format of the emission. Alternatively, the coded information should be emitted, as an absolute minimum, after each of the first five identified minutes in each hour.

3.5 Other information which may be emitted in that part of the time-signal emission designated in § 3.3 and 3.4 for coded information on DUT1 should be of a sufficiently different format that it will not be confused with DUT1.

3.6 In addition, UT1 – UTC may be given to the same or higher precision by other means, for example, by messages associated with maritime bulletins, weather forecasts, etc.; announcements of forthcoming leap-seconds may also be made by these methods.

3.7 The IERS is requested to continue to publish, in arrears, definitive values of the differences UT1 – UTC and UT2 – UTC.

E DTAI

The value of the difference TAI – UTC, as disseminated with time signals, shall be denoted DTAI. DTAI = TAI – UTC may be regarded as a correction to be added to UTC to obtain TAI.

The TAI – UTC values are published in the BIPM Circular T. The IERS should announce the value of DTAI in integer multiples of one second in the same announcement as the introduction of a leap-second (see § D.2).

ANNEX 2

Code for the transmission of DUT1

A positive value of DUT1 will be indicated by emphasizing a number, n, of consecutive second markers following the minute marker from second marker one to second marker, n, inclusive; n being an integer from 1 to 8 inclusive.

$$\text{DUT1} = (n \times 0.1)\ \text{s}$$

A negative value of DUT1 will be indicated by emphasizing a number, m, of consecutive second markers following the minute marker from second marker nine to second marker $(8 + m)$ inclusive, m being an integer from 1 to 8 inclusive.

$$\text{DUT1} = -(m \times 0.1)\ \text{s}$$

A zero value of DUT1 will be indicated by the absence of emphasized second markers.

The appropriate second markers may be emphasized, for example, by lengthening, doubling, splitting or tone modulation of the normal second markers.

Examples:

FIGURE 1

DUT1 = + 0.5 s

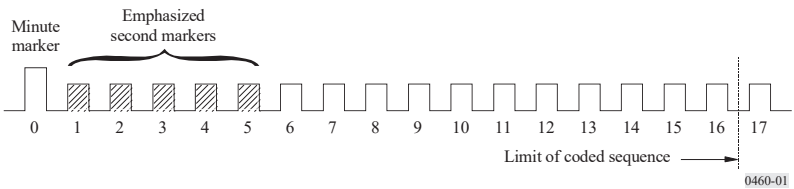
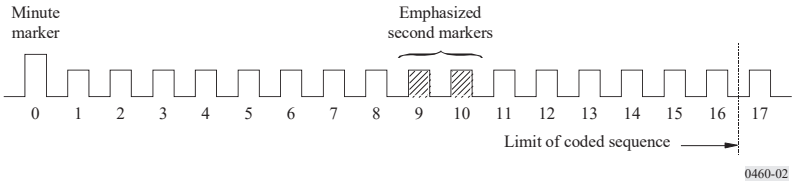


FIGURE 2

DUT1 = – 0.2 s



ANNEX 3

Dating of events in the vicinity of a leap-second

The dating of events in the vicinity of a leap-second shall be effected in the manner indicated in the following Figures:

FIGURE 3

Positive leap-second

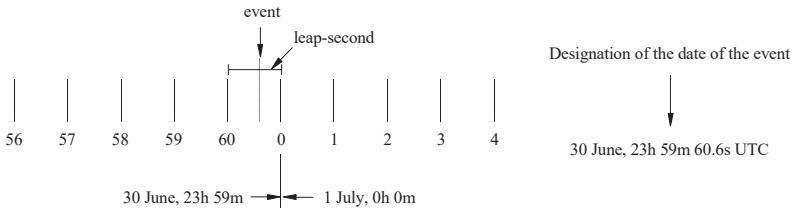
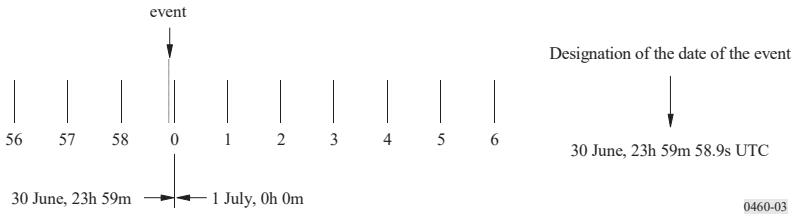


FIGURE 4

Negative leap-second



RECOMMENDATION ITU-R M.489-2*

TECHNICAL CHARACTERISTICS OF VHF RADIOTELEPHONE EQUIPMENT OPERATING IN THE MARITIME MOBILE SERVICE IN CHANNELS SPACED BY 25 kHz

(1974-1978-1995)

Summary

The Recommendation describes the technical characteristics of VHF radiotelephone transmitters and receivers (or transceivers) used in the maritime mobile service when operating in 25 kHz channels of Appendix S18 [Appendix 18] of the Radio Regulations (RR). It also contains those additional characteristics of transceivers required to operate digital selective calling.

The ITU Radiocommunication Assembly,

considering

a) that Resolution No. 308 of the World Administrative Radio Conference (Geneva, 1979) stipulated that:

– all maritime mobile VHF radiotelephone equipment shall conform to 25 kHz standards by 1 January 1983;

b) that RR Appendix S18 [Appendix 18] gives a table of transmitting frequencies which is based upon the principle of 25 kHz channel separations for the maritime mobile service;

c) that in Opinion 42, the International Electrotechnical Commission (IEC) has been invited to advise the ITU Radiocommunication Sector of any methods of measurement applicable to radio equipment used in land mobile services; and that such methods of measurement may also be suitable for radio equipment used in maritime mobile services;

d) that there is a need to specify the technical characteristics of VHF radiotelephone equipment operating in the maritime mobile service in channels spaced by 25 kHz,

recommends

1 that the following characteristics should be met by VHF (metric) FM radiotelephone equipment used for the maritime mobile services operating on the frequencies specified in RR Appendix S18 [Appendix 18].

1.1 General characteristics

1.1.1 The class of emission should be F3E/G3E.

1.1.2 The necessary bandwidth should be 16 kHz.

1.1.3 Only phase modulation (frequency modulation with a pre-emphasis characteristic of 6 dB/octave) should be used.

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* This Recommendation should be brought to the attention of the International Maritime Organization (IMO) and the Telecommunication Standardization Sector (ITU-T).

Note by the Secretariat: The references made to the Radio Regulations (RR) in this Recommendation refer to the RR as revised by the World Radiocommunication Conference 1995. These elements of the RR will come into force on 1 June 1998. Where applicable, the equivalent references in the current RR are also provided in square brackets.

1.1.4 The frequency deviation corresponding to 100% modulation should approach ± 5 kHz as nearly as practicable. In no event should the frequency deviation exceed ± 5 kHz. Deviation limiting circuits should be employed such that the maximum frequency deviation attainable should be independent of the input audio frequency.

1.1.5 Where duplex or semi-duplex systems are in use, the performance of the radio equipment should continue to comply with all the requirements of this Recommendation.

1.1.6 The equipment should be designed so that frequency changes between assigned channels can be carried out within 5 s.

1.1.7 Emissions should be vertically polarized at the source.

1.1.8 Stations using digital selective calling shall have the following capabilities:

a) sensing to determine the presence of a signal on 156.525 MHz (channel 70); and

b) automatic prevention of the transmission of a call, except for distress and safety calls, when the channel is occupied by calls.

1.2 Transmitters

1.2.1 The frequency tolerance for coast station transmitters should not exceed 5 parts in 10^6, and that for ship station transmitters should not exceed 10 parts in 10^6.

1.2.2 Spurious emissions on discrete frequencies, when measured in a non-reactive load equal to the nominal output impedance of the transmitter, should be in accordance with the provisions of RR Appendix S3 [Appendix 8].

1.2.3 The carrier power for coast stations should not normally exceed 50 W.

1.2.4 The carrier power for ship station transmitters should not exceed 25 W. Means should be provided to readily reduce this power to 1 W or less for use at short ranges, except for digital selective calling equipment operating on 156.525 MHz (channel 70) in which case the power reduction facility is optional (see also Recommendation ITU-R M.541 *recommends* 3.7).

1.2.5 The upper limit of the audio-frequency band should not exceed 3 kHz.

1.2.6 The cabinet radiated power should not exceed 25 μW. In some radio environments, lower values may be required.

1.3 Receivers

1.3.1 The reference sensitivity should be equal to or less than 2.0 μV, e.m.f., for a given reference signal-to-noise ratio at the output of the receiver.

1.3.2 The adjacent channel selectivity should be at least 70 dB.

1.3.3 The spurious response rejection ratio should be at least 70 dB.

1.3.4 The radio frequency intermodulation rejection ratio should be at least 65 dB.

1.3.5 The power of any conducted spurious emission, measured at the antenna terminals, should not exceed 2.0 nW at any discrete frequency. In some radio environments lower values may be required.

1.3.6 The effective radiated power of any cabinet radiated spurious emission on any frequency up to 70 MHz should not exceed 10 nW. Above 70 MHz, the spurious emissions should not exceed 10 nW by more than 6 dB/octave in frequency up to 1 000 MHz. In some radio environments, lower values may be required;

2 that reference should also be made to Recommendations ITU-R SM.331 and ITU-R SM.332 and to the relevant IEC publications on methods of measurement.

RECOMMENDATION ITU-R M.492-6*

OPERATIONAL PROCEDURES FOR THE USE OF DIRECT-PRINTING TELEGRAPH EQUIPMENT IN THE MARITIME MOBILE SERVICE

(Question ITU-R 5/8)

(1974-1978-1982-1986-1990-1992-1995)

Summary

The Recommendation provides in Annex 1 operational procedures for the use of direct-printing telegraph equipment in communication between a ship and a coast station in the selective ARQ-mode on a fully automated or semi-automated basis and to a number of ship stations or a single ship in the broadcast FEC-mode. It also specifies interworking between equipments in accordance with technical characteristics given in Recommendations ITU-R M.476 and ITU-R M.625. Appendix 1 contains procedures for setting up of calls.

The ITU Radiocommunication Assembly,

considering

a) that narrow-band direct-printing telegraph services are in operation using equipment as described in Recommendations ITU-R M.476, ITU-R M.625 and ITU-R M.692;

b) that an improved narrow-band direct-printing telegraph system providing automatic identification and capable of using the 9-digit ship station identity is described in Recommendation ITU-R M.625;

c) that the operational procedures necessary for such services should be agreed upon;

d) that, as far as possible, these procedures should be similar for all services and for all frequency bands (different operational procedures may be required in frequency bands other than the HF and MF bands);

e) that a large number of equipments complying with Recommendation ITU-R M.476 exist;

f) that interworking between equipments in accordance with Recommendations ITU-R M.476 and ITU-R M.625 is required, at least for a transitionary period,

recommends

1 that the operational procedures given in Annex 1 be observed for the use of narrow-band direct-printing telegraph equipment in accordance with either Recommendation ITU-R M.476 or ITU-R M.625 in the MF and HF bands of the maritime mobile service;

2 that when using direct-printing telegraphy or similar systems in any of the frequency bands allocated to the maritime mobile service, the call may, by prior arrangement, be made on a working frequency available for such systems.

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* This Recommendation should be brought to the attention of the International Maritime Organization (IMO) and the Telecommunication Standardization Sector (ITU-T).

ANNEX 1

Operational procedures

1 Mode A (ARQ)

1.1 Methods used for setting up narrow-band direct-printing telegraph communications between a ship station and a coast station in the ARQ-mode should be on a fully automatic or semi-automatic basis, insofar that a ship station should have direct access to a coast station on a coast station receiving frequency and a coast station should have direct access to a ship station on a coast station transmitting frequency.

1.2 However, where necessary, prior contact by Morse telegraphy, radiotelephony or other means is not precluded.

1.3 Through connection to a remote teleprinter station over a dedicated circuit or to a subscriber of the international telex network may be achieved by manual, semi-automatic or automatic means.

NOTE 1 – Before an international automatic service can be introduced, agreement has to be reached on a numbering plan, traffic routing and charging. This should be considered by both the ITU-T and the ITU-R.

NOTE 2 – Recommendations ITU-R M.476 (see § 3.1.5) and ITU-R M.625 (see § 3.8) make provision for automatic re-establishment of radio circuits by rephasing in the event of interruption. However, it has been reported that this procedure has, in some countries, resulted in technical and operational problems when radio circuits are extended into the public switched network or to certain types of automated switching or store-and-forward equipments. For this reason, some coast stations do not accept messages if the rephasing procedure is used.

NOTE 3 – When a connection is set up in the ARQ mode with the international telex network via a coast station, where practicable the general requirements specified in ITU-T Recommendation U.63 should be met.

1.4 When, by prior arrangement, unattended operation is required for communication from a coast station to a ship station, or between two ship stations, the receiving ship station should have a receiver tuned to the other station's transmitting frequency and a transmitter tuned or a transmitter capable of being tuned automatically to the appropriate frequency and ready to transmit on this frequency.

1.5 For unattended operation a ship station should be called selectively by the initiating coast or ship station as provided for by Recommendations ITU-R M.476 and ITU-R M.625. The ship station concerned could have available traffic stored ready for automatic transmission on demand of the calling station.

1.6 At the "over" signal, initiated by the calling station, any available traffic in the ship's traffic store could be transmitted.

1.7 At the end of the communication, an "end of communication" signal should be transmitted, whereupon the ship's equipment should automatically revert to the "stand-by" condition.

1.8 A "free channel" signal may be transmitted by a coast station where necessary to indicate when a channel is open for traffic. The "free channel" signals should preferably be restricted to only one channel per HF band and their duration should be kept as short as possible. In accordance with Article 18 of the Radio Regulations and recognizing the heavy loading of the frequencies available for narrow-band direct printing in the HF bands, "free channel" signals should not be used in future planned systems.

1.9 The format of the "free channel" signal should be composed of signals in the 7-unit error detecting code as listed in § 2 of Annex 1 to Recommendation ITU-R M.476 and § 2 of Annex 1 to Recommendation ITU-R M.625. Three of these signals should be grouped into a block, the middle signal being the "signal repetition" (RQ), the first signal of the block being any of the signals VXKMCF TBOZA and the third signal of the block being any of the signals VMPCYFS OIRZDA (see Recommendation ITU-R M.491). These signals should be indicated in the ITU List of Coast Stations.

Selections of new signals should preferably be chosen to correspond to the first two digits of that coast station's 4-digit identification number. If this is not possible because the characters needed are not listed above, or if this is not desired because this combination is already in use by another coast station, it is preferred that a combination of characters be selected from those listed above in the second part of each row, i.e. TBOZA for the first signal and OIRZDA for the third signal of the free channel block. The signals in the block are transmitted at a modulation rate of 100 Bd and the blocks are separated by pauses of 240 ms. For manual systems this "free channel" signal should be interrupted either by a period of no signal or by a signal or signals, that would enable an operator to recognize the "free channel" condition by ear. An aurally recognizable signal, e.g. a Morse signal, may be used alone as the "free channel" signal in manual systems. At least 8 blocks of the 7-unit signal should be transmitted before interruption.

1.10 In the case of single frequency operation, as described in Recommendation ITU-R M.692, the free channel signal should be interrupted by listening periods of at least 3 s.

1.11 General operational procedures for setting up calls between ship stations and between ship stations and coast stations are given below and specific procedures are given in Appendix 1.

1.12 Manual procedures

1.12.1 Ship to coast station

1.12.1.1 The operator of the ship station establishes communication with the coast station by A1A Morse telegraphy, telephony or by other means using normal calling procedures. The operator then requests direct-printing communication, exchanges information regarding the frequencies to be used and, when applicable, gives the ship station the direct-printing selective call number assigned in accordance with Recommendation ITU-R M.476 or ITU-R M.625 as appropriate, or the ship station identity assigned in accordance with the Preface to List VII A.

1.12.1.2 The operator of the coast station then establishes direct-printing communication on the frequency agreed, using the appropriate identification of the ship.

1.12.1.3 Alternatively the operator of the ship station, using the direct-printing equipment, calls the coast station on a predetermined coast station receive frequency using the identification of the coast station assigned in accordance with Recommendation ITU-R M.476 or ITU-R M.625 as appropriate, or the coast station identity assigned in accordance with the Preface to List VII A.

1.12.1.4 The operator of the coast station then establishes direct-printing communication on the corresponding coast station transmit frequency.

1.12.2 Coast station to ship

1.12.2.1 The operator of the coast station calls the ship station by A1A Morse telegraphy, telephony or other means, using normal calling procedures.

1.12.2.2 The operator of the ship station then applies the procedures of § 1.12.1.1 or § 1.12.1.3.

1.12.3 Intership

1.12.3.1 The operator of the calling ship station establishes communication with the called ship station by A1A Morse telegraphy, telephony, or by other means, using normal calling procedures. The operator then requests direct-printing communication, exchanges information regarding the frequencies to be used and, when applicable, gives the direct-printing selective call number of the calling ship station assigned in accordance with Recommendation ITU-R M.476 or ITU-R M.625 as appropriate, or the ship station identity assigned in accordance with the Preface to List VII A.

1.12.3.2 The operator of the called ship station then establishes direct-printing communication on the frequency agreed, using the appropriate identification of the calling ship.

1.13 Procedures for automatic operation

1.13.1 Ship to coast station

1.13.1.1 The ship station calls the coast station on a predetermined coast station receive frequency, using the direct-printing equipment and the identification signal of the coast station assigned in accordance with Recommendation ITU-R M.476 or ITU-R M.625 as appropriate, or the coast station identity assigned in accordance with the Preface to List VII A.

1.13.1.2 The coast station's direct-printing equipment detects the call and the coast station responds directly on the corresponding coast station transmit frequency, either automatically or under manual control.

1.13.2 Coast station to ship

1.13.2.1 The coast station calls the ship station on a predetermined coast station transmit frequency, using the direct-printing equipment and the ship station direct-printing selective call number assigned in accordance with Recommendation ITU-R M.476 or ITU-R M.625 as appropriate, or the ship station identity assigned in accordance with the Preface to List VII A.

1.13.2.2 The ship station's direct-printing equipment tuned to receive the predetermined coast station transmit frequency detects the call, whereupon the reply is given in one of the following ways:

a) the ship station replies either immediately on the corresponding coast station receive frequency or at a later stage, using the procedure of § 1.12.1.3; or

b) the ship station's transmitter is automatically started on the corresponding coast station receive frequency and the direct-printing equipment responds by sending appropriate signals to indicate readiness to receive traffic automatically.

1.14 Message format

1.14.1 Where the appropriate facilities are provided by the coast station, traffic may be exchanged with the telex network:

a) in a conversational mode where the stations concerned are connected directly, either automatically or under manual control; or

b) in a store-and-forward mode where traffic is stored at the coast station until the circuit to the called station can be set up, either automatically or under manual control.

1.14.2 In the shore-to-ship direction, the message format should conform to normal telex network practice (see also Appendix 1, § 2).

1.14.3 In the ship-to-shore direction, the message format should conform to the operational procedures specified in Appendix 1, § 1.

2 Mode B (FEC)

2.1 Messages may, by prior arrangement, be sent in the B mode from a coast station or a ship station to a number of ships or to a single ship, preceded if desired by the selective call code of the ship(s) concerned where:

2.1.1 a receiving ship station is not permitted or not able to use its transmitter, or

2.1.2 communications are intended for more than one ship, or

2.1.3 unattended reception of the B mode is required and automatic acknowledgement is not necessary.

In such cases, the ship station receivers should be tuned to the appropriate coast or ship station transmitting frequency.

2.2 All B mode messages should start with “carriage return” and “line feed” signals.

2.3 When the ship station receives phasing signals in the B mode, its teleprinter should start automatically and should stop automatically when reception of the emission ceases.

2.4 Ship stations may acknowledge the reception of B mode messages by A1A Morse telegraphy, telephony or by other means.

3 Inter-working between equipments in accordance with Recommendations ITU-R M.476 and ITU-R M.625

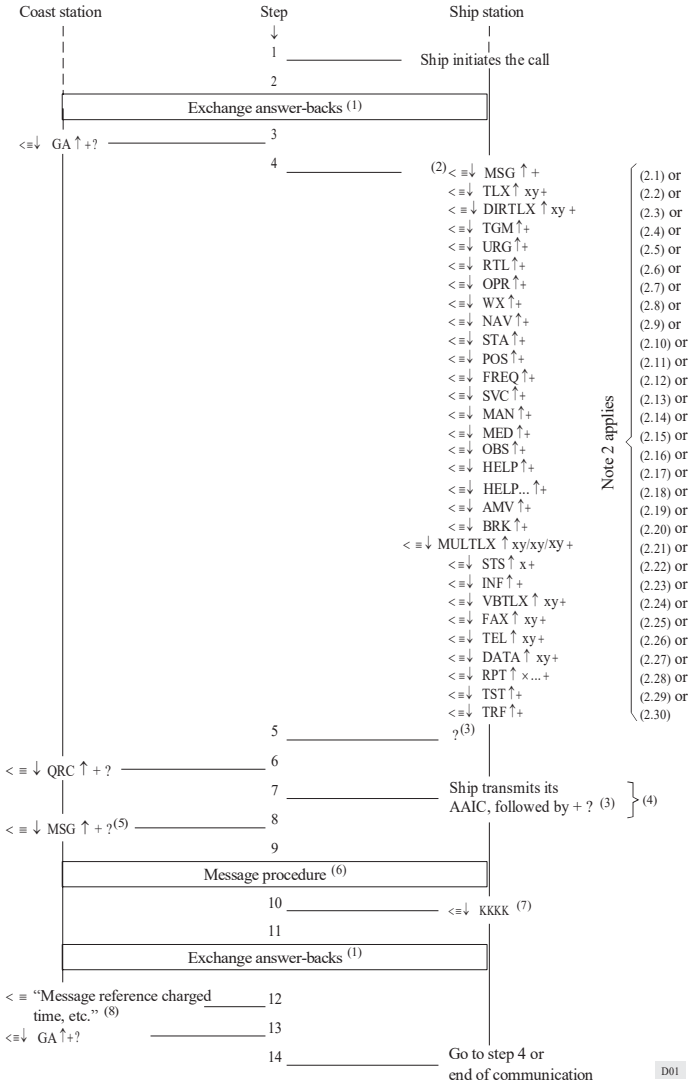
3.1 Recommendation ITU-R M.625 provides for automatic inter-working with equipment which is in accordance with Recommendation ITU-R M.476. The criteria for determining whether one or both stations are of the Recommendation ITU-R M.476 type are the length of the call signal and the composition of the call blocks.

3.2 If both stations have equipment in accordance with Recommendation ITU-R M.625, automatic station identification is a part of the automatic call set-up procedures. However, if one or both stations have equipment in accordance with Recommendation ITU-R M.476, no automatic station identification takes place. For this reason, and because Recommendation ITU-R M.625 accommodates the use of the 9-digit ship station identity for the direct-printing equipment call signal, it is desirable that all new equipment be in accordance with Recommendation ITU-R M.625 at the earliest practicable time.

3.3 In order to attain full compatibility with the large number of existing equipment, it will be necessary to assign both a 9-digit and a 5- (or 4-) digit identity (i.e. 7- and 4-signal call signals) to such new stations. Ship and coast station lists should contain both signals.

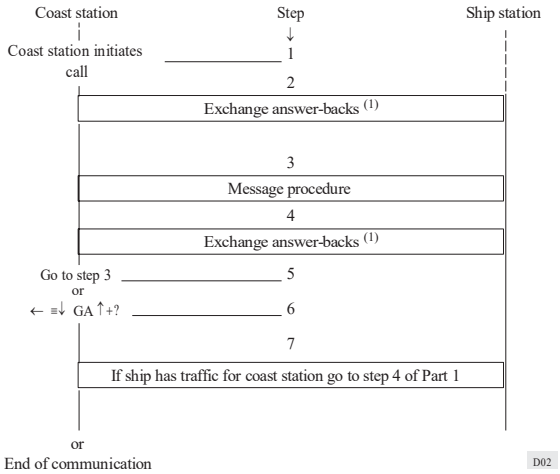
APPENDIX 1

1 Procedure for setting up a call in the ship-to-coast station direction



2 Procedure for setting up a call in the coast-to-ship station direction

Operation in the direction coast station to ship may need to be in the store-and-forward mode owing to the fact that radio propagation conditions may not allow the setting up of a call at the intended time.



Notes relative to § 1 and 2:

(1) a) In automatic operation the answer-back exchange is initiated and controlled by the coast station. For calls set up by the ship station the answer-back exchange in manual operation may be initiated by the ship station.

For calls set up by the coast station the answer-back exchange in manual operation is initiated by the coast station, thereby defining the order in which the exchange takes place.

b) Answer-back code as defined in ITU-T Recommendations F.130 for ship stations and F.60 for coast stations.

(2) A coast station need not provide all of the facilities indicated. However, where specific facilities are provided, the facility codes indicated should be used. The facility "HELP" should always be available.

(2.1) MSG indicates that the ship station needs to immediately receive any messages held for it at the coast station.

(2.2) TLX ↑ xy indicates that the following message is for immediate connection to a store-and-forward facility located at the coast station.

y indicates the subscriber's national telex number.

x is used where applicable to indicate the country code (ITU-T Recommendation F.69) preceded by 0 (when applicable). (Where the store-and-forward system is remote from the coast station, TLX alone may be used.)

TLXA may optionally be used instead of TLX which indicates that ship wishes to be advised (using the normal shore-to-ship procedures) when the message has been delivered to the indicated telex number.

(2.3) DIRTLX ↑ xy indicates that a direct telex connection is required.

y indicates the subscriber's national telex number.

x is used where applicable to indicate the country code (ITU-T Recommendation F.69) preceded by 0 (when applicable).

RDL + may optionally be used to indicate that the last DIRTLX ↑ xy telex number should be redialled.

(2.4) TGM indicates that the following message is a radio telegram.

(2.5) URG indicates that the ship station needs to be connected immediately to a manual assistance operator and an audible alarm may be activated. This code should only be used in case of emergency.

(2.6) RTL indicates that the following message is a radio telex letter.

(2.7) OPR indicates that connection to a manual assistance operator is required.

(2.8) WX indicates that the ship station needs to immediately receive weather information.

(2.9) NAV indicates that the ship station needs to immediately receive navigational warnings.

(2.10) STA indicates that the ship station needs to immediately receive a status report of all store-and-forward messages which have been sent by that ship station, but which the ship station has not already received on retransmitted or non-delivered information (see also ([6])). STA ↑ x may also be used where the ship station needs to immediately receive a status report of such a message where x indicates the message reference provided by the coast station.

(2.11) POS indicates that the following message contains the ship's position. Some administrations use this information to assist in the subsequent automatic transmission or reception of messages (e.g. for calculating the optimum traffic frequency and/or the appropriate directional antennas to use).

(2.12) FREQ indicates that the following message indicates the frequency on which the ship is keeping watch.

(2.13) SVC indicates that the following message is a service message (for subsequent manual attention).

(2.14) MAN indicates that the following message is to be stored and manually forwarded to a country which cannot be accessed automatically.

(2.15) MED indicates that an urgent medical message follows.

(2.16) OBS indicates that the following message is to be sent to the meteorological organization.

(2.17) HELP indicates that the ship station needs to immediately receive a list of available facilities within the system.

(2.18) If information is needed on the application of procedures for individual facilities at a coast station, request for further details concerning the specific procedure can be obtained by the facility code HELP followed by the appropriate facility code for which the information is needed, e.g.: < ≡ ↓HELP DIRTLX ↑ + indicates that the ship station needs information on the procedures (action by ship operator) for ordering a dialogue-mode connection with a telex network subscriber via the coast station.

(2.19) AMV indicates that the following message is to be sent to the AMVER organization.

(2.20) BRK indicates that the use of the radio path is to be immediately discontinued (for use where the ship's operator can only use a teleprinter for controlling the ARQ equipment).

(2.21) MULTLX ↑ xy/xy/xy□+ indicates that the following message is a multiple address message for immediate connection to a store-and-forward facility located at the coast station.

y indicates the subscriber's national telex number.

x is used where applicable to indicate the country code (ITU-T Recommendation F.69) preceded by 0 (when applicable).

Each separate xy indicates a different telex number to which the same message should be forwarded. At least two separate telex numbers should be included.

MULTLXA may optionally be used instead of MULTLX which indicates that the ship wishes to be advised (using the normal shore-to-ship procedures) when the messages have been delivered to the indicated telex numbers.

(2.22) STS ↑ x + indicates that the following message is for transmission to a ship using a store-and-forward facility located at the coast station. x indicates the addressed ship's 5- or 9-digit identity number.

(2.23) INF indicates that the ship station needs to immediately receive information from the coast station's database. Some administrations provide a variety of different database information in which case INF returns a directory listing and a subsequent facility code is used to select the desired information.

(2.24) VBTLX ↑ xy indicates that the following message should be dictated, by the coast station, to a voicebank (voice messaging) telephone number for subsequent retrieval by the addressee, and that a copy of the message should be forwarded to telex number xy. The voicebank telephone number should be included in the first line of the message text.

(2.25) FAX ↑ xy indicates that the following message should be forwarded, via the PSTN, by facsimile to the telephone number xy.

(2.26) TEL ↑ xy indicates that the following message should be telephoned, by the coast station, to the telephone number xy.

(2.27) DATA ↑ xy indicates that the following message should be forwarded by the coast station using data facilities to the subscriber number xy (via the PSTN).

(2.28) RPT ↑ xy… indicates that the ship needs to receive, using the ARQ mode, a specific identified message (e.g., earlier transmitted in the FEC mode), if still available for automatic retransmission. x… is used as the message identifier.

(2.29) TST indicates that the ship needs to receive an automatically transmitted test text (e.g. "the quick brown fox …").

(2.30) TRF indicates that the ship needs to receive information, automatically transmitted, on tariffs currently applicable to the coast station.

(3) The symbol "?" is not necessary where the coast station is automatic. It is normally required only for manual systems.

(4) In cases where the coast station requires information about the relevant Accounting Authority Identification Code (AAIC), this information should be provided by the ship operator on receipt of the combination < ≡ ↓ QRC ↑ + from the coast station.

Some coast stations may request additional information, e.g. ship's name, call sign, etc.

(5) This sequence may be preceded where necessary by suitable prompts or facility selection information and, if appropriate, any consequent ship station reply, or may be deleted where not applicable (e.g. where facility codes WX, NAV, STA, MSG or HELP are input at step 4). Where facility code DIRTLX ↑ xy was input at step 4, this sequence may be replaced by the distant end answer-back or by any service signal (e.g. NC, OCC, etc.) received from the telex network.

(6) Message procedures depend on which facility is used:

For TLX where the store-and-forward system is remote from the coast station, ITU-T Recommendation F.72 may apply. Where the store-and-forward system is located at the coast station, the complete information content of the message sent at this step will be forwarded to the subscriber whose telex number is given by xy.

For DIRTLX, see ITU-T Recommendation F.60.

For TGM, see ITU-T Recommendations F.1 and F.31.

For SVC and MED, the message will normally be plain text and no specific message procedure is required.

For RTL, the message will be plain text but should include the postal address of the addressee.

For STA, the appropriate status information is returned to the ship in accordance with ITU-T Recommendation F.72, § 11.3 and 11.4.

For POS and FREQ, specific national procedures may apply.

(7) This sequence of 4 K's "KKKK" (4 combination No. 11 signals in the letter case) indicates that any network connection should be cleared but that the radio path should be maintained and that the procedure should immediately proceed to step 11. This sequence may be used elsewhere in the procedure in which case the procedure reverts to step 3.

(8) This step is optional and may not apply to all facilities.

RECOMMENDATION ITU-R P.525-4

Calculation of free-space attenuation

(1978-1982-1994-2016-2019)

Scope

Recommendation ITU-R P.525 provides methods to calculate the attenuation in free space.

Keywords

Free space, attenuation, telecommunication links

The ITU Radiocommunication Assembly,

considering

that free-space propagation is a fundamental reference for radio-engineering,

recommends

that the methods in the Annex should be used for the calculation of attenuation in free space.

Annex

1 Introduction

For the purposes of radiocommunication, free space is defined as a perfect vacuum which may be considered of infinite extent in all directions, so that free space propagation is the propagation of a radio wave radiating in free space[1].

As free-space propagation is often used as a reference in other texts, this Annex presents relevant formulae.

2 Basic formulae for telecommunication links

Free-space propagation may be calculated in different ways, each of which is adapted to a particular type of service.

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[1] The International Standards Organisation in its electrotechnical vocabulary (electropedia) has a more general definition:

Free space propagation: propagation of an electromagnetic wave in a homogeneous ideal dielectric medium which may be considered of infinite extent in all directions

NOTE – For propagation in free space, the magnitude of each vector of the electromagnetic field in any given direction from the source is proportional to the reciprocal of the distance from the source beyond a distance determined by the size of the source and the wavelength.

2.1 Point-to-area links

If there is a transmitter serving several randomly-distributed receivers (broadcasting, mobile service), the electric field is calculated at a point located at some appropriate distance from the transmitter by the expression:

$$e = \frac{\sqrt{30\,p}}{d} \tag{1}$$

where:

e: r.m.s. field strength (V/m) (see Note 1)

p: equivalent isotropically radiated power (e.i.r.p.) of the transmitter in the direction of the point in question (W) (see Note 2)

d: distance from the transmitter to the point in question (m).

Equation (1) is often replaced by equation (2) which uses practical units:

$$e_{\text{mV/m}} = 173\,\frac{\sqrt{p_{\text{kW}}}}{d_{\text{km}}} \tag{2}$$

where:

$e_{\text{mV/m}}$: r.m.s field strength (mV/m)

p_{kW}: equivalent isotropically radiated power (e.i.r.p.) of the transmitter in the direction of the point in question (kW)

d_{km}: distance from the transmitter to the point in question (km).

For antennas operating in free-space conditions the cymomotive force may be obtained by multiplying together e and d in equation (1). Its dimension is volts.

NOTE 1 – If the wave is elliptically polarized and not linear, and if the electric field components along two orthogonal axes are expressed by e_x and e_y, the left-hand term of equation (1) should be replaced by $\sqrt{e_x^2 + e_y^2}$. e_x and e_y can be deduced only if the axial ratio is known. e should be replaced by $e\sqrt{2}$ in the case of circular polarization.

NOTE 2 – In the case of antennas located at ground level (typically at relatively low frequencies) with vertical polarization, radiation is generally considered only in the upper half-space. When the ground is assumed to be plane and perfectly conducting, the power flux-density for a given radiated power is doubled, as compared with an antenna in free space. (Alternatively, when considering field strengths, the field strength is similarly increased by 3 dB.) This should be taken into account in determining the radiated power (and is already included in Recommendations ITU-R P.368 and ITU-R P.341, Annex3).

2.2 Point-to-point links

With a point-to-point link it is preferable to calculate the free-space attenuation between isotropic antennas, also known as the free-space basic transmission loss (symbols: L_{bf} or A_{bf}), as follows (see Recommendation ITU-R P.341):

$$L_{bf} = 20\,\log\left(\frac{4\pi\,d}{\lambda}\right) \qquad \text{dB} \tag{3}$$

where:

L_{bf}: free-space basic transmission loss (dB)

d: distance

λ: wavelength, and

d and λ are expressed in the same unit.

Equation (3) can also be written using the frequency instead of the wavelength.

$$L_{bf} = 32.4 + 20 \log f + 20 \log d \quad \text{dB} \tag{4}$$

where:

f: frequency (MHz)

d: distance (km).

2.3 Relations between the characteristics of a plane wave

There are also relations between the characteristics of a plane wave (or a wave which can be treated as a plane wave) at a point:

$$s = \frac{e^2}{120\pi} = \frac{4\pi\, p_r}{\lambda^2} \tag{5}$$

where:

s: power flux-density (W/m^2)

e: r.m.s. field strength (V/m)

p_r: power (W) available from an isotropic antenna located at this point

λ: wavelength (m).

3 The free-space basic transmission loss for a radar system (symbols: L_{br} or A_{br})

Radar systems represent a special case because the signal is subjected to a loss while propagating both from the transmitter to the target and from the target to the receiver. For radars using a common antenna for both transmitter and receiver, a radar free-space basic transmission loss, L_{br}, can be written as follows:

$$L_{br} = 103.4 + 20 \log f + 40 \log d - 10 \log \sigma \quad \text{dB} \tag{6}$$

where:

σ: radar target cross-section (m^2)

d: distance from the radar to the target (km)

f: frequency of the system (MHz).

The radar target cross-section of an object is the ratio of the total isotropically equivalent scattered power to the incident power density.

4 Conversion formulae

On the basis of free-space propagation, the following conversion formulae may be used.

Field strength for a given isotropically transmitted power:

$$E = P_t - 20 \log d + 74.8 \tag{7}$$

Available power received through a conjugately matched isotropic receiving antenna for a given field strength:

$$P_r = E - 20 \log f - 167.2 \tag{8}$$

Free-space basic transmission loss for a given isotropically transmitted power and field strength:

$$L_{bf} = P_t - E + 20 \log f + 167.2 \tag{9}$$

Power flux-density for a given field strength:

$$S = E - 145.8 \tag{10}$$

where:

P_t: isotropically transmitted power (dB(W))

P_r: available power received through a conjugately matched antenna (dB(W))

E: electric field strength (dB(μV/m))

f: frequency (GHz)

d: radio path length (km)

L_{bf}: free-space basic transmission loss (dB)

S: power flux-density (dB(W/m^2)).

Note that equations (7) and (9) can be used to derive equation (4).

RECOMMENDATION ITU-R P.526-15

Propagation by diffraction

(Question ITU-R 202/3)

(1978-1982-1992-1994-1995-1997-1999-2001-2003-2005-2007-2009-2012-2013-2018-2019)

Scope

This Recommendation presents several models to enable the reader to evaluate the effect of diffraction on the received field strength. The models are applicable to different obstacle types and to various path geometries.

Keywords

diffraction, irregular terrain, obstacles, knife-edge, aperture, screen

The ITU Radiocommunication Assembly,

considering

that there is a need to provide engineering information for the calculation of field strengths over diffraction paths,

recommends

that the methods described in Annex 1 be used for the calculation of field strengths over diffraction paths, which may include a spherical earth surface, or irregular terrain with different kinds of obstacles.

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Annex 1

1 Introduction

Although diffraction is produced only by the surface of the ground or other obstacles, account must be taken of the mean atmospheric refraction on the transmission path to evaluate the geometrical parameters situated in the vertical plane of the path (angle of diffraction, radius of curvature, height of obstacle). For this purpose, the path profile has to be traced with the appropriate equivalent Earth radius (Recommendation ITU-R P.834). If no other information is available, an equivalent Earth radius of 8 500 km may be taken as a basis.

2 Basic concepts

Diffraction of radiowaves over the Earth's surface is affected by terrain irregularities. In this context, before going further into the prediction methods for this propagation mechanism, a few basic concepts are given in this section.

2.1 Fresnel ellipsoids and Fresnel zones

In studying radiowave propagation between two points A and B, the intervening space can be subdivided by a family of ellipsoids, known as Fresnel ellipsoids, all having their focal points at A and B such that any point M on one ellipsoid satisfies the relation:

$$\mathrm{AM} + \mathrm{MB} = \mathrm{AB} + n\frac{\lambda}{2} \tag{1}$$

where n is a whole number characterizing the ellipsoid and $n = 1$ corresponds to the first Fresnel ellipsoid, etc., and λ is the wavelength.

As a practical rule, propagation is assumed to occur in line-of-sight (LoS), i.e. with negligible diffraction phenomena if there is no obstacle within the first Fresnel ellipsoid.

The radius of an ellipsoid at a point between the transmitter and the receiver can be approximated in self-consistent units by:

$$R_n = \left[\frac{n\,\lambda\,d_1\,d_2}{d_1 + d_2}\right]^{1/2} \tag{2}$$

or, in practical units:

$$R_n = 550\left[\frac{n\,d_1\,d_2}{(d_1 + d_2)\,f}\right]^{1/2} \tag{3}$$

where f is the frequency (MHz) and d_1 and d_2 are the distances (km) between transmitter and receiver at the point where the ellipsoid radius (m) is calculated.

Some problems require consideration of Fresnel zones which are the zones obtained by taking the intersection of a family of ellipsoids by a plane. The zone of order n is the part between the curves obtained from ellipsoids n and $n - 1$, respectively.

2.2 Penumbra width

The transition from light to shadow defines the penumbra region. This transition takes place along a narrow strip (penumbra width) in the boundary of geometric shadow. Figure 1 shows the penumbra width (W) in the case of a transmitter located a height, h, above a smooth spherical earth, which is given by:

$$w = \left[\frac{\lambda a_e^2}{\pi}\right]^{1/3} \text{m} \tag{4}$$

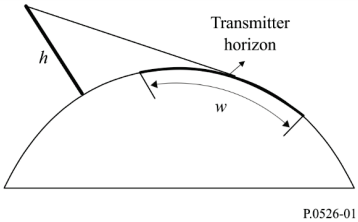
where:

λ: wavelength (m)

a_e: effective Earth radius (m)

FIGURE 1

Definition of penumbra width



2.3 Diffraction zone

The diffraction zone of a transmitter extends from the LoS distance where the path clearance is equal to 60% of the first Fresnel zone radius, (R_1), up to a distance well beyond the transmitter horizon where the mechanism of troposcatter becomes predominant.

2.4 Obstacle surface smoothness criterion

If the surface of the obstacle has irregularities not exceeding Δh,

where:

$$\Delta h = 0.04 \left[R\lambda^2 \right]^{1/3} \qquad \text{m} \tag{5}$$

where:

R: obstacle curvature radius (m)

λ: wavelength (m);

then the obstacle may be considered smooth and the methods described in §§ 3 and 4.2 may be used to calculate the attenuation.

2.5 Isolated obstacle

An obstacle can be considered isolated if there is no interaction between the obstacle itself and the surrounding terrain. In other words, the path attenuation is only due to the obstacle alone without any contribution from the remaining terrain. The following conditions must be satisfied:

– no overlapping between penumbra widths associated with each terminal and the obstacle top;

– the path clearance on both sides of the obstacles should be, at least, 0.6 of the first Fresnel zone radius;

– no specular reflection on both sides of the obstacle.

2.6 Types of terrain

Depending on the numerical value of the parameter Δh (see Recommendation ITU-R P.310) used to define the degree of terrain irregularities, three types of terrain can be classified:

a) *Smooth terrain*

The surface of the Earth can be considered smooth if terrain irregularities are of the order or less than $0.1R$, where R is the maximum value of the first Fresnel zone radius in the propagation path. In this case, the prediction model is based on the diffraction over the spherical Earth (see § 3).

b) *Isolated obstacles*

The terrain profile of the propagation path consists of one or more isolated obstacles. In this case, depending on the idealization used to characterize the obstacles encountered in the propagation path, the prediction models described in § 4 should be used.

c) *Rolling terrain*

The profile consists of several small hills, none of which form a dominant obstruction. Within its frequency range Recommendation ITU-R P.1546 is suitable for predicting field strength but it is not a diffraction method.

2.7 Fresnel integrals

The complex Fresnel integral is given by:

$$F_c(\nu) = \int_0^{\nu} \exp\left(j\,\frac{\pi s^2}{2}\right) \mathrm{d}s = C(\nu) + jS(\nu) \tag{6}$$

where j is the complex operator equal to $\sqrt{-1}$, and $C(\nu)$ and $S(\nu)$ are the Fresnel cosine and sine integrals defined by:

$$C(\nu) = \int_0^{\nu} \cos\left(\frac{\pi s^2}{2}\right) \mathrm{d}s \tag{7a}$$

$$S(\nu) = \int_0^{\nu} \sin\left(\frac{\pi s^2}{2}\right) \mathrm{d}s \tag{7b}$$

The complex Fresnel integral $F_c(\nu)$ can be evaluated by numerical integration, or with sufficient accuracy for most purposes for positive ν using:

$$F_c(\nu) = \exp(jx)\sqrt{\frac{x}{4}} \sum_{n=0}^{11} \left[(a_n - jb_n)\left(\frac{x}{4}\right)^n\right] \qquad \text{for} \quad 0 \le x < 4 \tag{8a}$$

$$F_c(\nu) = \left(\frac{1+j}{2}\right) + \exp(jx)\sqrt{\frac{4}{x}} \sum_{n=0}^{11} \left[(c_n - jd_n)\left(\frac{4}{x}\right)^n\right] \qquad \text{for} \quad x \ge 4 \tag{8b}$$

where:

$$x = 0.5\pi\,\nu^2 \tag{9}$$

and a_n, b_n, c_n and d_n are the Boersma coefficients given below:

a_0 = +1.595769140	b_0 = -0.000000033	c_0 = +0.000000000	d_0 = +0.199471140
a_1 = -0.000001702	b_1 = +4.255387524	c_1 = -0.024933975	d_1 = +0.000000023
a_2 = -6.808568854	b_2 = -0.000092810	c_2 = +0.000003936	d_2 = -0.009351341
a_3 = -0.000576361	b_3 = -7.780020400	c_3 = +0.005770956	d_3 = +0.000023006
a_4 = +6.920691902	b_4 = -0.009520895	c_4 = +0.000689892	d_4 = +0.004851466
a_5 = -0.016898657	b_5 = +5.075161298	c_5 = -0.009497136	d_5 = +0.001903218
a_6 = -3.050485660	b_6 = -0.138341947	c_6 = +0.011948809	d_6 = -0.017122914
a_7 = -0.075752419	b_7 = -1.363729124	c_7 = -0.006748873	d_7 = +0.029064067
a_8 = +0.850663781	b_8 = -0.403349276	c_8 = +0.000246420	d_8 = -0.027928955
a_9 = -0.025639041	b_9 = +0.702222016	c_9 = +0.002102967	d_9 = +0.016497308
a_{10} = -0.150230960	b_{10} = -0.216195929	c_{10} = -0.001217930	d_{10} = -0.005598515
a_{11} = +0.034404779	b_{11} = +0.019547031	c_{11} = +0.000233939	d_{11} = +0.000838386

$C(\nu)$ and $S(\nu)$ may be evaluated for negative values of ν by noting that:

$$C(-\nu) = -C(\nu) \tag{10a}$$

$$S(-\nu) = -S(\nu) \tag{10b}$$

3 Diffraction over a spherical Earth

The additional transmission loss due to diffraction over a spherical Earth can be computed by the classical residue series formula. A computer program GRWAVE, available from the ITU, provides the complete method. A subset of the outputs from this program (for antennas close to the ground and at lower frequencies) is presented in Recommendation ITU-R P.368.

The following subsections describe numerical and nomogram methods which may be used for frequencies 10 MHz and above. For frequencies below 10 MHz, GRWAVE should always be used. Section 3.1 gives methods for over-the-horizon paths. Section 3.1.1 is a numerical method. Section 3.1.2 is a nomogram method. Section 3.2 is a method applicable for the smooth earth case for any distance and for frequencies 10 MHz and above. This utilizes the numerical method in § 3.1.1.

3.1 Diffraction loss for over-the-horizon paths

At long distances over the horizon, only the first term of the residue series is important. Even near or at the horizon this approximation can be used with a maximum error around 2 dB in most cases.

This first term can be written as the product of a distance term, F, and two height gain terms, G_T and G_R. Sections 3.1.1 and 3.1.2 describe how these terms can be obtained from simple formula or from nomograms.

3.1.1 Numerical calculation

3.1.1.1 Influence of the electrical characteristics of the surface of the Earth

The extent to which the electrical characteristics of the surface of the Earth influence the diffraction loss can be determined by calculating a normalized factor for surface admittance, K, given by the formulae:

in self-consistent units:

$$K_H = \left(\frac{2\pi\, a_e}{\lambda}\right)^{-1/3} \left[(\varepsilon - 1)^2 + (60\,\lambda\,\sigma)^2\right]^{-1/4} \quad \text{for horizontal polarization} \tag{11}$$

and

$$K_V = K_H \left[\varepsilon^2 + (60\,\lambda\,\sigma)^2\right]^{1/2} \quad \text{for vertical polarization} \tag{12}$$

or, in practical units:

$$K_H = 0.36\,(a_e\, f)^{-1/3} \left[(\varepsilon - 1)^2 + (18\,000\,\sigma / f)^2\right]^{-1/4} \tag{11a}$$

$$K_V = K_H \left[\varepsilon^2 + (18\,000\,\sigma / f)^2\right]^{1/2} \tag{12a}$$

where:

a_e: effective radius of the Earth (km)

ε: effective relative permittivity

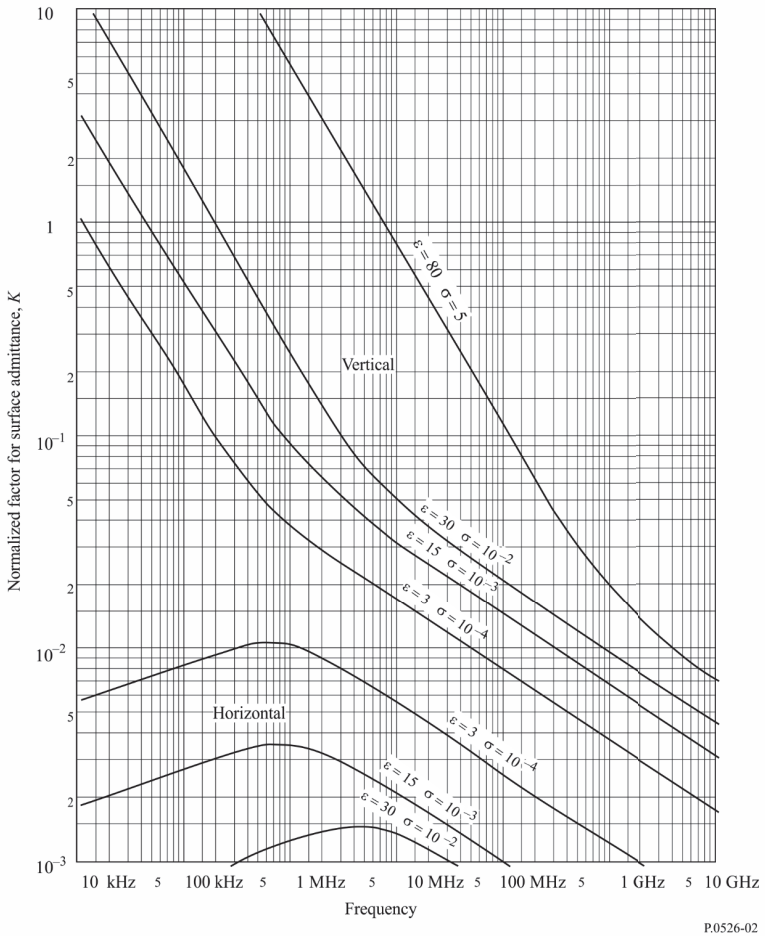
σ: effective conductivity (S/m)

f: frequency (MHz).

Typical values of *K* are shown in Fig. 2.

FIGURE 2

Calculation of *K*



If *K* is less than 0.001, the electrical characteristics of the Earth are not important. For values of *K* greater than 0.001 and less than 1, the appropriate formulae given in § 3.1.1.2 can be used. When *K* has a value greater than about 1, the diffraction field strength calculated using the method of § 3.1.1.2 differs from the results given by the computer program GRWAVE, and the difference increases rapidly as *K* increases. GRWAVE should be used for *K* greater than 1. This only occurs for vertical

polarization, at frequencies below 10 MHz over sea, or below 200 kHz over land. In all other cases the method of § 3.1.1.2 is valid.

3.1.1.2 Diffraction field strength formulae

The diffraction field strength, E, relative to the free-space field strength, E_0, is given by the formula:

$$20 \log \frac{E}{E_0} = F(X) + G(Y_1) + G(Y_2) \qquad \text{dB} \tag{13}$$

where X is the normalized length of the path between the antennas at normalized heights Y_1 and Y_2 (and where $20 \log \frac{E}{E_0}$ is generally negative).

In self-consistent units:

$$X = \beta \left(\frac{\pi}{\lambda \, a_e^2} \right)^{1/3} d \tag{14}$$

$$Y = 2\beta \left(\frac{\pi^2}{\lambda^2 \; a_e} \right)^{1/3} h \tag{15}$$

or, in practical units:

$$X = 2.188 \, \beta \, f^{1/3} a_e^{-2/3} \, d \tag{14a}$$

$$Y = 9.575 \times 10^{-3} \, \beta \, f^{2/3} \, a_e^{-1/3} \, h \tag{15a}$$

where:

d: path length (km)

a_e: equivalent Earth's radius (km)

h: antenna height (m)

f: frequency (MHz).

β is a parameter allowing for the type of ground and for polarization. It is related to K by the following semi-empirical formula:

$$\beta = \frac{1 + 1.6 \, K^2 + 0.67 \, K^4}{1 + 4.5 \, K^2 + 1.53 \, K^4} \tag{16}$$

For horizontal polarization at all frequencies, and for vertical polarization above 20 MHz over land or 300 MHz over sea, β may be taken as equal to 1.

For vertical polarization below 20 MHz over land or 300 MHz over sea, β must be calculated as a function of K. However, it is then possible to disregard ε and write:

$$K^2 \approx 6.89 \, \frac{\sigma}{k^{2/3} \; f^{5/3}} \tag{16a}$$

where σ is expressed in S/m, f (MHz) and k is the multiplying factor of the Earth's radius.

The distance term is given by the formula:

$$F(X) = 11 + 10 \log (X) - 17.6\, X \qquad \text{for } X \geq 1.6 \tag{17a}$$

$$F(X) = -20 \log (X) - 5.6488 X^{1.425} \qquad \text{for } X < 1.6 \tag{17b}$$

The height gain term, $G(Y)$ is given by the following formulae:

$$G(Y) \cong 17.6(B-1.1)^{1/2} - 5\log(B-1.1) - 8 \text{ for } B > 2 \tag{18}$$

$$G(Y) \cong 20\log(B + 0.1B^3) \text{ for } B \leq 2 \tag{18a}$$

If $G(Y) < 2 + 20\log K$, set $G(Y)$ to the value $2 + 20\log K$

In the above:

$$B = \beta Y \tag{18b}$$

The accuracy of the diffracted field strength given by equation (13) is limited by the approximation inherent in only using the first term of the residue series. Equation (13) is accurate to better than 2 dB for values of X, Y_1 and Y_2 that are constrained by the formula:

$$X - (\beta Y_1)^{1/2} \Delta(Y_1, K) - (\beta Y_2)^{1/2} \Delta(Y_2, K) > X_{lim} \tag{19}$$

where:

$$X_{lim} = 1.096 - 1.280\,(1 - \beta) \tag{19a}$$

$$\Delta(Y, K) = \Delta(Y, 0) + 1.779\,(1 - \beta)\left[\Delta(Y, \infty) - \Delta(Y, 0)\right] \tag{19b}$$

$\Delta(Y,0)$ and $\Delta(Y,\infty)$ are given by:

$$\Delta(Y, 0) = 0.5\left[1 + \tanh\left(\frac{0.5 \log(\beta Y) - 0.255}{0.3}\right)\right] \tag{19c}$$

$$\Delta(Y, \infty) = 0.5\left[1 + \tanh\left(\frac{0.5 \log(\beta Y) + 0.255}{0.25}\right)\right] \tag{19d}$$

Consequently, the minimum distance d_{min} for which equation (13) is valid is given by:

$$X_{min} = X_{lim} + (\beta Y_1)^{1/2} \Delta(Y_1, K) + (\beta Y_2)^{1/2} \Delta(Y_2, K) \tag{19e}$$

and d_{min} is obtained from X_{min} using equation (14a).

3.1.2 Calculation by nomograms

Under the same approximation condition (the first term of the residue series is dominant), the calculation may also be made using the following formula:

$$20 \log \frac{E}{E_0} = \mathrm{F}(d) + \mathrm{H}(h_1) + \mathrm{H}(h_2) \qquad \text{dB} \qquad (20)$$

where:

E: received field strength

E_0: field strength in free space at the same distance

d: distance between the extremities of the path

h_1 and h_2: heights of the antennas above the spherical earth.

The function F (influence of the distance) and H (height-gain) are given by the nomograms in Figs 3, 4, 5 and 6.

These nomograms (Figs 3 to 6) give directly the received level relative to free space, for $k = 1$ and $k = 4/3$, and for frequencies greater than approximately 30 MHz. k is the effective Earth radius factor, defined in Recommendation ITU-R P.310. However, the received level for other values of k may be calculated by using the frequency scale for $k = 1$, but replacing the frequency in question by a hypothetical frequency equal to f/k^2 for Figs 3 and 5, and $f/\sqrt{k}$ for Figs 4 and 6.

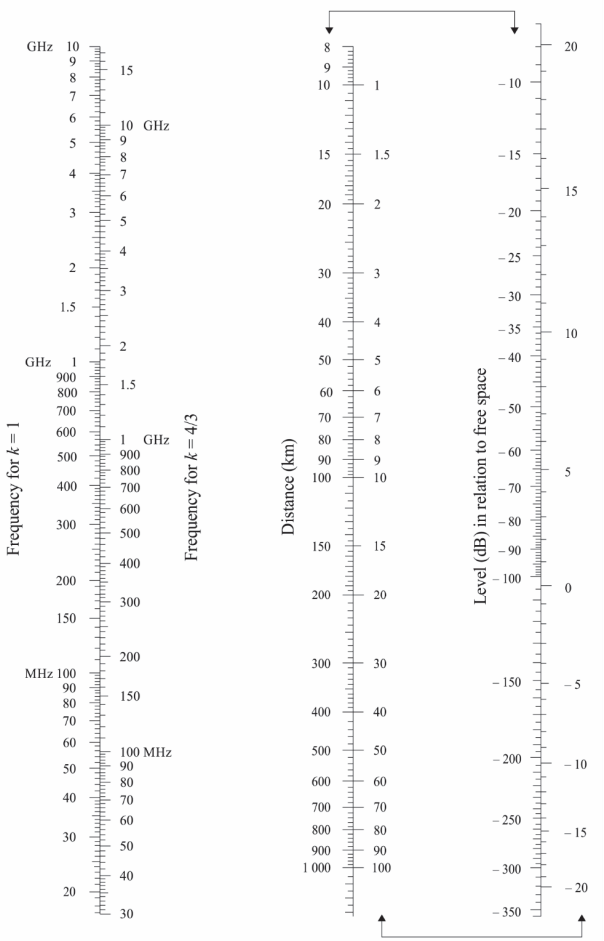
Very close to the ground the field strength is practically independent of the height. This phenomenon is particularly important for vertical polarization over the sea. For this reason Fig. 6 includes a heavy black vertical line AB. If the straight line should intersect this heavy line AB, the real height should be replaced by a larger value, so that the straight line just touches the top of the limit line at A.

NOTE 1 – Attenuation relative to free space is given by the negative of the values given by equation (20). If equation (20) gives a value above the free-space field, the method is invalid.

NOTE 2 – The effect of line AB is included in the numerical method given in § 3.1.1.

FIGURE 3

Diffraction by a spherical Earth – effect of distance



Horizontal polarization over land and sea
Vertical polarization over land

(The scales joined by arrows should be used together)

P.0526-03

FIGURE 4

Diffraction by a spherical Earth – height-gain

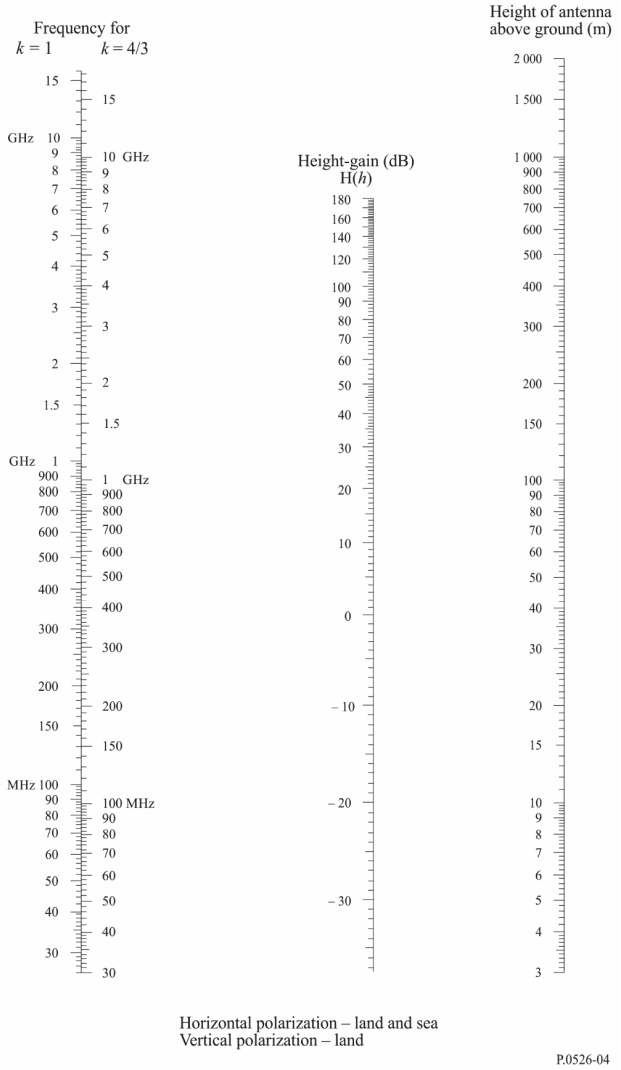
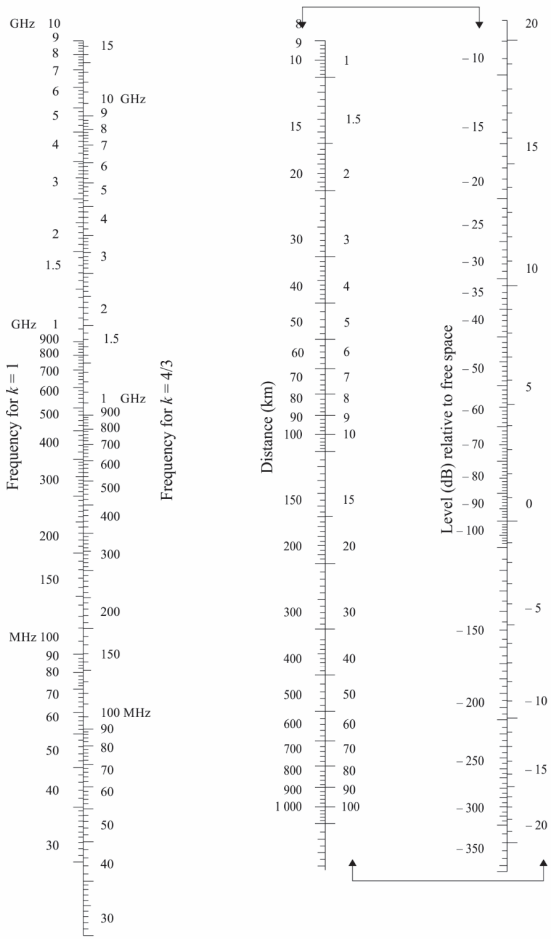


FIGURE 5

Diffraction by a spherical Earth – effect of distance



Vertical polarization over sea
(The scales joined by arrows should be used together)

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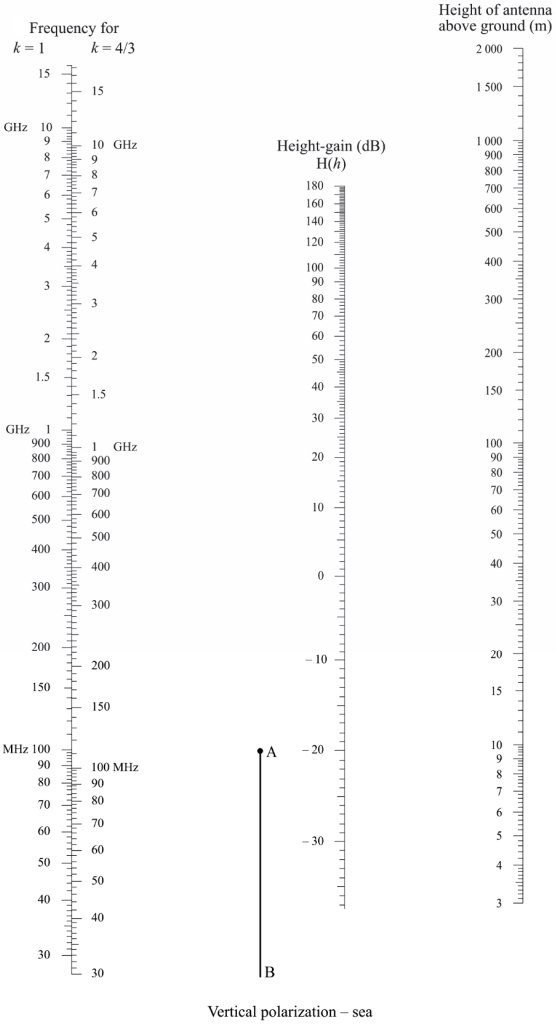
FIGURE 6

Diffraction by a spherical Earth – height-gain



3.2 Diffraction loss for any distance at 10 MHz and above

The following step-by-step procedure should be used for a spherical-earth path of any length at frequencies of 10 MHz and above, for effective Earth radius $a_e > 0$. The method uses the calculation in § 3.1.1 for over-the-horizon cases, and otherwise an interpolation procedure based on a notional effective-earth radius.

The procedure uses self-consistent units and proceeds as follows:

Calculate the marginal LoS distance given by:

$$d_{los} = \sqrt{2a_e}\ \left(\sqrt{h_1} + \sqrt{h_2}\right) \tag{21}$$

If $d \geq d_{los}$ calculate diffraction loss using the method in § 3.1.1. No further calculation is necessary.

Otherwise continue:

Calculate the smallest clearance height between the curved-earth path and the ray between the antennas, h (see Fig. 7), given by:

$$h = \frac{\left(h_1 - \frac{d_1^2}{2a_e}\right)d_2 + \left(h_2 - \frac{d_2^2}{2a_e}\right)d_1}{d} \tag{22}$$

$$d_1 = \frac{d}{2}\ (1 + b) \tag{22a}$$

$$d_2 = d - d_1 \tag{22b}$$

$$b = 2\sqrt{\frac{m+1}{3m}}\cos\left\{\frac{\pi}{3} + \frac{1}{3}\arccos\left(\frac{3c}{2}\sqrt{\frac{3m}{(m+1)^3}}\right)\right\} \tag{22c}$$

$$c = \frac{h_1 - h_2}{h_1 + h_2} \tag{22d}$$

$$m = \frac{d^2}{4a_e(h_1 + h_2)} \tag{22e}$$

Calculate the required clearance for zero diffraction loss, h_{req}, given by:

$$h_{req} = 0.552\sqrt{\frac{d_1\, d_2\, \lambda}{d}} \tag{23}$$

If $h > h_{req}$ the diffraction loss for the path is zero. No further calculation is required.

Otherwise continue:

Calculate the modified effective earth radius, a_{em}, which gives marginal LoS at distance d given by:

$$a_{em} = 0.5\left(\frac{d}{\sqrt{h_1}+\sqrt{h_2}}\right)^2 \tag{24}$$

Use the method in § 3.1.1 to calculate the diffraction loss for the path using the modified effective earth radius a_{em} in place of the effective earth radius a_e, and designate this loss A_h.

If A_h is negative, the diffraction loss for the path is zero, and no further calculation is necessary.

Otherwise calculate the interpolated diffraction loss, A (dB), given by:

$$A = \left[1 - h / h_{req}\right] A_h \tag{25}$$

4 Diffraction over isolated obstacles or a general terrestrial path

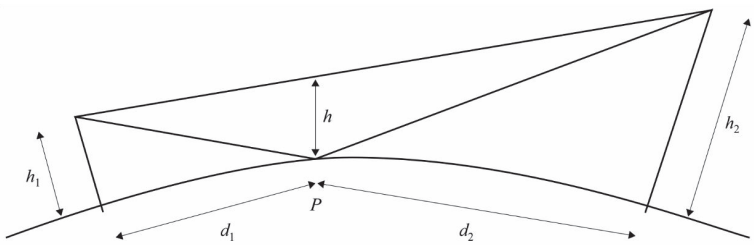
Many propagation paths encounter one obstacle or several separate obstacles and it is useful to estimate the losses caused by such obstacles. To make such calculations, it is necessary to idealize the form of the obstacles, either assuming a knife-edge of negligible thickness or a thick smooth obstacle with a well-defined radius of curvature at the top. Real obstacles have, of course, more complex forms, so that the indications provided in this Recommendation should be regarded only as an approximation. These models do not take into account the profile transverse to the direction of the radio link, which may have a significant effect on diffraction loss.

In those cases where the direct path between the terminals is much shorter than the diffraction path, it is necessary to calculate the additional transmission loss due to the longer path.

The data given below apply when the wavelength is fairly small in relation to the size of the obstacles, i.e. mainly to VHF and shorter waves (f > 30 MHz).

FIGURE 7

Path clearance



P: Reflection point

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4.1 Single knife-edge obstacle

In this extremely idealized case (see Figs 8a) and 8b)), all the geometrical parameters are combined together in a single dimensionless parameter normally denoted by ν which may assume a variety of equivalent forms according to the geometrical parameters selected:

$$\nu = h\sqrt{\frac{2}{\lambda}\left(\frac{1}{d_1} + \frac{1}{d_2}\right)} \tag{26}$$

$$\nu = \theta\sqrt{\frac{2}{\lambda\left(\frac{1}{d_1} + \frac{1}{d_2}\right)}} \tag{27}$$

$$\nu = \sqrt{\frac{2\,h\,\theta}{\lambda}} \quad (\nu \text{ has the sign of } h \text{ and } \theta) \tag{28}$$

$$\nu = \sqrt{\frac{2\,d}{\lambda} \cdot \alpha_1\,\alpha_2} \quad (\nu \text{ has the sign of } \alpha_1 \text{ and } \alpha_2) \tag{29}$$

where:

h: height of the top of the obstacle above the straight line joining the two ends of the path. If the height is below this line, h is negative

d_1 and d_2: distances of the two ends of the path from the top of the obstacle

d: length of the path

θ: angle of diffraction (rad); its sign is the same as that of h. The angle θ is assumed to be less than about 0.2 rad, or roughly 12º

α_1 and α_2: angles in radians between the top of the obstacle and one end as seen from the other end. α_1 and α_2 are of the sign of h in the above equations.

NOTE 1 – In equations (26) to (29) inclusive h, d, d_1, d_2 and λ should be in self-consistent units.

FIGURE 8

Geometrical elements

(For definitions of θ, α_1, α_2, d, d_1, d_2 and R, see § 4.1 and 4.2)

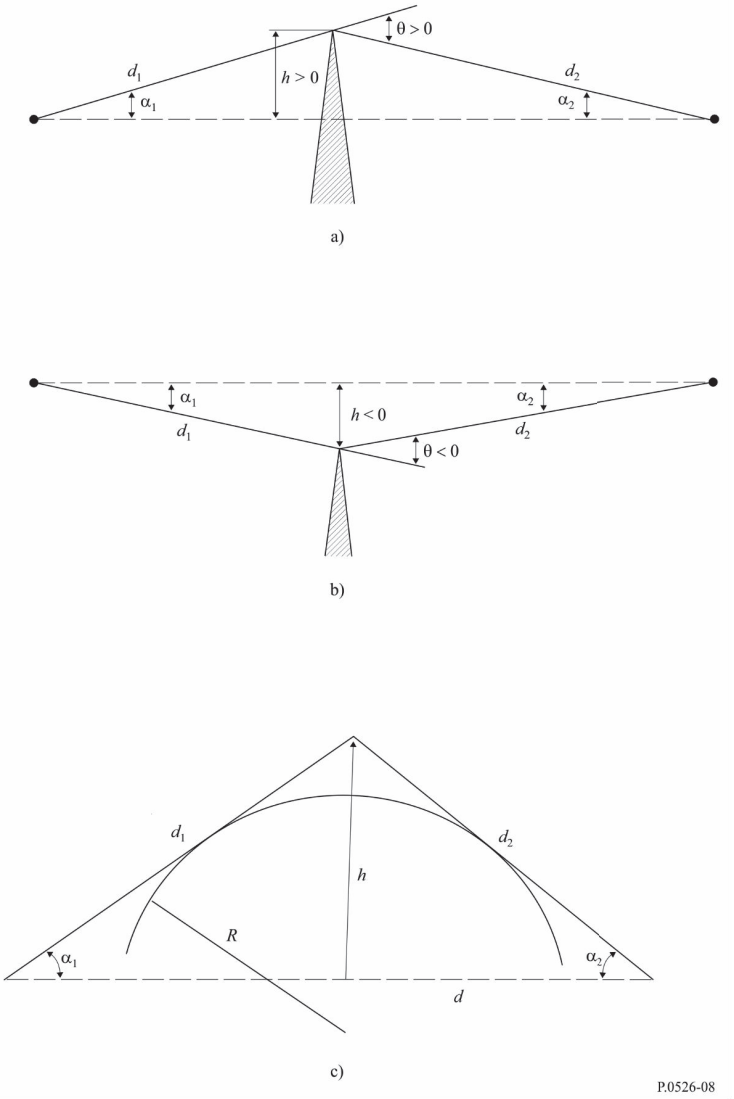


Figure 9 gives, as a function of ν, the loss $J(\nu)$ (dB).

$J(\nu)$ is given by:

$$J(\nu) = -20 \log \left(\frac{\sqrt{\left[1 - C(\nu) - S(\nu)\right]^2 + \left[C(\nu) - S(\nu)\right]^2}}{2} \right) \tag{30}$$

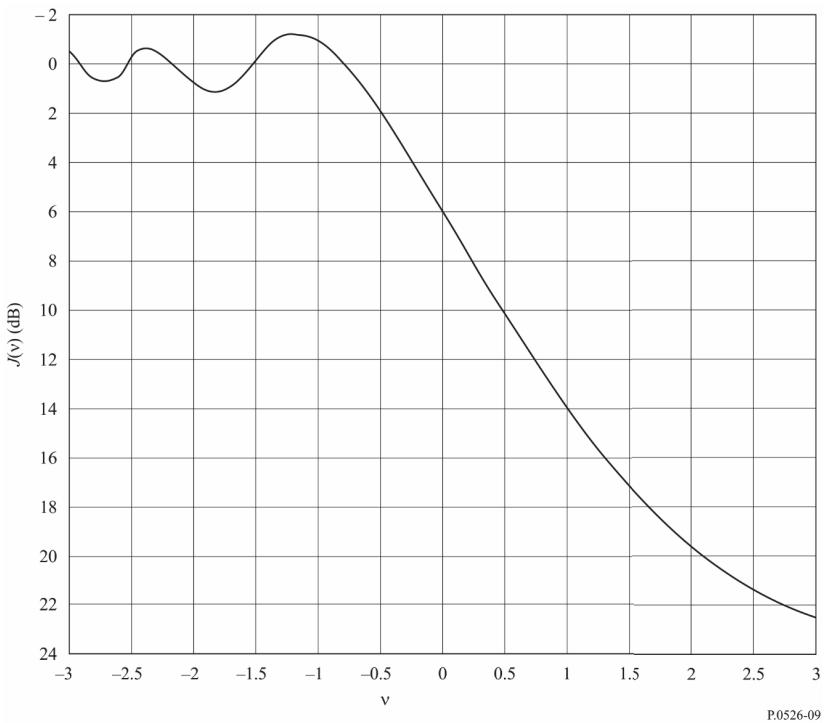
where $C(\nu)$ and $S(\nu)$ are the real and imaginary parts respectively of the complex Fresnel integral $F(\nu)$ defined in § 2.7.

For ν greater than −0.78 an approximate value can be obtained from the expression:

$$J(\nu) = 6.9 + 20 \log \left(\sqrt{(\nu - 0.1)^2 + 1} + \nu - 0.1 \right) \quad \text{dB} \tag{31}$$

FIGURE 9

Knife-edge diffraction loss



4.2 Single rounded obstacle

The geometry of a rounded obstacle of radius R is illustrated in Fig. 8c). Note that the distances d_1 and d_2, and the height h above the baseline, are all measured to the vertex where the projected rays intersect above the obstacle. The diffraction loss for this geometry may be calculated as:

$$A = J(\nu) + T(m,n) \qquad \text{dB} \tag{32}$$

where:

a) $J(\nu)$ is the Fresnel-Kirchoff loss due to an equivalent knife-edge placed with its peak at the vertex point. The dimensionless parameter ν may be evaluated from any of equations (26) to (29) inclusive. For example, in practical units equation (26) may be written:

$$\nu = 0.0316\, h \left[\frac{2(d_1 + d_2)}{\lambda\, d_1\, d_2} \right]^{1/2} \tag{33}$$

where h and λ are in metres, and d_1 and d_2 are in kilometres.

$J(\nu)$ may be obtained from Fig. 9 or from equation (31). Note that for an obstruction to LoS propagation, ν is positive and equation (31) is valid.

b) $T(m,n)$ is the additional attenuation due to the curvature of the obstacle:

$$T(m,n) = 7.2m^{1/2} - (2 - 12.5n)m + 3.6m^{3/2} - 0.8m^2 \text{ dB} \qquad \text{for } mn \le 4 \tag{34a}$$

$$T(m,n) = -6 - 20 \log (mn) + 7.2m^{1/2} - (2 - 17n)m + 3.6m^{3/2} - 0.8m^2 \text{ dB} \quad \text{for } mn > 4 \tag{34b}$$

and

$$m = R \left[\frac{d_1 + d_2}{d_1 d_2} \right] \Big/ \left[\frac{\pi R}{\lambda} \right]^{1/3} \tag{35}$$

$$n = h \left[\frac{\pi R}{\lambda} \right]^{2/3} \Big/ R \tag{36}$$

and R, d_1, d_2, h and λ are in self-consistent units.

Note that as R tends to zero, $T(m,n)$ also tend to zero. Thus equation (32) reduces to knife-edge diffraction for a cylinder of zero radius.

The obstacle radius of curvature corresponds to the radius of curvature at the apex of a parabola fitted to the obstacle profile in the vicinity of the top. When fitting the parabola, the maximum vertical distance from the apex to be used in this procedure should be of the order of the first Fresnel zone radius where the obstacle is located. An example of this procedure is shown in Fig. 10, where:

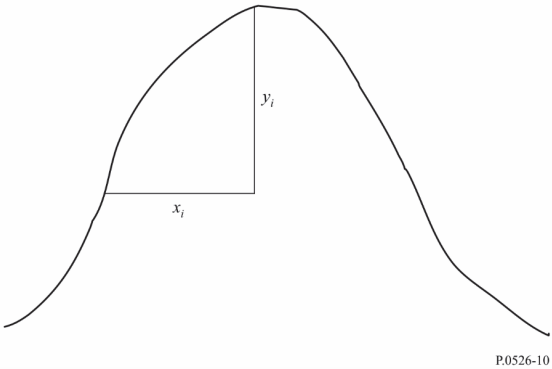
$$y_i = \frac{x_i^2}{2r_i} \tag{37}$$

and r_i is the radius of curvature corresponding to the sample i of the vertical profile of the ridge. In the case of N samples, the median radius of curvature of the obstacle is given by:

$$r = \frac{1}{N} \sum_{1}^{N} \frac{x_i^2}{2y_i} \tag{38}$$

FIGURE 10

Vertical profile of the obstacle



4.3 Double isolated edges

This method consists of applying single knife-edge diffraction theory successively to the two obstacles, with the top of the first obstacle acting as a source for diffraction over the second obstacle (see Fig. 11). The first diffraction path, defined by the distances a and b and the height h'_1, gives a loss L_1 (dB). The second diffraction path, defined by the distances b and c and the height h'_2, gives a loss L_2 (dB). L_1 and L_2 are calculated using formulae of § 4.1. A correction term L_c (dB) must be added to take into account the separation b between the edges. L_c may be estimated by the following formula:

$$L_c = 10 \log \left[\frac{(a + b)\ (b + c)}{b\,(a + b + c)} \right] \tag{39}$$

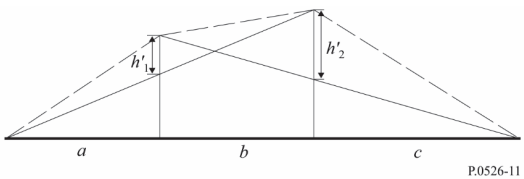
which is valid when each of L_1 and L_2 exceeds about 15 dB. The total diffraction loss is then given by:

$$L = L_1 + L_2 + L_c \tag{40}$$

The above method is particularly useful when the two edges give similar losses.

FIGURE 11

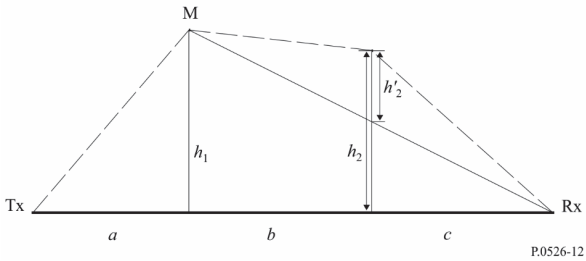
Method for double isolated edges



If one edge is predominant (see Fig. 12), the first diffraction path is defined by the distances a and $b + c$ and the height h_1. The second diffraction path is defined by the distances b and c and the height h'_2.

FIGURE 12

Figure showing the main and the second obstacle



The method consists of applying single knife-edge diffraction theory successively to the two obstacles. First, the higher h/r ratio determines the main obstacle, M, where h is the edge height from the direct path TxRx as shown in Fig. 12, and r is the first Fresnel ellipsoid radius given by equation (2). Then h'_2, the height of the secondary obstacle from the sub-path MR, is used to calculate the loss caused by this secondary obstacle. A correction term T_c (dB) must be subtracted, in order to take into account the separation between the two edges as well as their height. T_c (dB) may be estimated by the following formula:

$$T_c = \left[12 - 20 \log_{10} \left(\frac{2}{1 - \frac{\alpha}{\pi}} \right) \right] \left(\frac{q}{p} \right)^{2p} \tag{41}$$

with:

$$p = \left[\frac{2}{\lambda} \frac{(a+b+c)}{(b+c)a} \right]^{1/2} h_1 \tag{42a}$$

$$q = \left[\frac{2}{\lambda} \frac{(a+b+c)}{(a+b)c} \right]^{1/2} h_2 \tag{42b}$$

$$\tan \alpha = \left[\frac{b(a+b+c)}{ac} \right]^{1/2} \tag{42c}$$

h_1 and h_2 are the edge heights from the direct path transmitter-receiver.

The total diffraction loss is given by:

$$L = L_1 + L_2 - T_c \tag{43}$$

The same method may be applied to the case of rounded obstacles using § 4.3.

In cases where the diffracting obstacle may be clearly identified as a flat-roofed building a single knife-edge approximation is not sufficient. It is necessary to calculate the phasor sum of two components: one undergoing a double knife-edge diffraction and the other subject to an additional reflection from the roof surface. It has been shown that, where the reflectivity of the roof surface and

any difference in height between the roof surface and the side walls are not accurately known, then a double knife-edge model produces a good prediction of the diffracted field strength, ignoring the reflected component.

4.4 Multiple isolated cylinders

This method is recommended for diffraction over irregular terrain which forms one or more obstacles to LoS propagation where each obstacle can be represented by a cylinder with a radius equal to the radius of curvature at the obstacle top, being advisable when detailed vertical profile through the ridge is available.

The terrain height profile should be available as a set of samples of ground height above sea level, the first and last being the heights of the transmitter and receiver above sea level. Atmospheric refractivity gradient should be taken into account via the concept of effective Earth radius. Distance and height values are described as though stored in arrays indexed from 1 to N, where N equals the number of profile samples.

In the following a systematic use of suffices is made:

h_i: height above sea level of the i-th point

d_i: distance from the transmitter to the i-th point

d_{ij}: distance from the i-th to the j-th points.

The first step is to perform a "stretched string" analysis of the profile. This identifies the sample points which would be touched by a string stretched over the profile from transmitter to receiver. This may be done by the following procedure, in which all values of height and distance are in self-consistent units, and all angles are in radians. The method includes approximations which are valid for radio paths making small angles to the horizontal. If a path has ray gradients exceeding about 5º more exact geometry may be justified.

Each string point is identified as the profile point with the highest angular elevation above the local horizontal as viewed from the previous string point, starting at one end of the profile and finishing at the other. Viewed from point s, the elevation of the i-th profile sample ($i > s$) is given by:

$$e = \left[(h_i - h_s) / d_{si}\right] - \left[d_{si} / 2a_e\right] \tag{44}$$

where:

a_e: effective Earth radius, given by:

$= k \times 6\,371$ (km)

and

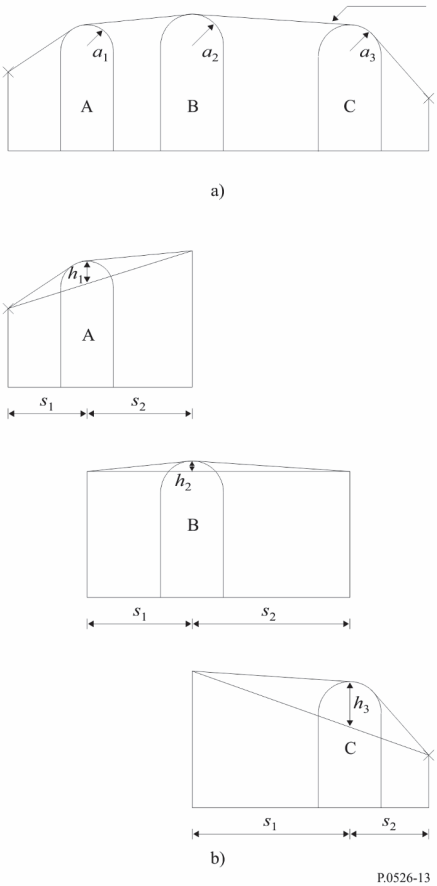
k: effective Earth-radius factor.

A test is now applied to determine whether any group of two or more string points should represent the same terrain obstruction. For samples at spacings of 250 m or less any group of string points which are consecutive profile samples, other than the transmitter or receiver, should be treated as one obstruction.

Each obstruction is now modelled as a cylinder, as illustrated in Fig. 13. The geometry of each individual cylinder corresponds with Fig. 8c). Note that in Fig. 13 the distances s_1, s_2 for each cylinder are shown as measured horizontally between the vertex points, and that for near-horizontal rays these distances approximate to the slope distances d_1 and d_2 in Fig. 8c). For ray angles to the horizontal greater than about 5º it may be necessary to set s_1 and s_2 to the inter-vertex slope distances d_1 and d_2.

FIGURE 13

The cascaded cylinder model a), overall problem b), details



Similarly in Fig. 13, the height h of each cylinder is shown as measured vertically from its vertex down to the straight line joining the adjacent vertex or terminal points. The value of h for each cylinder corresponds to h in Fig. 8c). Again, for near-horizontal rays the cylinder heights may be computed as though vertical, but for steeper ray angles it may be necessary to compute h at right angles to the baseline of its cylinder.

Figure 14 illustrates the geometry for an obstruction consisting of more than one string point. The following points are indicated by:

w: closest string point or terminal on the transmitter side of the obstruction which is not part of the obstruction

x: string point forming part of the obstruction which is closest to the transmitter

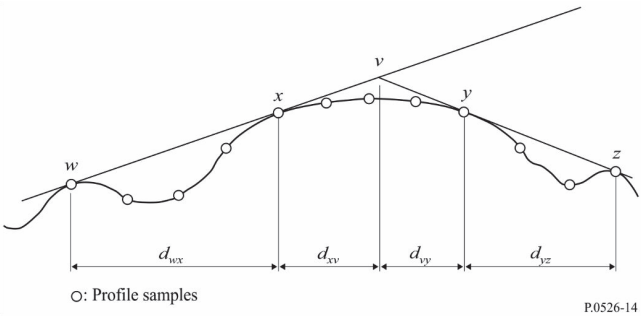
y: string point forming part of the obstruction which is closest to the receiver

z: closest string point or terminal on the receiver side of the obstruction which is not part of the obstruction

v: vertex point made by the intersection of incident rays above the obstruction.

FIGURE 14

Geometry of a multipoint obstacle



The letters w, x, y and z will also be indices to the arrays of profile distance and height samples. For an obstruction consisting of an isolated string point, x and y will have the same value, and will refer to a profile point which coincides with the vertex. Note that for cascaded cylinders, points y and z for one cylinder are points w and x for the next, etc.

A step-by-step method for fitting cylinders to a general terrain profile is described in Attachment 1 to Annex 1. Each obstruction is characterized by w, x, y and z. The method of Attachment 1 to Annex 1 is then used to obtain the cylinder parameters s_1, s_2, h and R. Having modelled the profile in this way, the diffraction loss for the path is computed as the sum of three terms:

– the sum of diffraction losses over the cylinders;

– the sum of sub-path diffraction between cylinders (and between cylinders and adjacent terminals);

– a correction term.

The total diffraction loss, in dB relative to free-space loss, may be written:

$$L_d = \sum_{i=1}^{N} L'_i + L''(w\,x)_1 + \sum_{i=1}^{N} L''(y\,z)_i - 20 \log C_N \quad \text{dB} \qquad (45)$$

where:

L'_i: diffraction loss over the i-th cylinder calculated by the method of § 4.2

$L''(w\,x)_1$: sub-path diffraction loss for the section of the path between points w and x for the first cylinder

$L''(y\,z)_i$: sub-path diffraction loss for the section of the path between points y and z for all cylinders

C_N: correction factor to account for spreading loss due to diffraction over successive cylinders.

Attachment 2 to Annex 1 gives a method for calculating L'' for each LoS section of the path between obstructions.

The correction factor, C_N, is calculated using:

$$C_N = (P_a / P_b)^{0.5} \tag{46}$$

where:

$$P_a = s_1 \prod_{i=1}^{N} \left[(s_2)_i\right] \left(s_1 + \sum_{j=1}^{N} \left[(s_2)_j\right] \right) \tag{47}$$

$$P_b = (s_1)_1 \, (s_2)_N \prod_{i=1}^{N} \left[(s_1)_i + (s_2)_i\right] \tag{48}$$

and the suffices to round brackets indicate individual cylinders.

4.5 Method for a general terrestrial path

This method is recommended for situations where an automatic process is required to predict diffraction loss for any type of path as defined by a profile, whether LoS or trans-horizon, and whether the terrain is rough or smooth. This model is based on the Bullington construction, but also makes use of the spherical Earth diffraction model as described in § 3.2. These models are combined so that for a completely smooth path, the result will be the same as the spherical Earth model.

The path must be described by a profile consisting of samples of terrain height in metres above sea level for a succession of distances from one terminal to the other. Unlike the profile required in § 4.4, the first and last points of this profile, (d_1, h_1) and (d_n, h_n), must give terrain height underneath the two antennas, and the antenna heights above ground must be supplied separately.

In this model, there is no requirement for the profile points to be equally spaced. However, it is important that the maximum point spacing is not large compared to the sample spacing of the topographic data from which it is extracted. It is particularly inadvisable to represent a section of constant height profile, such as water, by a first and last point separated by the length of the flat section of the path. The model performs no interpolation between profile points, and due to Earth curvature a large distance between profile points, however flat the profile between, can lead to significant errors.

Where urbanization or tree cover exists along the profile, it will normally improve accuracy to add a representative clutter height to bare earth terrain heights. This should not be done for the terminal locations (first and last profile points) and care is needed close to the terminals to ensure that the addition of cover heights does not cause an unrealistic increase in the horizon elevation angles as seen by each antenna. If a terminal is in an area with ground cover and below the representative cover height, it may be preferable to raise the terminal to the cover height for the application of this model, and to use a separate height-gain correction for the additional loss actually experienced by the terminal in its actual (lower) position.

This method should be used when there is no *a priori* information as to the nature of the propagation path or of possible terrain obstructions. This is typical of the case where a computer program is used for profiles selected from a terrain height database on a fully automatic basis, with no individual inspection of path characteristics. The method gives reliable results for all types of path, LoS or trans-horizon, rough or smooth, or over the sea or large bodies of water.

The method contains two sub-models:

a) the Bullington diffraction method used with a tapered correction to provide a smooth transition between LoS and trans-horizon;

b) the spherical Earth method given in § 3.2.

The Bullington part of the method is used twice. The following subsection gives a general description of the Bullington calculation.

4.5.1 Bullington model

In the following equations slopes are calculated in m/km relative to the baseline joining sea level at the transmitter to sea level at the receiver. The distance and height of the i-th profile point are d_i km and h_i m above sea level respectively, i takes values from 1 to n where n is the number of profile points, and the complete path length is d km. For convenience the terminals at the start and end of the profile are referred to as transmitter and receiver, with heights in m above sea level h_{ts} and h_{rs}, respectively. Effective Earth curvature C_e km^{-1} is given by $1/r_e$ where r_e is effective Earth radius in km. Wavelength in metres is represented by λ.

Find the intermediate profile point with the highest slope of the line from the transmitter to the point.

$$S_{tim} = \max\left[\frac{h_i + 500 C_e d_i (d - d_i) - h_{ts}}{d_i}\right] \qquad \text{m/km} \tag{49}$$

where the profile index i takes values from 2 to n − 1.

Calculate the slope of the line from transmitter to receiver assuming an LoS path:

$$S_{tr} = \frac{h_{rs} - h_{ts}}{d} \qquad \text{m/km} \tag{50}$$

Two cases must now be considered.

Case 1. Path is LoS

If $S_{tim} < S_{tr}$ the path is LoS.

Find the intermediate profile point with the highest diffraction parameter ν:

$$\nu_{\max} = \max\left\{\left[h_i + 500 C_e d_i (d - d_i) - \frac{h_{ts}(d - d_i) + h_{rs} d_i}{d}\right]\sqrt{\frac{0.002 d}{\lambda d_i (d - d_i)}}\right\} \tag{51}$$

where the profile index i takes values from 2 to n − 1.

In this case, the knife-edge loss for the Bullington point is given by:

$$L_{uc} = J(\nu_{\max}) \qquad \text{dB} \tag{52}$$

where the function J is given by equation (31) for ν_b greater than −0.78, and is zero otherwise.

Case 2. Path is trans-horizon

If $S_{tim} \geq S_{tr}$ the path is trans-horizon.

Find the intermediate profile point with the highest slope of the line from the receiver to the point.

$$S_{rim} = \max\left[\frac{h_i + 500 C_e d_i (d - d_i) - h_{rs}}{d - d_i}\right] \qquad \text{m/km} \tag{53}$$

where the profile index i takes values from 2 to n − 1.

Calculate the distance of the Bullington point from the transmitter:

$$d_b = \frac{h_{rs} - h_{ts} + S_{rim} d}{S_{tim} + S_{rim}} \qquad \text{km} \tag{54}$$

Calculate the diffraction parameter, ν_b, for the Bullington point:

$$\nu_b = \left[h_{ts} + S_{tim} d_b - \frac{h_{ts}(d-d_b)+h_{rs}d_b}{d}\right]\sqrt{\frac{0.002d}{\lambda d_b(d-d_b)}} \tag{55}$$

In this case, the knife-edge loss for the Bullington point is given by:

$$L_{uc} = J(\nu_b) \qquad \text{dB} \tag{56}$$

For L_{uc} calculated using either equation (52) or (56), Bullington diffraction loss for the path is now given by:

$$L_b = L_{uc} + [1 - \exp(-L_{uc}/6)](10 + 0.02\,d) \tag{57}$$

4.5.2 Complete method

Use the method in § 4.5.1 for the actual terrain profile and antenna heights. Set the resulting Bullington diffraction loss for the actual path, L_{ba} dB, to L_b as given by equation (57).

Find the effective transmitter and receiver heights relative to a smooth surface fitted to the profile.

Calculate initial provisional values for the heights of the smooth surface at the transmitter and receiver ends of the path, as follows:

$$v_1 = \sum_{i=2}^{n}(d_i - d_{i-1})(h_i + h_{i-1}) \tag{58}$$

$$v_2 = \sum_{i=2}^{n}(d_i - d_{i-1})\left[h_i(2d_i + d_{i-1}) + h_{i-1}(d_i + 2d_{i-1})\right] \tag{59}$$

$$h_{stip} = \left(\frac{2v_1 d - v_2}{d^2}\right) \tag{60a}$$

$$h_{srip} = \left(\frac{v_2 - v_1 d}{d^2}\right) \tag{60b}$$

Find the highest obstruction height above the straight-line path from transmitter to receiver h_{obs}, and the horizon elevation angles α_{obt}, α_{obr}, all based on flat-Earth geometry, according to:

$$h_{obs} = \max\{h_{obi}\} \qquad \text{m} \tag{61a}$$

$$\alpha_{obt} = \max\{h_{obi}/d_i\} \qquad \text{mrad} \tag{61b}$$

$$\alpha_{obr} = \max\{h_{obi}/(d-d_i)\} \qquad \text{mrad} \tag{61c}$$

where:

$$h_{obi} = h_i - [h_{ts}(d-d_i) + h_{rs}d_i]/d \qquad \text{m} \tag{61d}$$

and the profile index i takes values from 2 to $(n - 1)$.

Calculate provisional values for the heights of the smooth surface at the transmitter and receiver ends of the path:

If h_{obs} is less than or equal to zero, then:

$$h_{stp} = h_{stip} \qquad \text{masl} \tag{62a}$$

$$h_{srp} = h_{srip} \qquad \text{masl} \tag{62b}$$

otherwise:

$$h_{stp} = h_{stip} - h_{obs} g_t \qquad \text{masl} \tag{62c}$$

$$h_{srp} = h_{srip} - h_{obs} g_r \qquad \text{masl} \tag{62d}$$

where:

$$g_t = \alpha_{obt} / (\alpha_{obt} + \alpha_{obr}) \tag{62e}$$

$$g_r = \alpha_{obr} / (\alpha_{obt} + \alpha_{obr}) \tag{62f}$$

Calculate final values for the heights of the smooth surface at the transmitter and receiver ends of the path:

If h_{stp} is greater than h_1 then:

$$h_{st} = h_1 \qquad \text{masl} \tag{63a}$$

otherwise:

$$h_{st} = h_{stp} \qquad \text{masl} \tag{63b}$$

If h_{srp} is greater than h_n then:

$$h_{sr} = h_n \qquad \text{masl} \tag{63c}$$

otherwise:

$$h_{sr} = h_{srp} \qquad \text{masl} \tag{63d}$$

Use the method in § 4.5.1 for a smooth profile by setting all profile heights h_i to zero, and with modified antenna heights:

$$h'_{ts} = h_{ts} - h_{st} \qquad \text{masl} \tag{64a}$$

$$h'_{rs} = h_{rs} - h_{sr} \qquad \text{masl} \tag{64b}$$

Set the resulting Bullington diffraction loss for the smooth path, L_{bs} dB, to L_b as given by equation (57).

Use the method for diffraction over spherical earth given in § 3.2 for the actual path length d km and with:

$$h_1 = h'_{ts} \qquad \text{m} \tag{65a}$$

$$h_2 = h'_{rs} \qquad \text{m} \tag{65b}$$

Set the resulting spherical-earth diffraction loss, L_{sph} dB, to A as given by equation (25).

The diffraction loss for the general path is now given by:

$$L = L_{ba} + \max\{L_{sph} - L_{bs}, 0\} \qquad \text{dB} \tag{66}$$

5 Diffraction by thin screens

The following methods assume that the obstruction is in the form of a thin screen. They can be applied to propagation around an obstacle or through an aperture.

5.1 Finite-width screen

Interference suppression for a receiving site (e.g. a small earth station) may be obtained by an artificial screen of finite width transverse to the direction of propagation. For this case the field in the shadow of the screen may be calculated by considering three knife-edges, i.e. the top and the two sides of the screen. Constructive and destructive interference of the three independent contributions will result in rapid fluctuations of the field strength over distances of the order of a wavelength. The following simplified model provides estimates for the average and minimum diffraction loss as a function of location. It consists of adding the amplitudes of the individual contributions for an estimate of the minimum diffraction loss and a power addition to obtain an estimate of the average diffraction loss. The model has been tested against accurate calculations using the uniform theory of diffraction (UTD) and high-precision measurements.

Step 1: Calculate the geometrical parameter ν for each of the three knife-edges (top, left side and right side) using any of equations (26) to (29).

Step 2: Calculate the loss factor $j(\nu) = 10^{J(\nu)/20}$ associated with each edge from equation (31).

Step 3: Calculate minimum diffraction loss J_{min} from:

$$J_{min}(\nu) = -20 \log \left[\frac{1}{j_1(\nu)} + \frac{1}{j_2(\nu)} + \frac{1}{j_3(\nu)} \right] \quad \text{dB} \tag{67}$$

or, alternatively,

Step 4: Calculate average diffraction loss J_{av} from:

$$J_{av}(\nu) = -10 \log \left[\frac{1}{j_1^2(\nu)} + \frac{1}{j_2^2(\nu)} + \frac{1}{j_3^2(\nu)} \right] \quad \text{dB} \tag{68}$$

5.2 Diffraction by rectangular apertures and composite apertures or screens

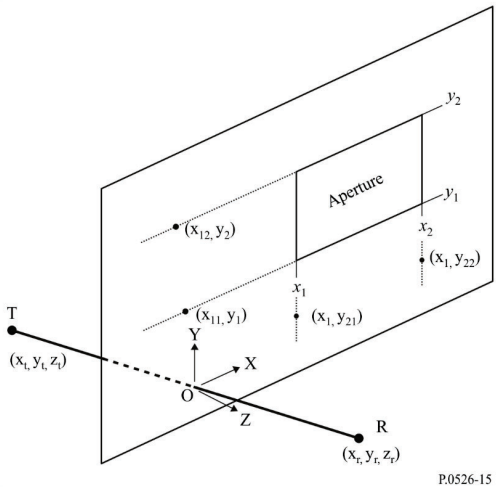
The method described below can be used to predict the diffraction loss due to a rectangular aperture in an otherwise totally absorbing thin screen. The method can be extended to cover several rectangular apertures or finite screens, and is thus an alternative method for the finite-width screen discussed in § 5.1.

5.2.1 Diffraction by a single rectangular aperture

Figure 15 shows the geometry used to represent a rectangular aperture in an infinite totally absorbing thin screen.

FIGURE 15

Geometry for a single rectangular aperture



The positions of the aperture edges, x_1, x_2, y_1 and y_2, are given in a Cartesian coordinate system with origin at the point where the straight line from transmitter T at coordinates x_t, y_t, z_t, to receiver R at coordinates x_r, y_r, z_r, passes through the screen in the X-Y plane, with propagation not necessarily parallel to the Z axis. The origin is on the plane of the screen.

The angle θ_p between the direction of propagation and the Z axis is

$$\theta_p = \arctan\left(\frac{\sqrt{(x_r-x_t)^2+(y_r-y_t)^2}}{z_r-z_t}\right) \qquad \text{rad} \tag{69}$$

The field strength, e_a, at the receiver in linear units normalized to free space, and in complex form, may be evaluated accurately for small θ_p by the Fresnel integral method of § 5.2.1.1, or with reasonable accuracy for any θ_p by the semi-empirical method of § 5.2.1.2.

The corresponding diffraction loss L_a is given by:

$$L_a = -20 \log (|e_a|) \qquad \text{dB} \tag{70}$$

5.2.1.1 Fresnel integral method

$$e_a(x_1,x_2,y_1,y_2) = 0.5(C_xS_y + S_xC_y) + j\,0.5(S_xS_y - C_xC_y) \tag{71}$$

where:

$$C_x = C(\nu_{x2}) - C(\nu_{x1}) \tag{72a}$$

$$C_y = C(\nu_{y2}) - C(\nu_{y1}) \tag{72b}$$

$$S_x = S(\nu_{x2}) - S(\nu_{x1}) \tag{72c}$$

$$S_y = S(\nu_{y2}) - S(\nu_{y1}) \tag{72d}$$

$C(\nu)$ and $S(\nu)$ are as given in equations (7a) and (7b) and may be evaluated from the complex Fresnel coefficient using equations (8a) and (8b).

The four diffraction parameters ν_{x1}, ν_{x2}, ν_{y1}, and ν_{y2} are:

$$\nu_{x1} = \mathrm{sgn}(x_1)\sqrt{\frac{2}{\lambda}|x_1|^{1.18}\left(\frac{1}{z_r} - \frac{1}{z_t}\right)^{0.18}|\phi_{21}|^{0.82}} \tag{73a}$$

$$\nu_{x2} = \mathrm{sgn}(x_2)\sqrt{\frac{2}{\lambda}|x_2|^{1.18}\left(\frac{1}{z_r} - \frac{1}{z_t}\right)^{0.18}|\phi_{22}|^{0.82}} \tag{73b}$$

$$\nu_{y1} = \mathrm{sgn}(y_1)\sqrt{\frac{2}{\lambda}|y_1|^{1.18}\left(\frac{1}{z_r} - \frac{1}{z_t}\right)^{0.18}|\phi_{11}|^{0.82}} \tag{73c}$$

$$\nu_{y2} = \mathrm{sgn}(y_2)\sqrt{\frac{2}{\lambda}|y_2|^{1.18}\left(\frac{1}{z_r} - \frac{1}{z_t}\right)^{0.18}|\phi_{12}|^{0.82}} \tag{73d}$$

with:

$$\phi_{21} = \arctan\left(\frac{x_1 - x_r}{z_r}\right) - \arctan\left(\frac{x_1 - x_t}{z_t}\right) \quad \text{rad} \tag{73e}$$

$$\phi_{22} = \arctan\left(\frac{x_2 - x_r}{z_r}\right) - \arctan\left(\frac{x_2 - x_t}{z_t}\right) \quad \text{rad} \tag{73f}$$

$$\phi_{11} = \arctan\left(\frac{y_1 - y_r}{z_r}\right) - \arctan\left(\frac{y_1 - y_t}{z_t}\right) \quad \text{rad} \tag{73g}$$

$$\phi_{12} = \arctan\left(\frac{y_2 - y_r}{z_r}\right) - \arctan\left(\frac{y_2 - y_t}{z_t}\right) \quad \text{rad} \tag{73h}$$

5.2.1.2 Semi-empirical method

For reasonable accuracy at any θ_p, the following method does not require the Fresnel integrals $C(\nu)$ and $S(\nu)$:

$$e_a = \prod_{i=1}^{2}\left[\mathrm{sgn}(\phi_{i1})\left(\frac{1}{2} - \frac{ph_{i1}}{Ph}G_{i1}\right) - \mathrm{sgn}(\phi_{i2})\left(\frac{1}{2} - \frac{ph_{i2}}{Ph}G_{i2}\right)\right] \tag{74}$$

where:

$$G_{ij} = \cos\left(\frac{\phi_{ij}}{2}\right)\left[\frac{1}{2} - \frac{1}{\pi}\arctan\left(1.4\nu_{ij}\right)\right] \tag{75}$$

with φ_{ij} from equations (73e) to (73h), and

$$\nu_{ij} = 2\sqrt{\frac{1}{\lambda}\left(D_{t-proj-ij} + D_{r-proj-ij} - r_{proj-i}\right)} \tag{76}$$

$$r_{proj-1} = \sqrt{(z_r - z_t)^2 + (y_r - y_t)^2} \tag{77a}$$

$$r_{proj-2} = \sqrt{(z_r - z_t)^2 + (x_r - x_t)^2} \tag{77b}$$

$$D_{t-proj-11} = \sqrt{z_t^2 + (y_1 - y_t)^2} \tag{78a}$$

$$D_{t-proj-12} = \sqrt{z_t^2 + (y_2 - y_t)^2} \tag{78b}$$

$$D_{t-proj-21} = \sqrt{z_t^2 + (x_1 - x_t)^2} \tag{78c}$$

$$D_{t-proj-22} = \sqrt{z_t^2 + (x_2 - x_t)^2} \tag{78d}$$

$$D_{r-proj-11} = \sqrt{z_r^2 + (y_1 - y_r)^2} \tag{78e}$$

$$D_{r-proj-12} = \sqrt{z_r^2 + (y_2 - y_r)^2} \tag{78f}$$

$$D_{r-proj-21} = \sqrt{z_r^2 + (x_1 - x_r)^2} \tag{78g}$$

$$D_{r-proj-22} = \sqrt{z_r^2 + (x_2 - x_r)^2} \tag{78h}$$

Evaluate D_{11}, D_{12}, D_{21}, D_{22}:

$$D_{ij} = \sqrt{(z_r)^2 + (y_r - y_{ij})^2 + (x_r - x_{ij})^2} + \sqrt{(z_t)^2 + (y_t - y_{ij})^2 + (x_t - x_{ij})^2} \tag{79}$$

where, if $D_{\text{r-proj-1}j} \neq D_{\text{t-proj-1}j}$

$$x_{1j} = \frac{x_t \left(D_{\text{r-proj-1}j}\right)^2 - x_r \left(D_{\text{t-proj-1}j}\right)^2 - D_{\text{t-proj-1}j} D_{\text{r-proj-1}j} (x_t - x_r)}{\left(D_{\text{r-proj-1}j}\right)^2 - \left(D_{\text{t-proj-1}j}\right)^2}, \tag{80a}$$

or if $D_{\text{r-proj-1}j} = D_{\text{t-proj-1}j}$

$$x_{1j} = \frac{x_t + x_r}{2}, \tag{80b}$$

and if $D_{\text{r-proj-2}j} \neq D_{\text{t-proj-2}j}$

$$y_{2j} = \frac{y_t \left(D_{\text{r-proj-2}j}\right)^2 - y_r \left(D_{\text{t-proj-2}j}\right)^2 - D_{\text{t-proj-2}j} D_{\text{r-proj-2}j} (y_t - y_r)}{\left(D_{\text{r-proj-2}j}\right)^2 - \left(D_{\text{t-proj-2}j}\right)^2}, \tag{81a}$$

or if $D_{\text{r-proj-2}j} = D_{\text{t-proj-2}j}$

$$y_{2j} = \frac{y_t + y_r}{2} \tag{81b}$$

and $$y_{1j} = y_j \, , x_{2j} = x_j \tag{82}$$

using ph_{11}, ph_{12}, ph_{21}, ph_{22}, from

$$ph_{ij} = \exp\left(\frac{-j2\pi D_{ij}}{\lambda} \right) \tag{83}$$

and Ph:

$$Ph = \exp\left(\frac{-j2\pi r}{\lambda} \right) \tag{84}$$

5.2.2 Diffraction by composite apertures or screens

The method for a single rectangular aperture can be extended as follows:

Since in the linear units normalized to free space of equations (71) or (74) the free-space field is given by 1.0 + j 0.0, the normalized complex field e_s due to a single rectangular screen (isolated from ground) is given by:

$$e_s = 1.0 - e_a \tag{85}$$

where e_a is calculated using equations (71) or (74) for an aperture of the same size and position as the screen.

– The normalized field due to combinations of several rectangular apertures or isolated screens can be calculated by adding the results of equations (71) or (74).

– Arbitrarily shaped apertures or screens can be approximated by suitable combinations of rectangular apertures or screens.

– Since the $C(\nu)$ and $S(\nu)$ integrals converge to 0.5 + j 0.5 as ν approaches infinity, equation (71) can be applied to rectangles of unlimited extent in one or more directions.

6 Diffraction over a finitely conducting wedge

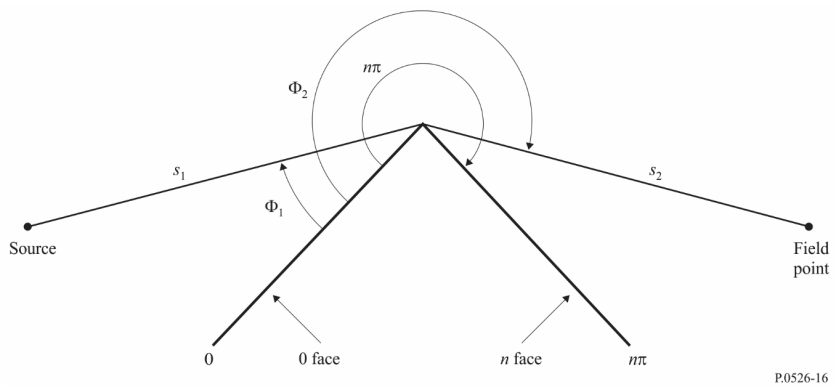
The method described below can be used to predict the diffraction loss due to a finitely conducting wedge. Suitable applications are for diffraction around the corner of a building or over the ridge of a roof, or where terrain can be characterized by a wedge-shaped hill. The method requires the conductivity and relative dielectric constant of the obstructing wedge, and assumes that no transmission occurs through the wedge material.

The method is based on UTD. It takes account of diffraction in both the shadow and line-of-sight region, and a method is provided for a smooth transition between these regions.

The geometry of a finitely conducting wedge-shaped obstacle is illustrated in Fig. 16.

FIGURE 16

Geometry for application of UTD wedge diffraction



The UTD formulation for the electric field at the field point, specializing to two dimensions, is:

$$e_{UTD} = e_0 \frac{\exp(-\mathrm{j}ks_1)}{s_1} D^{\perp\parallel} \cdot \sqrt{\frac{s_1}{s_2(s_1 + s_2)}} \cdot \exp(-\mathrm{j}ks_2) \tag{86}$$

where:

e_{UTD}: electric field at the field point

e_0: relative source amplitude

s_1: distance from source point to diffracting edge

s_2: distance from diffracting edge to field point

k: wave number $2\pi/\lambda$

$D^{\perp\parallel}$: diffraction coefficient depending on the polarization (parallel or perpendicular to the plane of incidence) of the incident field on the edge

and s_1, s_2 and λ are in self-consistent units.

The diffraction coefficient for a finitely conducting wedge is given as:

$$D^{\perp\parallel} = \frac{-\exp(-\mathrm{j}\pi/4)}{2n\sqrt{2\pi k}} \left\{ \begin{array}{l} \cot\left(\dfrac{\pi + (\Phi_2 - \Phi_1)}{2n}\right) \cdot F(kLa^+(\Phi_2 - \Phi_1)) \\ + \cot\left(\dfrac{\pi - (\Phi_2 - \Phi_1)}{2n}\right) \cdot F(kLa^-(\Phi_2 - \Phi_1)) \\ + R_0^{\perp\parallel} \cdot \cot\left(\dfrac{\pi - (\Phi_2 + \Phi_1)}{2n}\right) \cdot F(kLa^-(\Phi_2 + \Phi_1)) \\ + R_n^{\perp\parallel} \cdot \cot\left(\dfrac{\pi + (\Phi_2 + \Phi_1)}{2n}\right) \cdot F(kLa^+(\Phi_2 + \Phi_1)) \end{array} \right\} \tag{87}$$

where:

Φ_1: incidence angle, measured from incidence face (0 face)

Φ_2: diffraction angle, measured from incidence face (0 face)

n: external wedge angle as a multiple of π radians (actual angle = $n\pi$ (rad))

$\mathrm{j} = \sqrt{-1}$

and where $F(x)$ is a Fresnel integral:

$$F(x) = 2\mathrm{j}\sqrt{x} \cdot \exp(\mathrm{j}x) \cdot \int_{\sqrt{x}}^{\infty} \exp(-\mathrm{j}t^2)\, \mathrm{d}t \tag{88}$$

$$\int_{\sqrt{x}}^{\infty} \exp(-\mathrm{j}t^2)\, \mathrm{d}t = \sqrt{\frac{\pi}{8}}(1 - \mathrm{j}) - \int_{0}^{\sqrt{x}} \exp(-\mathrm{j}t^2)\, \mathrm{d}t \tag{89}$$

The integral may be calculated by numerical integration.

Alternatively a useful approximation is given by:

$$\int_{\sqrt{x}}^{\infty} \exp(-\mathrm{j}t^2)\, \mathrm{d}t = \sqrt{\frac{\pi}{2}} A(x) \tag{90}$$

where:

$$A(x) = \begin{cases} \dfrac{1 - \mathrm{j}}{2} - \exp(-\mathrm{j}x)\sqrt{\dfrac{x}{4}} \displaystyle\sum_{n=0}^{11} \left[(a_n + \mathrm{j}b_n)\left(\frac{x}{4}\right)^n \right] & \text{if } x < 4 \\ -\exp(-\mathrm{j}x)\sqrt{\dfrac{4}{x}} \displaystyle\sum_{n=0}^{11} \left[(c_n + \mathrm{j}d_n)\left(\frac{4}{x}\right)^n \right] & \text{otherwise} \end{cases} \tag{91}$$

and the coefficients a, b, c, d are given in § 2.7.

$$L = \frac{s_2 \cdot s_1}{s_2 + s_1} \tag{92}$$

$$a^{\pm}(\beta) = 2\cos^2\left(\frac{2n\pi N^{\pm} - \beta}{2}\right) \tag{93}$$

where:

$$\beta = \Phi_2 \pm \Phi_1 \tag{94}$$

In equation (45), $N^{\pm}$ are the integers which most nearly satisfy the equation.

$$N^{\pm} = \frac{\beta \pm \pi}{2n\pi} \tag{95}$$

$R_0^{\perp\|}, R_n^{\perp\|}$ are the reflection coefficients for either perpendicular or parallel polarization given by:

$$R^{\perp} = \frac{\sin(\Phi) - \sqrt{\eta - \cos(\Phi)^2}}{\sin(\Phi) + \sqrt{\eta - \cos(\Phi)^2}} \tag{96}$$

$$R^{\|} = \frac{\eta \cdot \sin(\Phi) - \sqrt{\eta - \cos(\Phi)^2}}{\eta \cdot \sin(\Phi) + \sqrt{\eta - \cos(\Phi)^2}} \tag{97}$$

where:

$$\Phi = \Phi_1 \text{ for } R_0 \text{ and } \Phi = (n\pi - \Phi_2) \text{ for } R_n$$

$$\eta = \varepsilon_r - \mathrm{j} \times 18 \times 10^9 \sigma / f$$

ε_r: relative dielectric constant of the wedge material

σ: conductivity of the wedge material (S/m)

f: frequency (Hz).

Note that if necessary the two faces of the wedge may have different electrical properties.

At shadow and reflection boundaries one of the cotangent functions in equation (87) becomes singular.

However $D^{\perp\parallel}$ remains finite, and can be readily evaluated. The term containing the singular cotangent function is given for small ε as:

$$\cot\left(\frac{\pi \pm \beta}{2n}\right) \cdot F(kLa^{\pm}(\beta)) \cong n \cdot \left[\sqrt{2\pi kL} \cdot \operatorname{sign}(\varepsilon) - 2kL\varepsilon \cdot \exp(\mathrm{j}\pi/4)\right] \cdot \exp(\mathrm{j}\pi/4) \tag{98}$$

with ε defined by:

$$\varepsilon = \pi + \beta - 2\pi n N^{+} \quad \text{for} \quad \beta = \Phi_2 + \Phi_1 \tag{99}$$

$$\varepsilon = \pi - \beta + 2\pi n N^{-} \quad \text{for} \quad \beta = \Phi_2 - \Phi_1 \tag{100}$$

The resulting diffraction coefficient will be continuous at shadow and reflection boundaries, provided that the same reflection coefficient is used when calculating reflected rays.

The field e_{LD} due to the diffracted ray, plus the LoS ray for $(\Phi_2 - \Phi_1) < \pi$, is given by:

$$e_{LD} = \begin{cases} e_{UTD} + \dfrac{\exp(-\mathrm{j}ks)}{s} & \text{for} \quad \Phi_2 < \Phi_1 + \pi \\ e_{UTD} & \text{for} \quad \Phi_2 \geq \Phi_1 + \pi \end{cases} \tag{101}$$

where:

s: straight-line distance between the source and field points.

Note that at $(\Phi_2 - \Phi_1) = \pi$ the 2nd cotangent term in equation (87) will become singular, and that the alternative approximation given by equation (98) must be used.

The field strength at the field point (dB) relative to the field which would exist at the field point in the absence of the wedge-shaped obstruction (i.e. dB relative to free space) is given by setting e_0 to unity in equation (86) and calculating:

$$E_{UTD} = 20 \log\left(\left|\frac{s \cdot e_{UTD}}{\exp(-\mathrm{j}ks)}\right|\right) \tag{102}$$

where:

s: straight-line distance between the source and field points.

Note that, for $n = 2$ and zero reflection coefficients, this should give the same results as the knife edge diffraction loss curve shown in Fig. 9.

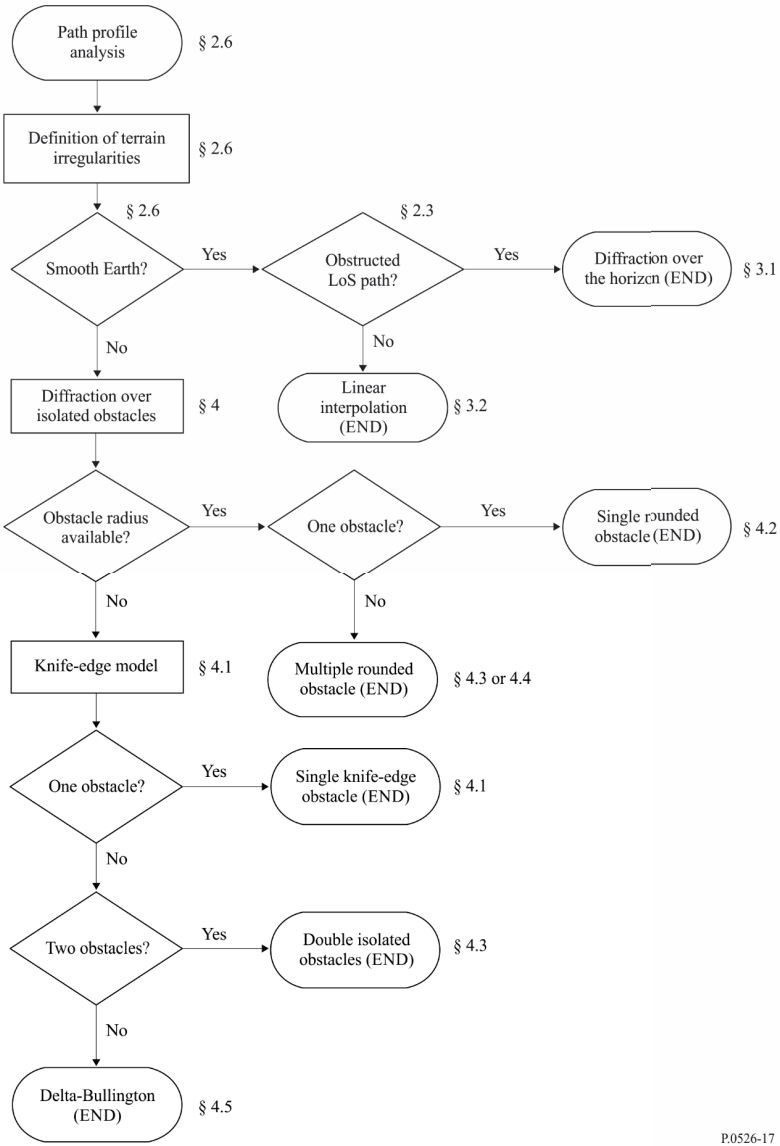
A MathCAD version of the UTD formulation is available from the Radiocommunication Bureau.

7 Guide to propagation by diffraction

A general guide for the evaluation of diffraction loss corresponding to §§ 3 and 4 is shown in Fig. 17. This flow chart summarizes the procedure to be adopted in each case.

FIGURE 17

Guide to propagation by diffraction



Attachment 1
to Annex 1

Calculation of cylinder parameters

The following procedure can be used to calculate the cylinder parameters illustrated in Figs 8c) and 14 for each of the terrain obstructions. Self-consistent units are used, and all angles are in radians. The approximations used are valid for radio paths which are within about 5º of horizontal.

1 Diffraction angle and position of vertex

Although not used directly as cylinder parameters, both the diffraction angle over the cylinder and the position of the vertex are required.

The diffraction angle over the obstacle is given by:

$$\theta = \alpha_w + \alpha_z + \alpha_e \tag{103}$$

where α_w and α_z are the angular elevations of points x and y above the local horizontal as viewed from points w and z respectively, given by:

$$\alpha_w = \frac{(h_x - h_w)}{d_{wx}} - \frac{d_{wx}}{2a_e} \tag{104}$$

$$\alpha_z = \frac{(h_y - h_z)}{d_{yz}} - \frac{d_{yz}}{2a_e} \tag{105}$$

and α_e is the angle subtended by the great-circle distance between points w and z given by:

$$\alpha_e = \frac{d_{wz}}{a_e} \tag{106}$$

The distance of the vertex from point w is calculated according to whether the obstruction is represented by a single profile sample or by more than one.

For a single-point obstruction:

$$d_{wv} = d_{wx} \tag{107}$$

For a multipoint obstruction it is necessary to protect against very small values of diffraction:

$$d_{wv} = \frac{\left[\left(\alpha_z + \frac{\alpha_e}{2}\right) d_{wz} + h_z - h_w\right]}{\theta} \qquad \text{for } \theta \cdot a_e \geq d_{xy} \tag{108a}$$

$$d_{wv} = \frac{(d_{wx} + d_{wy})}{2} \qquad \text{for } \theta \cdot a_e < d_{xy} \tag{108b}$$

The distance of point z from the vertex point is given by:

$$d_{vz} = d_{wz} - d_{wv} \tag{109}$$

The height of the vertex point above sea level is calculated according to whether the obstruction is represented by a single profile sample or by more than one.

For a single point obstruction:

$$h_v = h_x \tag{110}$$

For a multipoint obstruction:

$$h_v = d_{wv}\alpha_w + h_w + \frac{d_{wv}^2}{2a_e} \tag{111}$$

2 Cylinder parameters

The cylinder parameters illustrated in Fig. 8c) can now be calculated for each of the terrain obstacles defined by the string analysis:

d_1 and d_2 are the positive inter-vertex distances to the obstacles (or terminals) on the transmitter and receiver sides of the obstacle respectively,

and:

$$h = h_v + \frac{d_{wv}d_{vz}}{2a_e} - \frac{(h_w d_{vz} + h_z d_{wv})}{d_{wz}} \tag{112}$$

To calculate the cylinder radius use is made of two further profile samples:

p: the point adjacent to x on the transmitter side,

and:

q: the point adjacent to y on the receiver side.

Thus the profile indices p and q are given by:

$$p = x - 1 \tag{113}$$

and:

$$q = y + 1 \tag{114}$$

If a point given by p or q is a terminal, then the corresponding value of h should be the terrain height at that point, not the height above sea level of the antenna.

The cylinder radius is calculated as the difference in slope between the profile section p-x and y-q, allowing for Earth curvature, divided by the distance between p and q.

The distances between profile samples needed for this calculation are:

$$d_{px} = d_x - d_p \tag{115}$$

$$d_{yq} = d_q - d_y \tag{116}$$

$$d_{pq} = d_q - d_p \tag{117}$$

The difference in slope between the p-x and y-q profile sections is given in radians by:

$$t = \frac{(h_x - h_p)}{d_{px}} + \frac{(h_y - h_q)}{d_{yq}} - \frac{d_{pq}}{a_e} \tag{118}$$

where a_e is the effective Earth radius.

The cylinder radius is now given by:

$$R = \left[d_{pq} / t\right] \left[1 - \exp(-4\,\nu)\right]^3 \tag{119}$$

where ν is the dimensionless knife-edge parameter in equation (32).

In equation (119), the second factor is an empirical smoothing function applied to the cylinder radius to avoid discontinuities for marginally LoS obstructions.

Attachment 2 to Annex 1

Sub-path diffraction losses

1 Introduction

This Attachment provides a method for computing the sub-path diffraction loss for a LoS subsection of a diffraction path. The path has been modelled by cascaded cylinders each characterized by profile points *w*, *x*, *y* and *z* as illustrated in Figs 13 and 14. The sub-path diffraction is to be calculated for each subsection of the overall path between points represented by *w* and *x*, or by *y* and *z*. These are the LoS sections of the path between obstructions, or between a terminal and an obstruction.

The method can also be used for a LoS with sub-path diffraction, in which case it is applied to the entire path.

2 Method

For a LoS section of the profile between profile samples indexed by *u* and *v*, the first task is to identify the profile sample between but excluding *u* and *v* which obstructs the largest fraction of the first Fresnel zone for a ray travelling from *u* to *v*.

To avoid selecting a point which is essentially part of one of the terrain obstacles already modelled as a cylinder, the profile between *u* and *v* is restricted to a section between two additional indices *p* and *q*, which are set as follows:

– Set $p = u + 1$.

– If both $p < v$ and $h_p > h_{p+1}$, then increase *p* by 1 and repeat.

– Set $q = v - 1$.

– If both $q > u$ and $h_q > h_{q-1}$, then decrease *q* by 1 and repeat.

If $p = q$ then the sub-path obstruction loss is set to 0. Otherwise the calculation proceeds as follows.

It is now necessary to find the minimum value of normalized clearance, C_F, given by h_z/F_1, where in self-consistent units:

h_z: height of ray above profile point

F_1: radius of first Fresnel zone.

The minimum normalized clearance may be written:

$$C_F = \min_{i=p}^{q} \left[(h_z)_i / (F_1)_i \right] \tag{120}$$

where:

$$(h_z)_i = (h_r)_i - (h_t)_i \tag{121}$$

$$(F_1)_i = \sqrt{\lambda \cdot d_{ui} \cdot d_{iv} / d_{uv}} \tag{122}$$

$(h_r)_i$, the height of the ray above a straight line joining sea level at u and v at the i-th profile point is given by:

$$(h_r)_i = (h_u \cdot d_{iv} + h_v \cdot d_{ui}) / d_{uv} \tag{123}$$

$(h_t)_i$, the height of the terrain above a straight line joining sea level at u and v at the i-th profile point is given by:

$$(h_t)_i = h_i + d_{ui} \cdot d_{iv} / 2a_e \tag{124}$$

The minimum value of normalized clearance is used to compute the knife-edge diffraction geometrical parameter for the most significant sub-path obstruction:

$$\nu = -C_F \cdot \sqrt{2} \tag{125}$$

The sub-path diffraction loss L'' is now obtained from equation (31) or Fig. 9.

For some applications it may be undesirable to include sub-path diffraction enhancements. In this case a value of L'' should be set to zero when it would otherwise be negative.

RECOMMENDATION ITU-R M.541-11*

Operational procedures for the use of digital selective calling equipment in the maritime mobile service

(1978-1982-1986-1990-1992-1994-1995-1996-1997-2004-2015-2023)

Scope

The Recommendation contains the operational procedures for digital selective calling (DSC) equipment whose technical characteristics are given in Recommendation ITU-R M.493. The Recommendation contains six annexes. In Annexes 1 and 2 the provisions and procedures are described for distress, urgency and safety calls and for routine calls, respectively. In Annexes 3, 4, 5 and 6 the operational procedures for ships, for coast stations and man overboard (MOB) devices are described, and Annex 7 lists the frequencies to be used for DSC.

Keywords

Digital selective calling, equipment, operational procedures, GMDSS, distress alert

Abbreviations/Glossary

ACS	Automatic connection system
AIS	Automatic identification system
AMRD	Autonomous maritime radio device
BQ	End of sequence for an acknowledge message
DSC	Digital selective calling
FEC	Forward error correction
kHz	Kilohertz
GMDSS	Global maritime distress and safety system
HF	High frequency
MF	Medium frequency
MHz	Megahertz
MMSI	Maritime mobile service identity
MOB	Man overboard
MSI	Maritime safety information
NBDP	Narrowband direct-printing
RCC	Rescue coordination centre
RQ	End of sequence acknowledge required
RR	Radio Regulations
SOLAS	International Convention for the Safety of Life at Sea
UTC	Coordinated universal time

* This Recommendation should be brought to the attention of the International Maritime Organization (IMO) and the ITU Telecommunication Standardization Sector (ITU-T).

VHF Very high frequency

Related ITU Recommendations

Recommendation ITU-R M.493 – Digital selective-calling system for use in the maritime mobile service

Recommendation ITU-R M.585 – Assignment and use of identities in the maritime mobile service

Recommendation ITU-R M.689 – International maritime VHF radiotelephone system with automatic facilities based on DSC signalling format

Recommendation ITU-R M.1082 – International maritime MF/HF radiotelephone system with automatic facilities based on digital selective calling signalling format

Recommendation ITU-R M.1171 – Radiotelephony procedures in the maritime mobile service

Recommendation ITU-R M.1371 – Technical characteristics for an automatic identification system using time-division multiple access in the VHF maritime mobile band

Recommendation ITU-R M.2135 – Technical characteristics of autonomous maritime radio devices operating in the frequency band 156-162.05 MHz

The ITU Radiocommunication Assembly,

considering

a) that digital selective calling (DSC) will be used as described in Recommendation ITU-R M.493;

b) that the requirements of Chapter IV of the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended, for the global maritime distress and safety system (GMDSS) are based on the use of DSC for distress alerting and calling and that operational procedures are necessary for the use of that system;

c) that, as far as is practicable, operational procedures in all frequency bands and for all types of communications should be similar;

d) that DSC provides the primary means of transmitting a distress alert. Provisions of transmitting a distress alert by other methods and procedures are described in the Radio Regulations (RR);

e) that conditions when alarms have to be actuated should be specified,

recommends

1 that the technical characteristics of equipment used for DSC in the maritime mobile service should be in conformity with the relevant ITU-R Recommendations;

2 that the operational procedures to be observed in the MF, HF and VHF bands for DSC should be in accordance with Annex 1 for distress, urgency and safety calls and Annex 2 for other calls;

3 that provisions should be made at stations equipped for DSC for:

3.1 the manual entry of address, type of call, category and various messages into a DSC sequence;

3.2 displaying the information in a user readable format;

3.3 the verification and, if necessary, the correction of such manually formed sequences;

3.4 automatically set the information when possible;

3.5 a specific audible alarm to indicate receipt of a distress or urgency call or a call having distress category. It should not be possible to disable this alarm. Provisions should be made to ensure that they can be reset only manually;

3.6 audible indication: the term used to describe a brief self-terminating sound which is repeated once every 30 seconds until confirmation or self-terminating after 5 minutes indicating the reception of a DSC call of a category other than distress or urgency or a repetition of a call of categories distress or urgency already received;

3.7 visual indicators to indicate:

3.7.1 type of received call address (to all stations, to a group of stations, geographical, individual);

3.7.2 category of call;

3.7.3 identity of calling station;

3.7.4 numerical or alpha-numerical type of information, e.g. frequency information and telecommand;

3.7.5 type of "end of sequence" character;

3.7.6 detection of errors, if any;

4 that the equipment should be simple to operate;

5 that the operational procedures given in Annexes 3, 4 and 5, which are based on the relevant procedures from RR Chapter **VII**, Articles **30**, **31**, **32** and **33**, be used as guidance for ships and coast stations;

6 that the operational characteristics of the automatic connection system (ACS) should be in conformity with Annex 5;

7 that the operational characteristics of the autonomous maritime radio devices (AMRD) Group A MOB devices should be in conformity with Annex 6;

8 that the frequencies used for DSC are those contained in Annex 7 to this Recommendation.

NOTE 1 – The following definitions are used throughout this Recommendation:

Single frequency: the same frequency is used for transmission and reception.

Paired frequencies: frequencies which are associated in pairs; each pair consisting of one transmitting and one receiving frequency.

International DSC frequencies: those frequencies designated in the RR for exclusive use for DSC on an international basis.

National DSC frequencies: those frequencies assigned to individual coast stations or a group of stations on which DSC is permitted (this may include working frequencies as well as calling frequencies). The use of these frequencies must be in accordance with the RR.

Automatic DSC operation at a ship station: a mode of operation employing automatic tuneable transmitters and receivers, suitable for unattended operation, which provide for automatic call acknowledgements upon reception of a DSC and automatic transfer to the appropriate working frequencies.

Call attempt: one or a limited number of call sequences directed to the same stations on one or more frequencies and within a relatively short time period (e.g. a few minutes). A call attempt is considered unsuccessful if a calling sequence contains the "acknowledge RQ" (symbol No. 117) at the end of the sequence and no acknowledgement is received in this time interval.

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Annex 1

Operational procedures for distress, urgency and safety calls

A1-1 Introduction

The terrestrial elements of the GMDSS adopted by the 1988 Amendments to the International Convention for SOLAS, 1974, are based on the use of DSC for distress, urgency and safety communications.

A1-1.1 Method of calling

The provisions of RR Chapter VII are applicable to the use of DSC in cases of distress, urgency or safety.

A1-2 Digital selective calling distress alert

The DSC distress alert provides for alerting, maritime mobile service identity (MMSI), ship's position including time, and if entered nature of distress as defined in the RR (see RR Chapter VII).

A1-3 Procedures for digital selective calling distress alerts

A1-3.1 Transmission by a mobile unit in distress

A1-3.1.1 The DSC equipment should be capable of being pre-set to transmit the distress alert on at least one distress alerting frequency.

A1-3.1.2 The distress alert shall be composed in accordance with Recommendation ITU-R M.493. Although the equipment may be able to automatically include the ship's position information and the time the position was valid, if this information is not available to the equipment then the operator has to manually enter the ship's position and time at which it was valid. Enter the nature of distress as appropriate.

A1-3.1.3 Distress alert attempt

For MF/HF, a distress alert attempt should use multi-frequency call attempt (see § A3-6) by default, however, a single-frequency call attempt may be used when the operator wants to do so. A distress alert attempt for VHF can use single frequency call attempt only.

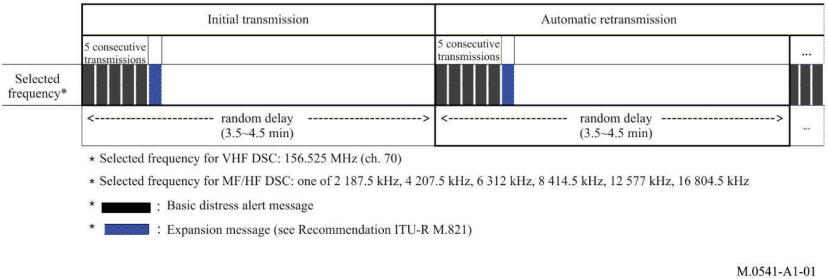
A1-3.1.3.1 Single frequency call attempt

A distress alert attempt should be transmitted as 5 consecutive calls on one frequency. To avoid call collision and the loss of acknowledgements, this call attempt may be transmitted on the same frequency again after a random delay of between 3 ½ and 4 ½ min from the beginning of the initial call. This allows acknowledgements arriving randomly to be received without being blocked by retransmission. The random delay should be generated automatically for each repeated transmission, however it should be possible to override the automatic repeat manually.

For MF/HF, single frequency call attempts may be repeated on different frequencies after a random delay of between 3 ½ and 4 ½ min from the beginning of the initial call. However, if a station is capable of receiving acknowledgements continuously on all distress frequencies except for the transmit frequency in use, then single frequency call attempts may be repeated on different frequencies without this delay.

FIGURE A1-1

Single-frequency call attempts



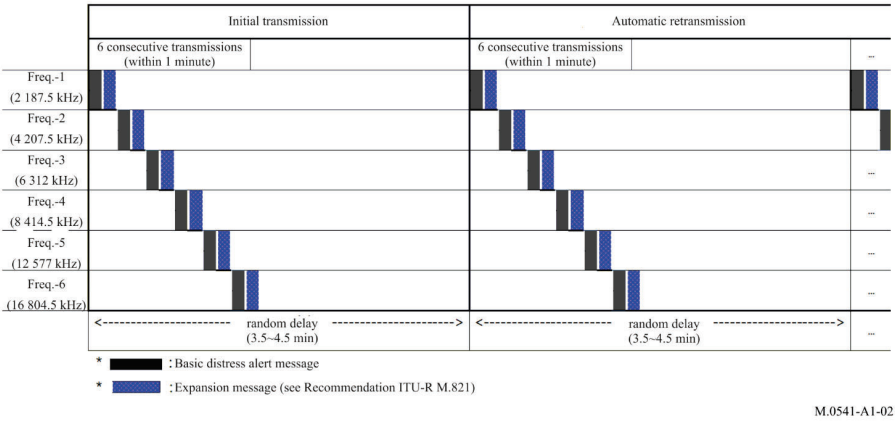
A1-3.1.3.2 Multi-frequency call attempt

A distress alert attempt may be transmitted as up to six consecutive calls dispersed over a maximum of six distress frequencies (one at MF and five at HF). A VHF call may be transmitted simultaneously with an MF/HF call. Stations transmitting multi-frequency distress alert attempts should be able to receive acknowledgements continuously on all frequencies except for the transmit frequency in use, or be able to complete the call attempt within 1 min.

Multi-frequency call attempts may be repeated after a random delay of between 3 ½ and 4 ½ min from the beginning of the previous call attempt.

FIGURE A1-2

Multi-frequency call attempts



A1-3.1.4 Distress

In the case of distress the operator should transmit a distress alert as described in Annex 3.

A1-3.2 Reception

The DSC equipment, except AMRD Group A MOB devices, should be capable of maintaining a reliable watch on a 24-hour basis on appropriate DSC distress alerting frequencies.

A1-3.3 Acknowledgement of distress alerts

Acknowledgements of distress alerts should be initiated manually.

Acknowledgements by DSC should be transmitted on the same frequency as the distress alert was received.

A1-3.3.1 Distress alerts should normally be acknowledged by DSC only by appropriate coast stations. Coast stations should, in addition, set watch on frequencies associated with the frequency on which the distress alert was received.

A1-3.3.2 Acknowledgements by coast stations of DSC distress alerts transmitted on MF or HF should be initiated with a minimum delay of 1 min after receipt of a distress alert, and normally within a maximum delay of 2⅓ min. This allows all calls within a single frequency or multi-frequency call attempt to be completed and should allow sufficient time for coast stations to respond to the distress alert. Acknowledgements by coast stations on VHF should be transmitted as soon as practicable.

A1-3.3.3 The acknowledgement of a distress alert consists of a single DSC distress acknowledgement call and automatically includes the MMSI of the ship whose distress alert is being acknowledged.

A1-3.3.4 Ships receiving a DSC distress alert from another ship should set watch on an associated radiotelephone distress and safety traffic frequency in order to receive subsequent distress calls and messages. The acknowledgement of a DSC distress alert from another ship should be made by radiotelephony after a short interval so that a coast station may acknowledge receipt in the first instance (see RR Nos. **32.28** – **32.35**).

A1-3.3.5 The automatic retransmission of a distress alert attempt should be terminated automatically on receipt of a DSC distress alert acknowledgement.

A1-3.4 Distress alert relays

Distress alert relays should be initiated manually.

A1-3.4.1 A distress alert relay should use the call format for distress alert relays as specified in Recommendation ITU-R M.493 and the calling attempt should follow the procedures described in §§ A1-3.1.3 to A1-3.1.3.2 for distress alerts, except that the distress relay is sent manually as a single call on a single frequency. Ship stations not provided with the DSC distress alert relay function should relay the alert by radio telephony.

A1-3.4.2 Any ship, receiving a distress alert on an HF channel which is not acknowledged by a coast station within 5 min, should transmit an individual distress alert relay addressed to the appropriate coast station or rescue coordination centre.

A1-3.4.3 Distress alert relays transmitted by coast stations, or by ship stations addressed to more than one vessel, should be acknowledged by ship stations using radiotelephony. Distress alert relays transmitted by ship stations should be acknowledged by a coast station transmitting a “distress alert relay acknowledgement” call in accordance with the procedures for distress acknowledgements given in §§ A1-3.3 to A1-3.3.3.

A1-4 Procedures for digital selective calling urgency and safety calls

A1-4.1 DSC, on the distress and safety calling frequencies, should be used by coast stations to advise shipping, and by ships to advise coast stations and/or ship stations, of the impending transmission of urgency, vital navigational and safety messages, except where the transmissions take place at routine times. The call should indicate the working frequency which will be used for the subsequent transmission of an urgent, vital navigational or safety message.

A1-4.2 The announcement and identification of medical transports should be carried out by DSC transmission, using appropriate distress and safety calling frequencies. Such calls should use the call format for an urgency call of the type medical transport and be addressed to all ships at VHF and Geographic Area at MF/HF.

A1-4.3 The operational procedures for urgency and safety calls should be in accordance with the relevant parts of §§ A3-2, A3-3, A3-6, A4-2, A4-3 and A4-6.

A1-5 Testing the equipment used for distress and safety calls

Testing on the exclusive DSC distress and safety calling frequencies should be limited as far as possible. DSC test calls should be in accordance with Recommendation ITU-R M.493 and the call should be acknowledged by the called station. Normally there would be no further communication between the two stations involved.

Annex 2

Operational procedures for routine calls

A2-1 Frequency/channels

A2-1.1 As a rule, paired frequencies should be used at HF and MF, in which case an acknowledgement is transmitted on the frequency paired with the frequency of the received call. In exceptional cases for national purposes a single frequency may be used. If the same call is received on several calling channels, the most appropriate shall be chosen to transmit the acknowledgement. A single frequency channel should be used at VHF.

A2-1.2 International calling

The paired frequencies listed in RR Appendix **17** and in Annex 6 of this Recommendation should be used for international DSC calling at HF.

A2-1.2.1 At HF and MF international DSC frequencies should only be used for shore-to-ship calls and for the associated call acknowledgements from ships fitted for automatic DSC operation where it is known that the ships concerned are not listening to the coast station's national frequencies.

A2-1.2.2 All ship-to-shore DSC calling at HF and MF should preferably be done on the coast station's national frequencies.

A2-1.3 National calling

Coast stations should avoid using the international DSC frequencies for calls that may be placed using national frequencies.

A2-1.3.1 Ship stations should keep watch on appropriate national and international channels. (Appropriate measures should be taken for an even loading of national and international channels.)

A2-1.3.2 Administrations are urged to find methods and negotiate terms to improve the utilization of the DSC channels available, e.g.:

– coordinated and/or joint use of coast station transmitters;

– optimizing the probability of successful calls by providing information to ships on suitable frequencies (channels) to be watched and by information from ships to a selected number of coast stations on the channels watched on-board.

A2-1.4 Method of calling

A2-1.4.1 The procedures set out in this section are applicable to the use of DSC techniques, except in cases of distress, urgency or safety, to which the provisions of RR Chapter VII are applicable.

A2-1.4.2 The call shall contain information indicating the station or stations to which the call is directed, and the identification of the calling station.

A2-1.4.3 The call should also contain information indicating the type of communication to be set up and may include supplementary information such as a proposed working frequency or channel; this information shall always be included in calls from coast stations, which shall have priority for that purpose.

A2-1.4.4 An appropriate digital selective calling channel chosen in accordance with the provisions of RR Nos. **52.128** to **52.137** or Nos. **52.145** to **52.153** as appropriate, shall be used for the call.

A2-2 Operating procedures

The technical format of the call sequence shall be in conformity with Recommendation ITU-R M.493.

The reply to a DSC call requesting an acknowledgement shall be made by transmitting an appropriate acknowledgement using DSC.

Acknowledgements may be initiated either manually or automatically. When an acknowledgement can be transmitted automatically, it shall be in conformity with Recommendation ITU-R M.493.

The technical format of the acknowledgement sequence shall be in conformity with Recommendation ITU-R M.493.

For communication between a coast station and a ship station, the coast station shall finally decide the working frequency or channel to be used.

The forwarding traffic and the control for working for radiotelephony shall be carried out in accordance with Recommendation ITU-R M.1171.

A2-2.1 Coast station initiates call to ship station (see Note 1)

If a ship station has to be called, the coast station selects the appropriate MMSI, frequency band and transmitter site, if available.

NOTE 1 – See Recommendations ITU-R M.689 and ITU-R M.1082 for further details of procedures applicable only to the automatic services.

A2-2.1.1 The call is composed by the coast station as follows:

– format specifier,
– address of the ship (MMSI),
– category of call,
– self-identification (MMSI) of the coast station, which is included automatically,
– telecommand information,
– working frequency information in the message part of the sequence, if appropriate,
– usually "end of sequence" signal "acknowledge RQ" (symbol No. 117). However, if the coast station knows that the ship station cannot respond or the call is to a group of ships the end of sequence signal should be 127, in which case the following procedures (§ A2-2.2) relating to an acknowledgement are not applicable.

A2-2.1.2 The coast station verifies the calling sequence.

The call shall be transmitted once on a single appropriate calling channel or frequency only. Only in exceptional circumstances may a call be transmitted simultaneously on more than one frequency.

A2-2.1.3 The coast station operator chooses the calling frequencies which are most suitable for the ship's location.

A2-2.1.3.1 The coast station initiates the transmission of the sequence on one of the frequencies chosen. Transmission on any one frequency should be limited to no more than two call sequences separated by intervals of at least 45 s to allow for reception of an acknowledgement from the ship.

A2-2.1.3.2 If appropriate, a "call attempt" may be transmitted, which may include the transmission of the same call sequence on other frequencies (if necessary with a change of working frequency information to correspond to the same band as the calling frequency) made in turn at intervals of not less than 5 min, following the same pattern as in § A2-2.1.3.1.

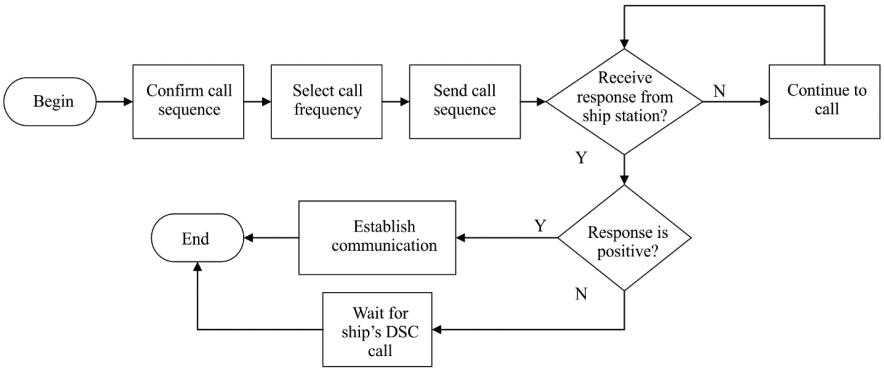
A2-2.1.4 If an acknowledgement is received further transmission of the call sequence should not take place.

If the acknowledgement is positive, the coast station shall then prepare to transmit traffic on the working channel or frequency it has proposed. If the acknowledgement is negative, the coast station should await the call from the ship station.

A2-2.1.5 When a station called does not reply, the call attempt should not normally be repeated until after an interval of at least 10 min. The aggregate of the times for which frequencies are occupied in one call attempt, should normally not exceed 1 min.

FIGURE A2-1

Procedure for coast station which initiates call to ship station



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A2-2.2 The following procedures apply at the ship stations:

A2-2.2.1 Upon receipt of a calling sequence at the ship station, the received message should be displayed.

A2-2.2.2 When a received call sequence contains an end of sequence signal "acknowledge RQ" (symbol No. 117), an acknowledgement sequence should be composed and transmitted.

The format specifier and category information should be identical to that in the received calling sequence.

A2-2.2.3 If the ship station is not equipped for automatic DSC operation, the ship's operator initiates an acknowledgement to the coast station after a delay of at least 5 s but no later than 4 ½ min of receiving the calling sequence. However the transmitted sequence should contain an "acknowledge BQ" (symbol No. 122) end of sequence signal in place of the "acknowledge RQ" (symbol No. 117) signal.

If such an acknowledgement cannot be transmitted within 5 min of receiving the calling sequence then the ship station should instead transmit a calling sequence to the coast station using the ship-to-shore calling procedure detailed in § A2-2.2.

A2-2.2.4 If the ship is equipped for automatic DSC operation, the ship station automatically transmits an acknowledgement with an end of sequence signal "acknowledge BQ" (symbol No. 122). The start of the transmission of this acknowledgement sequence should be within 30 s for HF and MF or within 3 s for VHF after the reception of the complete call sequence.

A2-2.2.5 If the ship is able to comply immediately the acknowledgement sequence should include a telecommand signal which is identical to that received in the calling sequence indicating that it is able to comply.

If no working frequency was proposed in the call, the ship station should include a proposal for a working frequency in its acknowledgement.

A2-2.2.6 If the ship is not able to comply immediately the acknowledgement sequence should include the first telecommand signal "unable to comply" (symbol No. 104), with a second telecommand signal giving additional information (see Recommendation ITU-R M.493).

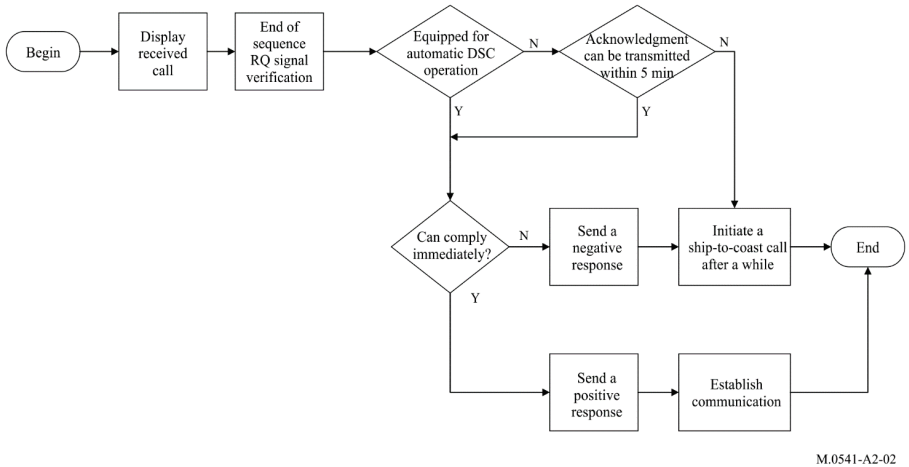
At some later time when the ship is able to accept the traffic being offered, the ship station initiates a call to the coast station using the ship-to-shore calling procedures detailed in § A2-2.3.

A2-2.2.7 If a call is acknowledged indicating ability to comply immediately and communication between coast station and ship station on the working channel agreed is established, the DSC call procedure is considered to be completed.

A2-2.2.8 If the ship station transmits an acknowledgement which is not received by the coast station then this will result in the coast station repeating the call (in accordance with § A2-2.1.5). In this event the ship station should transmit a new acknowledgement.

FIGURE A2-2

Procedure for ship station which receives call from coast station



A2-2.3 Ship station initiates call to coast station (see Note 1)

This procedure should also be followed both as a delayed response to a call received earlier from the coast station (see § A2-2.2.2) and to initiate traffic from the ship station.

NOTE 1 – See Recommendations ITU-R M.689 and ITU-R M.1082 for further details of procedures applicable only to the automatic services.

A2-2.3.1 The call is composed by the ship station as follows:

– format specifier,
– address of the coast station (MMSI),
– category of call (default is routine),
– self-identification (MMSI) of the ship station, which is automatically included,
– telecommand information,
– working frequency, or position (for MF/HF only) information in the message part of the sequence if appropriate,
– telephone number required (automatic connections only),
– usually “end of sequence” signal “acknowledge RQ” (symbol No. 117).

A2-2.3.2 The ship station verifies the calling sequence.

A2-2.3.3 The ship station selects the single most appropriate calling frequency preferably using the coast station's nationally assigned calling channels, for which purpose it shall send a single calling sequence on the selected frequency.

A2-2.3.4 If a called station does not reply, the call sequence from the ship station should not normally be repeated until after an interval of at least 5 min for manual connections, or 5 s or 35 s in the case automatic VHF or MF/HF connections respectively. These repetitions may be made on alternative frequencies if appropriate. Any subsequent repetitions to the same coast station should not be made until at least 15 min have elapsed.

A2-2.3.5 The coast station should transmit an acknowledgement, after a delay of at least 5 s but not later than 4½ min for manual connections, or, within 3 s for automatic connections, containing the format specifier, the address of the ship (MMSI), the category of call, the coast station self-identification and:

– if able to comply immediately on the working frequency suggested, the same telecommand and frequency information as in the call request;
– if no working frequency was suggested by the ship station then the acknowledgement sequence should include a channel/frequency proposal;
– if not able to comply on the working frequency suggested but able to comply immediately on an alternative frequency, the same telecommand information as in the call request but an alternative working frequency;
– if unable to comply immediately the first telecommand signal of "unable to comply" (symbol No. 104) with a second telecommand signal giving additional information. For manual connections only, this second telecommand signal may include a queue indication.

The end of sequence signal "acknowledge BQ" (symbol No. 122) should also be included.

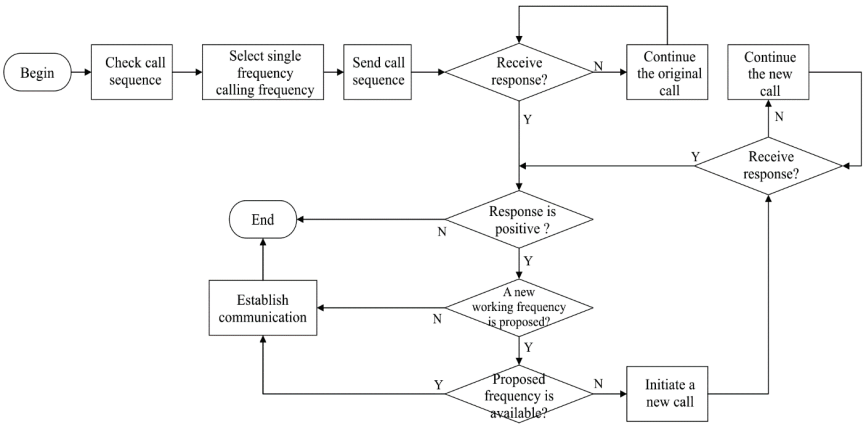
A2-2.3.6 For manual connections, if a working frequency is proposed in accordance with § A2-2.3.5 but this is not acceptable to the ship station, then the ship station should immediately transmit a new call requesting an alternative frequency.

A2-2.3.7 If an acknowledgement is received further transmission of the same call sequence should not take place. On receipt of an acknowledgement which indicates ability to comply, the DSC procedures are complete and both coast station and ship station should communicate on the working frequencies agreed with no further exchange of DSC calls.

A2-2.3.8 If the coast station transmits an acknowledgement which is not received at the ship station then the ship station should repeat the call in accordance with § A2-2.3.4.

FIGURE A2-3

Procedure for ship station which initiates call to coast station



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A2-2.4 Ship station initiates call to ship station

The ship-to-ship procedures should be similar to those given in § A2-2.3, where the receiving ship station complies with the procedures given for coast stations, as appropriate, except that, with respect to § A2-2.3.1, the calling ship should always insert working frequency information in the message part of the calling sequence.

Annex 3

Operational procedures for ships for digital selective calling communications on MF, HF and VHF

Introduction

Procedures for DSC communications on MF and VHF are described in §§ A3-1 to A3-5 below.

The procedures for DSC communications on HF are in general the same as for MF and VHF. Special conditions to be taken into account when making DSC communications on HF are described in § A3-6 below.

A3-1 Distress

A3-1.1 Transmission of digital selective calling distress alert

A distress alert should be transmitted if, in the opinion of the Master, the ship or a person is in distress and requires immediate assistance.

A DSC distress alert should as far as possible include the ship's last known position and the time (in UTC) when it was valid. The position and the time should be included automatically by the ship's navigational equipment if this information is not included it should be inserted manually.

The DSC distress alert attempt is transmitted as follows:

– tune the transmitter to the DSC distress channel (2 187.5 kHz on MF, channel 70 on VHF) if not done automatically by the ship station.
– if time permits, key in or select on the DSC equipment
  – the nature of distress,
  – the ship's last known position (latitude and longitude) if not provided automatically,
  – the time (in UTC) the position was valid if not provided automatically,
  – type of subsequent distress communication (telephony),

in accordance with the DSC equipment manufacturer's instructions;

– transmit the DSC distress alert;
– prepare for the subsequent distress traffic by tuning the transmitter and the radiotelephony receiver to the distress traffic channel in the same band, i.e. 2 182 kHz on MF, channel 16 on VHF, while waiting for the DSC distress acknowledgement.

A3-1.2 Actions on receipt of a distress alert

Ships receiving a DSC distress alert from another ship should normally not acknowledge the distress alert by DSC since acknowledgement of a DSC distress alert by use of DSC is normally made by coast stations or rescue coordination centre only (see §§ A1-3.3.4 and A3-6.1.4).

If a ship station continues to receive a DSC distress alert on an MF or VHF channel, a DSC acknowledgement should be transmitted to terminate the call only after consulting with a coast station or rescue coordination centre and being directed to do so.

Ships receiving a DSC distress alert from another ship should also defer the acknowledgement of the distress alert by radiotelephony for a short interval, if the ship is within an area covered by one or more coast stations, in order to give the coast station time to acknowledge the DSC distress alert first.

Ships receiving a DSC distress alert from another ship shall:

– watch for the reception of a distress acknowledgement on the distress channel (2 187.5 kHz on MF and channel 70 on VHF);
– prepare for receiving the subsequent distress communication by tuning the radiotelephony receiver to the distress traffic frequency in the same band in which the DSC distress alert was received, i.e. 2 182 kHz on MF, channel 16 on VHF;
– in accordance with the provisions of RR No. **32.23** acknowledge the receipt of the distress alert by transmitting a message by radiotelephony on the distress traffic frequency in the same band in which the DSC distress alert was received, i.e. 2 182 kHz on MF, channel 16 on VHF.

A3-1.3 Distress traffic

On receipt of a DSC distress acknowledgement the ship in distress should commence the distress traffic by radiotelephony on the distress traffic frequency (2 182 kHz on MF, channel 16 on VHF) in accordance with the provisions of RR Nos. **32.13C** and **32.13D**.

A3-1.4 Transmission of a digital selective calling distress alert relay

A3-1.4.1 Transmission of a digital selective calling distress relay call on receipt of a digital selective calling distress alert

In no case is a ship permitted to transmit an all ships DSC distress alert relay on receipt of a DSC distress alert on either VHF or MF channels. If no aural watch is present on the relative channel (2 182 kHz on MF, channel 16 on VHF), the coast station or rescue coordination centre should be contacted by sending an individual DSC distress alert relay.

The DSC distress alert relay is transmitted as follows:

– select the distress alert relay format on the DSC equipment;

– key in or select on the DSC equipment:

  • the address (MMSI) of the appropriate coast station or rescue coordination centre;

  • the contents of the DSC distress alert received from the ship in distress (included automatically), i.e. MMSI of the ship station in distress, nature of distress, position and time information and type of subsequent communication;

– transmit the DSC distress alert relay;

– prepare for the subsequent distress traffic by tuning the transmitter and the radiotelephony receiver to the distress traffic channel in the same band, i.e. 2 182 kHz on MF and channel 16 on VHF, while waiting for the DSC distress acknowledgement.

A3-1.4.2 Transmission of a digital selective calling distress relay call on behalf of someone else

A ship knowing that another ship is in distress shall transmit a DSC distress alert relay if:

– the ship in distress is not itself able to transmit the distress alert,

– the Master of the ship considers that further help is necessary.

In accordance with RR No. **32.19B** the DSC distress alert relay on behalf of somebody else should preferably be addressed to an individual coast station or rescue coordination centre.

The DSC distress alert relay is transmitted as follows:

– select the distress alert relay format on the DSC equipment,

– key in or select on the DSC equipment:

  – the MMSI (9-digit identity) of the appropriate coast station or in special circumstances all ships call (VHF) or geographic area call (MF/HF),

  – the MMSI (9-digit identity) of the ship in distress, if known,

  – the nature of distress, if known,

  – the latest position of the ship in distress, if known,

  – the time (in UTC) the position was valid (if known),

  – type of subsequent distress communication (telephony);

– transmit the DSC distress alert relay;

– prepare for the subsequent distress traffic by tuning the transmitter and the radiotelephony receiver to the distress traffic channel in the same band, i.e. 2 182 kHz on MF and channel 16 on VHF, while waiting for the DSC distress acknowledgement.

When the function of distress alert relay call by DSC is not implemented such as DSC class D or class E, distress alert relay should be transmitted to the appropriate coast station or rescue coordination

centre using radiotelephony in accordance with the provisions of RR No. **32.19E** when the DSC distress alert is not acknowledged by a coast station or another ship station within 5 minutes.

A3-1.5 Acknowledgement of a digital selective calling distress alert relay received from a coast station

Coast stations or rescue coordination centre, after having received and acknowledged a DSC distress alert, may if necessary, retransmit the information received as a DSC distress alert relay, addressed to all ships (VHF only), all ships in a specific geographical area (MF/HF only), or a specific ship.

Ships receiving a distress alert relay transmitted by a coast station shall not use DSC to acknowledge the call, but should acknowledge the receipt of the call by radiotelephony on the distress traffic channel in the same band in which the relay call was received, i.e. 2 182 kHz on MF, channel 16 on VHF.

Acknowledge the receipt of the distress alert relay by transmitting a message, in accordance with the provisions of RR No. **32.23**, by radiotelephony on the distress traffic frequency in the same band in which the DSC distress alert relay was received.

A3-1.6 Acknowledgement of a digital selective calling distress relay call received from another ship

Ships receiving a distress alert relay from another ship shall follow the same procedure as for acknowledgement of a distress alert, i.e. the procedure given in § A3-1.2 above.

A3-1.7 Cancellation of an inadvertent digital selective calling distress alert

A station transmitting an inadvertent DSC distress alert shall cancel the distress alert using the following procedure:

A3-1.7.1 Immediately cancel the distress alert by transmitting a DSC self-cancel on all the frequencies where the inadvertent DSC distress alert was transmitted, if the ship station is capable hereof. A DSC self-cancel is a distress acknowledgement where the self-id and the distress id is identical as defined in Recommendation ITU-R M.493.

A3-1.7.2 Subsequently cancel the distress alert aurally over the telephony distress traffic channel associated with each DSC channel on which the “distress alert” was transmitted, by transmitting a message in accordance with the provisions of RR No. **32.53E**.

A3-1.7.3 Monitor the telephony distress traffic channel associated with the DSC channel on which the distress alert was transmitted, and respond to any communications concerning that distress alert as appropriate.

A3-2 Urgency

A3-2.1 Transmission of urgency messages

Transmission of urgency messages shall be carried out in three steps:

– announcement of the urgency message using DSC;

– transmission of the urgency call; and

– transmission of the message using radiotelephony.

The announcement is carried out by transmission of a DSC urgency call on the DSC distress calling channel (2 187.5 kHz on MF, channel 70 on VHF).

The urgency call and message are transmitted on the distress traffic channel (2 182 kHz on MF, channel 16 on VHF).

The DSC urgency call may be addressed to all stations at VHF, or a geographic area at MF/HF, or to a specific station. The frequency on which the urgency message will be transmitted shall be included in the DSC urgency call.

The transmission of an urgency message is thus carried out as follows:

Announcement:

– select the appropriate calling format on the DSC equipment (all ships (VHF only), geographical area (MF/HF only) or individual);
– key in or select on the DSC equipment:
  – specific area or MMSI (9-digit identity) of the specific station, if appropriate,
  – the category of the call (urgency),
  – the frequency or channel on which the urgency message will be transmitted,
  – the type of communication in which the urgency message will be given (radiotelephony),

  in accordance with the DSC equipment manufacturer's instructions;
– transmit the DSC urgency announcement.

Transmission of the urgency call and message:

– tune the transmitter to the frequency or channel indicated in the DSC urgency announcement;
– transmit the urgency call and message using radiotelephony in accordance with the provisions of RR No. **33.12**.

A3-2.2 Reception of an urgency message

Ships receiving a DSC urgency call announcing an urgency message addressed to more than one station shall NOT acknowledge the receipt of the DSC call, but should tune the radiotelephony receiver to the frequency indicated in the call and listen to the urgency message.

A3-3 Safety

A3-3.1 Transmission of safety messages

Transmission of safety messages shall be carried out in three steps:

– announcement of the safety message using DSC;
– transmission of the safety message call; and
– transmission of the message using radiotelephony.

The announcement is carried out by transmission of a DSC safety call on the DSC distress calling channel (2 187.5 kHz on MF, channel 70 on VHF).

In accordance with RR No. **33.32** safety messages should preferably be transmitted on a working frequency in the same band(s) as those used for the safety call or announcement.

The DSC safety call may be addressed to all ships (VHF only), ships in a specific geographical area (MF/HF only), or to a specific station.

The frequency on which the safety message will be transmitted shall be included in the DSC call.

The transmission of a safety message is thus carried out as follows:

Announcement:

– select the appropriate calling format on the DSC equipment (all ships (VHF only), geographical area (MF/HF only), or individual);
– key in or select on the DSC equipment:
  – specific area or MMSI (9-digit identity) of specific station, if appropriate,
  – the category of the call (safety),
  – the frequency or channel on which the safety message will be transmitted,
  – the type of communication in which the safety message will be given (radiotelephony), in accordance with the DSC equipment manufacturer's instructions;
– transmit the DSC safety announcement.

Transmission of the safety call and message:

– tune the transmitter to the frequency or channel indicated in the DSC safety call;
– transmit the safety call and message in accordance with the provisions of RR No. **33.35**.

A3-3.2 Reception of a safety message

Ships receiving a DSC safety call announcing a safety message addressed to more than one station shall NOT acknowledge the receipt of the DSC safety call, but should tune the radiotelephony receiver to the frequency indicated in the call and listen to the safety message.

A3-4 Public correspondence

A3-4.1 Digital selective calling channels for public correspondence

A3-4.1.1 VHF

VHF DSC channel 70 is used for DSC for distress and safety purposes as well as for DSC for public correspondence.

A3-4.1.2 MF

International and national DSC channels separate from the DSC distress and safety calling channel 2 187.5 kHz are used for digital selective calling on MF for public correspondence.

Ships calling a coast station by DSC on MF for public correspondence should preferably use the coast station's national DSC channel.

The international DSC channel for public correspondence may as a general rule be used between ships and coast stations of different nationality. The ships transmitting frequency is 2 189.5 kHz, and the receiving frequency is 2 177 kHz.

The frequency 2 177 kHz is also used for DSC between ships for general communication.

A3-4.2 Transmission of a digital selective calling call for public correspondence to a coast station or another ship

A DSC call for public correspondence to a coast station or another ship is transmitted as follows:

– select the format for calling a specific station on the DSC equipment;
– key in or select on the DSC equipment:
  – the MMSI (9-digit identity) of the station to be called,

  - the category of the call (routine),
  - the type of the subsequent communication (normally radiotelephony),
  - a proposed working channel if calling another ship. A proposal for a working channel should NOT be included in calls to a coast station; the coast station will in its DSC acknowledgement indicate an appropriate working channel,

  in accordance with the DSC equipment manufacturer's instructions;
- transmit the DSC call.

A3-4.3 Repeating a call

A DSC call for public correspondence may be repeated on the same or another DSC channel, if no acknowledgement is received within 5 min.

Further call attempts should be delayed at least 15 min, if acknowledgement is still not received.

A3-4.4 Acknowledgement of a received call and preparation for reception of the traffic

On receipt of a DSC call from a coast station or another ship, a DSC acknowledgement is transmitted as follows:

- select the acknowledgement format on the DSC equipment;
- transmit an acknowledgement indicating whether the ship is able to communicate as proposed in the call (type of communication and working frequency);
- if able to communicate as indicated, tune the transmitter and the radiotelephony receiver to the indicated working channel and prepare to receive the traffic.

A3-4.5 Reception of acknowledgement and further actions

When receiving an acknowledgement indicating that the called station is able to receive the traffic, prepare to transmit the traffic as follows:

- tune the transmitter and receiver to the indicated working channel;
- commence the communication on the working channel by:
  - the MMSI (9-digit identity) or call sign or other identification of the called station;
  - "this is";
  - the MMSI (9-digit identity) or call sign or other identification of own ship.

It will normally rest with the ship to call again a little later in case the acknowledgement from the coast station indicates that the coast station is not able to receive the traffic immediately.

In case the ship, in response to a call to another ship, receives an acknowledgement indicating that the other ship is not able to receive the traffic immediately, it will normally rest with the called ship to transmit a call to the calling ship when ready to receive the traffic.

A3-5 Testing the equipment used for distress and safety

Testing on the exclusive DSC distress and safety calling frequency 2 187.5 kHz should be limited as far as possible. DSC test calls by ship stations should normally be transmitted using the DSC format specifier as "individual" and the category as "safety". The test of a distress button itself should be performed without any emission of radio waves.

Test calls should be transmitted by the ship station and acknowledged by the called station. Normally there would be no further communication between the two stations involved.

A VHF and MF test call to a station is transmitted as follows:

– key in or select the format for the test call on the DSC;

– key in the MMSI (9-digit identity) of the station to be called;

– transmit the DSC test call;

– wait for acknowledgement.

A3-6 Special conditions and procedures for digital selective calling communication on HF

General

The procedures for DSC communication on HF are – with some additions described in §§ A3-6.1 to A3-6.3 below – equal to the corresponding procedures for DSC communications on MF/VHF.

Due regard to the special conditions described in §§ A3-6.1 to A3-6.3 should be given when making DSC communications on HF.

A3-6.1 Distress

A3-6.1.1 Transmission of digital selective calling distress alert and choice of HF bands

In sea areas A3 and A4 a DSC distress alert on HF is intended to be received by coast stations and a DSC distress alert on MF and VHF is intended to be received by other ships in the vicinity.

The DSC distress alert should as far as possible include the ship's last known position and the time (in UTC) it was valid. If the position and time is not inserted automatically from the ship's navigational equipment, it should be inserted manually.

Propagation characteristics of HF radio waves are impacted by the seasons time of the day, sea conditions, and the weather. All these conditions should be taken into account when choosing HF bands for transmission of DSC distress alert. To maximize the probability of the successful reception of the alert by coast stations, the distress alert should be sent as a multi-frequency call attempt (see § A1-3.1.3.2).

As a general rule the DSC distress channel in the 8 MHz maritime band (8 414.5 kHz) may in many cases be an appropriate first choice.

DSC distress alert may be sent on a number of HF bands in two different ways:

a) either by transmitting the DSC distress alert on one HF band, and waiting a few minutes for receiving acknowledgement by a coast station;

   if no acknowledgement is received within 3 min, the process is repeated by transmitting the DSC distress alert on another appropriate HF band etc.;

b) or by transmitting the DSC distress alert at a number of HF bands with no, or only very short, pauses between the calls, without waiting for acknowledgement between the calls.

It is recommended to follow procedure a) in all cases, where time permits to do so; this will make it easier to choose the appropriate HF band for commencement of the subsequent communication with the coast station on the corresponding distress traffic channel.

Transmitting the DSC distress alert on HF:

– tune the transmitter to the chosen HF DSC distress channel (4 207.5, 6 312, 8 414.5, 12 577, 16 804.5 kHz);

– follow the instructions for keying in or selection of relevant information on the DSC equipment as described in § A3-1.1;

– transmit the DSC distress alert.

In special cases, for example in tropical zones, transmission of DSC distress alert on HF may, in addition to ship-to-shore alerting, also be useful for ship-to-ship alerting.

A3-6.1.2 Preparation for the subsequent distress traffic

After having transmitted the DSC distress alert on appropriate DSC distress channels (HF, MF and/or VHF), prepare for the subsequent distress traffic by tuning the radiocommunication set(s) (HF, MF and/or VHF as appropriate) to the corresponding distress traffic channel(s).

Where multiple frequency call attempts are transmitted the corresponding distress traffic frequency should be 8 291 kHz.

If method b) described in § A3-6.1.1 has been used for transmission of DSC distress alert on a number of HF bands:

– take into account in which HF band(s) acknowledgement has been successfully received from a coast station;

– if acknowledgements have been received on more than one HF band, commence the transmission of distress traffic on one of these bands, but if no response is received from a coast station then the other bands should be used in turn.

The distress traffic frequencies are (see RR Appendix **15**, Table 15-1):

HF (kHz):

Telephony 4 125 6 215 8 291 12 290 16 420

MF (kHz):

Telephony 2 182

VHF: Channel 16 (156.800 MHz).

A3-6.1.3 Distress traffic

The procedures described in § A3-1.3 are used when the distress traffic on MF/HF is carried out by *radiotelephony*.

A3-6.1.4 Actions on reception of a digital selective calling distress alert on HF from another ship

Ships receiving a DSC distress alert on HF from another ship shall *not* acknowledge the alert, but should:

– watch for reception of a DSC distress acknowledgement from a coast station;

– while waiting for reception of a DSC distress acknowledgement from a coast station:

  prepare for reception of the subsequent distress communication by tuning the HF radiocommunication set (transmitter and receiver) to the relevant distress traffic channel in the same HF band in which the DSC distress alert was received, observing the following conditions:

  – if radiotelephony mode was indicated in the DSC distress alert, the HF radiocommunication set should be tuned to the radiotelephony distress traffic channel in the HF band concerned;

  – if telex mode was indicated in the DSC distress alert, the HF radiocommunication set should be tuned to the radiotelex distress traffic channel in the HF band concerned. Ships able to do so should additionally watch the corresponding radiotelephony distress channel;

– if the DSC distress alert was received on more than one HF band, the radiocommunication set should be tuned to the relevant distress traffic channel in the HF band considered to be the best one in the actual case. If the DSC distress alert was received successfully on the 8 MHz band, this band may in many cases be an appropriate first choice;
– if no distress traffic is received on the HF channel within 1 to 2 min, tune the HF radiocommunication set to the relevant distress traffic channel in another HF band deemed appropriate in the actual case;
– if no DSC distress acknowledgement is received from a coast station within 5 min, and no distress communication is observed going on between a coast station and the ship in distress:
  – inform an RCC via appropriate radiocommunications means,
  – transmit a DSC distress alert relay if instructed to do so by a RCC or a coast station.

A3-6.1.5 Transmission of digital selective calling distress alert relay

In case it is considered appropriate to transmit a DSC distress alert relay:

– distress alert relays on HF should be initiated manually;
– follow the procedures described in § A3-6.1.1 above (except the call is sent manually as a single call on a single frequency) and should preferably be addressed to an individual coast station or rescue coordination centre;
– follow the instructions for keying in or selection of call format and relevant information on the DSC equipment as described in § A3-1.4;
– transmit the DSC distress alert relay.

A3-6.1.6 Acknowledgement of a HF digital selective calling distress alert relay received from a coast station

Ships receiving a DSC distress alert relay from a coast station on HF, addressed to all ships within a specified area, should NOT acknowledge the receipt of the relay alert by DSC, but by *radiotelephony* on the telephony distress traffic channel in the same band(s) in which the DSC distress relay call was received.

A3-6.2 Urgency

Transmission of urgency messages on HF should normally be addressed:

– either to all ships within a specified geographical area,
– or to a specific coast station.

Announcement of the urgency message is carried out by transmission of a DSC call with category urgency on the appropriate DSC distress channel.

The transmission of the urgency message itself on HF is carried out by radiotelephony on the appropriate distress traffic channel in the same band in which the DSC announcement was transmitted.

A3-6.2.1 Transmission of digital selective calling announcement of an urgency message on HF

– choose the HF band considered to be the most appropriate, taking into account that the propagation characteristics for HF radio waves are impacted by the seasons, time of the day,

sea conditions and the weather; the 8 MHz band may in many cases be an appropriate first choice;

– key in or select call format for either geographical area call or individual call on the DSC equipment, as appropriate;

– key in or select relevant information on the DSC equipment keyboard as described in § A3-2.1;

– transmit the DSC call; and

– if the DSC call is addressed to a specific coast station, wait for DSC acknowledgement from the coast station. If acknowledgement is not received within a few minutes, repeat the DSC call on another HF frequency deemed appropriate.

A3-6.2.2 Transmission of the urgency message and subsequent action

– tune the HF transmitter to the distress traffic channel (radiotelephony) indicated in the DSC announcement;

– if the urgency message is to be transmitted using *radiotelephony*, follow the procedure described in § A3-2.1.

Announcement and transmission of urgency messages addressed to all HF equipped ships within a specified area may be repeated on a number of HF bands as deemed appropriate in the actual situation.

A3-6.3 Safety

A3-6.3.1 Transmission of digital selective calling announcement and safety messages on HF

The procedures for transmission of DSC safety announcement and for transmission of the safety message are the same as for urgency messages, described in § A3-6.2, *except* that:

– in the DSC announcement, the category SAFETY shall be used,

– in the safety message, the safety signal “SECURITE” shall be used instead of the urgency signal “PAN PAN”.

A3-6.3.2 Reception of safety messages

When the DSC safety announcement for unscheduled HF MSI addressed to a geographical area is received on one of distress and safety calling frequencies, the HF MSI receiver shall be tuned to the frequency specified in the DSC announcement.

The DSC safety announcement is received as follows:

– the format specifier (geographical area),

– address (geographical area),

– the category of the call (safety),

– the frequency or channel on which the HF MSI will be transmitted,

– the type of communication in which the HF MSI will be transmitted (forward error correction – FEC).

Annex 4

Operational procedures for coast stations for digital selective calling communications on MF, HF and VHF

Introduction

Procedures for DSC communications on MF and VHF are described in §§ A4-1 to A4-5 below.

The procedures for DSC communications on HF are in general the same as for MF and VHF. Special conditions to be taken into account when making DSC communications on HF are described in § A4-6 below.

A4-1 Distress (see Note 1)

A4-1.1 Reception of a digital selective calling distress alert

The transmission of a distress alert indicates that a mobile unit (a ship, aircraft or other vehicle) or a person is in distress and requires immediate assistance. The distress alert is a digital selective call using a distress call format.

Coast stations in receipt of a distress alert shall ensure that it is routed as soon as possible to an RCC. The receipt of a distress alert is to be acknowledged as soon as possible by the appropriate coast station.

NOTE 1 – These procedures assume that the RCC is sited remotely from the DSC coast station; where this is not the case, appropriate amendments should be made locally.

A4-1.2 Acknowledgement of a digital selective calling distress alert

The coast station shall transmit the distress alert acknowledgement on the same DSC frequency on which the distress alert was received.

The acknowledgement of a DSC distress alert is transmitted as follows:

– key in or select on the DSC equipment:
  – distress alert acknowledgement,
  – MMSI (9-digit identity) of the ship in distress(will be inserted automatically, if available),
  – nature of distress(will be inserted automatically, if available),
  – distress coordinates(will be inserted automatically, if available),
  – the time (in UTC) when the position was valid(will be inserted automatically, if available);
– transmit the acknowledgement;
– prepare to handle the subsequent distress traffic by setting watch on radiotelephony the radiotelephone frequencies should be those associated with the frequency on which the distress alert was received (on MF 2 182 kHz or on VHF 156.8 MHz/channel 16).

A4-1.3 Transmission of a digital selective calling distress alert relay

Coast stations shall initiate and transmit a distress alert relay in any of the following cases:

– when the distress of the mobile unit has been notified to the coast station by other means and a broadcast alert to shipping is required by the RCC; and

– when the person responsible for the coast station considers that further help is necessary (close cooperation with the appropriate RCC is recommended under such conditions).

In the cases mentioned above, the coast station shall transmit a shore-to-ship distress alert relay addressed, as appropriate, to all ships (VHF only), to a geographical area (MF/HF only) or to a specific ship.

The distress alert relay shall contain the identification of the mobile unit in distress, its position and other information which might facilitate rescue.

The distress alert relay is transmitted as follows:

– key in or select on the DSC equipment:
  – distress alert relay,
  – the format specifier (all ships (VHF only), geographical area (MF/HF only), or individual station),
  – if appropriate, the address (MMSI) of the ship, or geographical area,
  – MMSI (9-digit identity) of the ship in distress, if known,
  – nature of distress, if known,
  – distress coordinates, if known,
  – the time (in UTC) when the position was valid, if known;
– transmit the distress alert relay;
– prepare for the reception of the acknowledgements by ship stations and for handling the subsequent distress traffic by switching over to the radiotelephony distress traffic channel in the same band, i.e. 2 182 kHz on MF, 156.8 MHz/channel 16 on VHF.

A4-1.4 Reception of a distress alert relay

If the distress alert relay is received from a ship station, coast stations on receipt of the distress alert relay shall ensure that the call is routed as soon as possible to an RCC. The receipt of the distress alert relay is to be acknowledged as soon as possible by the appropriate coast station using a DSC distress alert relay acknowledgement addressed to the ship station. If the distress relay call is received from a coast station, other coast stations will normally not have to take further action.

A4-2 Urgency

A4-2.1 Transmission of a digital selective calling announcement

The announcement of the urgency message shall be made on one or more of the distress and safety calling frequencies using DSC and the urgency call format.

The DSC urgency call may be addressed to all ships (VHF only), to a geographical area (MF/HF only), or to a specific ship. The frequency on which the urgency message will be transmitted after the announcement shall be included in the DSC urgency call.

The DSC urgency call is transmitted as follows:

– key in or select on the DSC equipment:
  – the format specifier (all ships call (VHF), geographical area (MF/HF only), or individual station),
  – if appropriate, the address (MMSI) of the ship, or geographical area,
  – the category of the call (urgency),

  - the frequency or channel on which the urgency message will be transmitted,
  - the type of communication in which the urgency message will be transmitted (radiotelephony);
- transmit the DSC urgency call.

After the DSC announcement, the urgency message will be transmitted on the frequency indicated in the DSC call.

A4-3 Safety

A4-3.1 Transmission of a digital selective calling announcement

The announcement of the safety message shall be made on one or more of the distress and safety calling frequencies using DSC and the safety call format.

The DSC safety call may be addressed to all ships (VHF only), to a geographical area (MF/HF only), or to a specific ship. The frequency on which the safety message will be transmitted after the announcement shall be included in the DSC safety call.

The DSC safety call is transmitted as follows:

- key in or select on the DSC equipment:
  - the format specifier (all ships call (VHF only), geographical area (MF/HF only), or individual station),
  - if appropriate, the address (MMSI) of the ship, or geographical area,
  - the category of the call (safety),
  - the frequency or channel on which the safety message will be transmitted,
  - the type of communication in which the safety message will be transmitted (radiotelephony);
- transmit the DSC safety call.

After the DSC announcement, the safety message will be transmitted on the frequency indicated in the DSC call.

A4-4 Public correspondence

A4-4.1 Digital selective calling frequencies/channels for public correspondence

A4-4.1.1 VHF

The frequency 156.525 MHz/channel 70 is used for DSC for distress and safety purposes. It may also be used for calling purposes other than distress and safety, e.g. public correspondence.

A4-4.1.2 MF

For public correspondence national and international DSC frequencies are used which are different from the frequencies used for distress and safety purposes.

When calling ship stations by DSC, coast stations should use for the call, in the order of preference:

- a national DSC channel on which the coast station is maintaining watch;
- the international DSC calling channel, with the coast station transmitting on 2 177 kHz and receiving on 2 189.5 kHz. In order to reduce interference on this channel, it may be used as a

general rule by coast stations to call ships of another nationality, or in cases where it is not known on which DSC frequencies the ship station is maintaining watch.

A4-4.2 Transmission of a digital selective calling from a coast station call to a ship

The DSC call is transmitted as follows:

- key in or select on the DSC equipment:
  - the MMSI (9-digit identity) of the ship to be called,
  - the category of the call routine,
  - the type of subsequent communication (radiotelephony),
  - working frequency information;
- transmit the DSC call.

A4-4.3 Repeating a call

Coast stations may transmit the call twice on the same calling frequency with an interval of at least 45 s between the two calls, provided that they receive no acknowledgement within that interval.

If the station called does not acknowledge the call after the second transmission, the call may be transmitted again on the same frequency or another calling frequency after a period of at least 10 min.

A4-4.4 Preparation for exchange of traffic

On receipt of a DSC acknowledgement with the indication that the called ship station can use the proposed working frequency, the coast station transfers to the working frequency or channel and prepares to receive the traffic.

A4-4.5 Acknowledgement of a received digital selective calling call

Acknowledgements shall normally be transmitted on the frequency paired with the frequency of the received call. If the same call is received on several calling channels, the most appropriate channel shall be chosen for transmission of the acknowledgement.

The acknowledgement of a DSC call is transmitted as follows:

- key in or select on the DSC equipment:
  - the format specifier (individual station),
  - MMSI (9-digit identity) of the calling ship,
  - the category of the call routine,
  - if able to comply immediately on the working frequency suggested by the ship station, the same frequency information as in the received call,
  - if no working frequency was suggested by the calling ship station, then the acknowledgement should include a channel/frequency proposal,
  - if not able to comply on the working frequency suggested, but able to comply immediately on an alternative frequency, the alternative working frequency,
  - if unable to comply immediately the appropriate information in that regard;
- transmit the acknowledgement after a delay of at least 5 s, but not later than 4½ min.

After having transmitted the acknowledgement, the coast station transfers to the working frequency or channel and prepares to receive the traffic.

A4-5 Test calls using digital selective calling

Perform VHF, MF and HF DSC test calls in accordance with Recommendation ITU-R M.493. DSC test calls by coast stations should normally be transmitted to a ship station using the DSC format specifier as "individual" and the category as "safety". The test calls by coast station should be acknowledged by a ship station called. Normally there would be no further communication between the two stations involved.

Acknowledgement of a digital selective calling test call from a ship

The coast station should acknowledge test calls from a ship station.

A4-6 Special conditions and procedures for digital selective calling communication on HF

General

The procedures for DSC communication on HF are – with some additions described in §§ A4-6.1 to A4-6.3 below – equal to the corresponding procedures for DSC communications on MF/VHF.

Due regard to the special conditions described in §§ A4-6.1 to A4-6.3 should be given when making DSC communications on HF.

A4-6.1 Distress

A4-6.1.1 Reception and acknowledgement of a digital selective calling distress alert on HF

Ships in distress may in some cases transmit the DSC distress alert on a number of HF bands with only short intervals between the individual calls.

The coast station shall transmit DSC acknowledgement on all HF DSC distress channels on which the DSC distress alert was received in order to ensure as far as possible that the acknowledgement is received by the ship in distress and by all ships which received the DSC distress alert.

A4-6.1.2 Distress traffic

The distress traffic should, as a general rule, be initiated on the appropriate distress traffic channel (radiotelephony) in the same band in which the DSC distress alert was received.

A4-6.1.3 Transmission of digital selective calling distress alert relay on HF

HF propagation characteristics should be taken into account when choosing HF band(s) for transmission of DSC distress alert relay.

IMO Convention ships equipped with HF DSC for distress and safety purposes are required to keep continuous automatic DSC watch on the DSC distress channel in the 8 MHz band and on at least one of the other HF DSC distress channels.

In order to avoid creating on board ships uncertainty regarding on which band the subsequent establishment of contact and distress traffic should be initiated, the HF DSC distress alert relay should be transmitted on one HF band at a time and the subsequent communication with responding ships be established before eventually repeating the DSC distress alert relay on another HF band.

A4-6.2 Safety

A4-6.2.1 Transmission of safety announcements and messages on HF

The announcement for unscheduled HF MSI shall be made on all MF/HF distress and safety calling frequencies (§ A7-1) using DSC and the safety call format. The DSC safety call shall be addressed to

a geographical area. The frequency on which the HF MSI will be transmitted after the announcement shall be included in the DSC safety call.

After the DSC announcement, the HF MSI message shall be transmitted on the frequency indicated in the DSC call.

The DSC announcement for unscheduled HF MSI is transmitted as follows:

– the format specifier (geographical area),
– address (geographical area),
– the category of the call (safety),
– the frequency or channel on which the HF MSI will be transmitted,
– the type of communication in which the HF MSI will be transmitted.

NOTE – For the announcements on all MF/HF DSC distress and safety calling frequencies, the frequency in message 2 should be the same MSI-HF frequency for narrowband direct-printing (NBDP) in Appendix **15** of Radio Regulations which is thought to be appropriate for the promulgation of the unscheduled HF NBDP MSI.

Annex 5

Operational procedures for both ship and coast stations for automatic connection system using digital selective calling communications on MF and HF

Introduction

The automatic connection system (ACS) means automatic connection function using DSC for shore-to-ship, ship-to-shore or ship-to-ship communication with the most appropriate working frequency (or channel) in the MF and HF bands of the maritime mobile service.

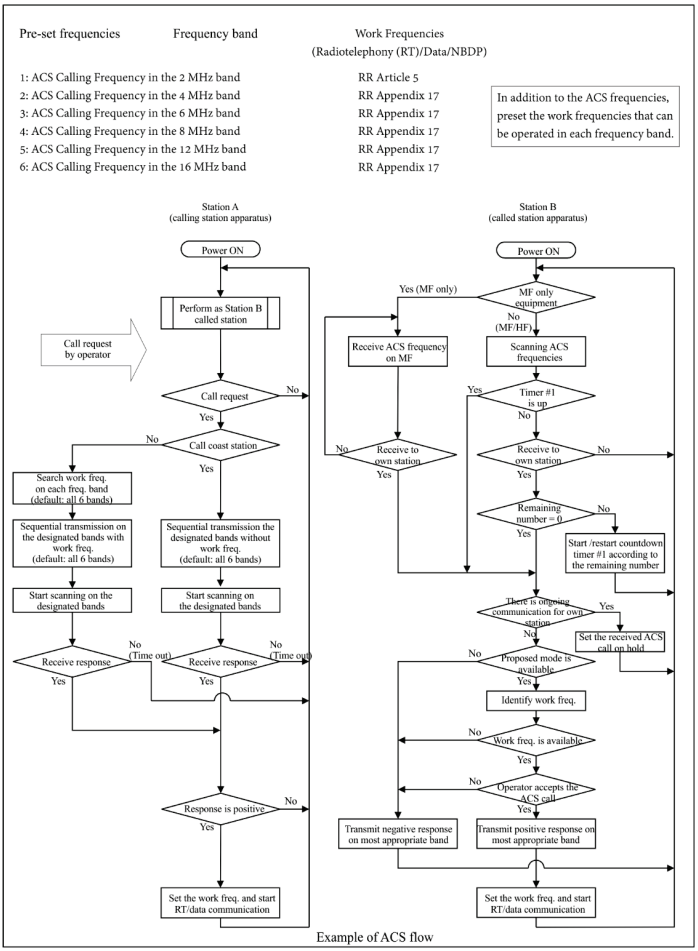
The procedures for ACS using DSC communications on MF and HF are described in this annex.

The procedure for ACS shall not interrupt a reliable watch on a 24-hour basis on appropriate DSC distress alerting frequencies unless while the equipment is transmitting.

An example of flowchart of ACS operational procedures is shown in Fig. A5-1.

FIGURE A5-1

Example of automatic connection system operational procedures



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A5-1 Frequencies and method of calling for automatic connection system

A5-1.1 Frequencies for automatic connection system

The frequencies described in § A7-2.3 of this Recommendation should be used for ACS.

A5-1.2 Method of calling

A5-1.2.1 The procedures set out in this section are applicable to the use of DSC techniques, except in cases of distress, urgency or safety, to which the provisions of RR Chapter VII are applicable.

A5-1.2.2 The ACS call should contain information indicating the station or stations to which the call is directed, and the identification of the calling station.

A5-1.2.3 The ACS call should also contain information indicating the type of subsequent communication to be set up and should include supplementary information such as a proposed working frequency or channel which is identified as the most appropriate with low noise level. This process should be repeated for each ACS frequency bands.

A5-2 Operating procedures

A5-2.1 Scanning

The receiver designated for ACS (ACS receiver) while the equipment is in standby should:

– for MF only equipment, monitor only the ACS frequency in the MF Band (2 MHz band) without scanning;

– for MF/HF equipment, scan up to six ACS frequencies in MF and HF band specified in § A5-1.1;

– scan all of six ACS frequencies within two seconds per one cycle;

– when the DSC dot pattern is detected, pause scanning on that frequency and decode receiving signal;

– resume standard scanning when the identification of the received signal is not addressed to the own station or remaining ACS sequential transmission is not completed;

– stop scanning when an acknowledgement is received;

– restart scanning ACS frequencies after completing call set up.

A5-2.2 Calling station

The following procedures should apply at calling station of ACS:

A5-2.2.1 The operator enters the identification (MMSI) of the called station and selects the type of subsequent communication and then initiates ACS call.

A5-2.2.2 The ACS receiver stops scanning during the transmission of the ACS message.

A5-2.2.3 When the called station is a ship station, the receiver searches the appropriate working frequency which is unoccupied and with low noise in each frequency band. The ACS complements the identified channels or frequencies into Message 2 for the ACS sequential transmission in each frequency band.

ACS sequential transmission to a ship station is composed as follows:

– Category of call:	ACS;
– Message 1 first telecommand:	type of communication (e.g. J3E, F1B or Data);
– Message 1 second telecommand:	number of remaining ACS sequential transmission;
– Message 2:	proposed working frequency which is in the same frequency band of the ACS transmission.

ACS sequential transmission to a coast station is composed as follows:

–	Category of call:	ACS;
–	Message 1 first telecommand:	type of communication (e.g. J3E, F1B or Data);
–	Message 1 second telecommand:	number of remaining ACS sequential transmission;
–	Message 2:	own ship's position information.

A5-2.2.4 ACS transmits up to six ACS sequential transmission using frequencies as specified in § A5-1.1. If there is a band for which no appropriate working frequency is found, the transmission is omitted for that band.

A5-2.2.5 The ACS receiver restarts scanning after up to six ACS sequential transmissions and then waits for a response from the called station.

A5-2.2.6 When calling station receives a response from called station within due time, the ACS receiver stops scanning.

A5-2.2.6.1 If the response is positive, ACS tune the transmitter using the working channel or frequency and type of communication in accordance with the received positive response. The ACS receiver restarts scanning after setting up communication the operator starts communication.

A5-2.2.6.2 If the response is negative, the ACS receiver restarts scanning, and the ACS procedure is terminated by operator.

A5-2.2.7 When calling station does not receive a response from called station within due time or operator selects the end of ACS calling, ACS procedure is terminated.

A5-2.3 Called station

The following procedures should apply at the called station when ACS receive call with its own identification:

A5-2.3.1 ACS checks the number of remaining ACS sequential transmissions calculating and updating the remaining time (Countdown Timer) according to the number of remaining ACS sequential transmissions, and records received signal conditions (e.g. received signal level, symbol error rate, noise level) for the received ACS frequency. If Countdown Timer or remaining number is zero, the procedure then goes to § A5-2.3.3. Otherwise, the procedure goes to § A5-2.3.2.

A5-2.3.2 The ACS receiver continues scanning ACS frequencies. During the scanning, if a call to own station on a different ACS frequency from the same calling station is received before Countdown Timer becomes zero, the procedure goes to A5-2.3.1. If no call to own station on a different ACS frequency from the same calling station is received before Countdown Timer becomes zero, the scanning ends and the procedure goes to § A5-2.3.3.

A5-2.3.3 ACS then makes audible indication and display that an ACS call request has been received. The system checks if there is on-going communication for own station. If all kinds of MF/HF radiocommunication (radiotelephone, data and so on) automated procedure are provided in the DSC equipment, the check can be made automatically according to the status (active or on hold) of every automated procedure. Otherwise, the check can be made by the operator manually. When there is on-going communication for own station, the received ACS call should be set as on hold and then the procedure goes to restart scanning. When there is no on-going communication for own station, the procedure goes to § A5-2.3.4.

A5-2.3.4 The proposed mode should be checked. If the proposed mode is unavailable for own station, a negative response should be transmitted on the most appropriate frequency as recorded in § A5-2.3.1 and then the procedure goes to restart scanning.

The negative response is composed as follows:

– Category: ACS
– Message 1 first telecommand: unable to comply
– Message 1 second telecommand: unable to use proposed mode
– Message 2: no information

If the proposed mode is available for own station, the frequency identification and following response should be made in accordance with § A5-2.4.

A5-2.3.5 When a suitable frequency has been identified and operator accept the ACS call, ACS initialises communication using designated working frequency and type of communication in accordance with the transmitted positive response.

A5-2.3.6 The receiver designated for ACS restarts scanning after setting up communication.

A5-2.3.7 The operator starts communication using the working frequency and type of communication in accordance with setting up communication.

A5-2.4 Frequency identification and following response to a calling station

A5-2.4.1 Response to a coast station

When the calling station is a coast station, the ACS of the called station (ship station) checks whether the working frequency (RX frequency for ship station) proposed by coast station is appropriate for the type of subsequent communication by using the receiver which is handling communication (e.g. the frequency is not busy, sufficient S/N etc.). When it is not suitable in the most appropriate frequency band as recorded in § A5-2.3.1, ACS of the called station (ship station) checks again the proposed working frequency for the selected type of communication in the second most appropriate frequency band as recorded in § A5-2.3.1.

When the proposed working frequency in most or second most appropriate working frequency band is suitable to use for subsequent communication, ACS notifies operator of the identified working frequency with proposed mode and the operator can decide whether to accept the ACS call.

If the operator decides to accept the ACS call, ACS responds to the calling station on the most appropriate ACS frequency as recorded in § A5-2.3.1 including the working frequency or channel positively. Then the procedure goes to § A5-2.3.5.

Positive response to a coast station with acceptance of the connection is composed as follows:

– Category of call: ACS
– Message 1 first telecommand: type of communication (e.g. J3E, F1B or Data)
– Message 1 second telecommand: no information
– Message 2: working frequency

If the operator decides to reject the ACS call, ACS responds to the calling station on the most appropriate ACS frequency as recorded in § A5-2.3.1 negatively and the procedure goes to restart scanning.

Negative response to a coast station when the operator decides to reject the call is composed is follows:

– Category: ACS
– Message 1 first telecommand: unable to comply
– Message 1 second telecommand: no operator available or Operator temporarily unavailable
– Message 2: position if available, or no information

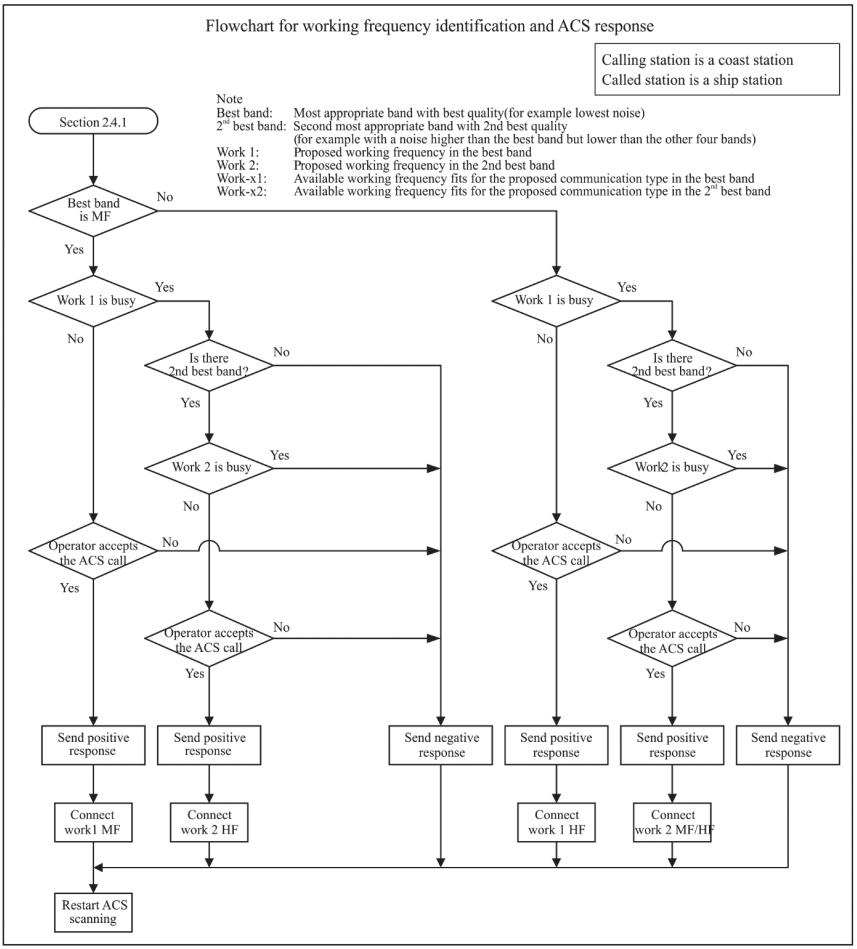
When it is not suitable on most and second most appropriate frequency band, ACS responds to reject the connection to the calling station on the most appropriate ACS frequency as recorded in accordance with § A5-2.3.1, and then the ACS receiver restarts scanning.

Negative response to a coast station with when there is no identified working frequency is composed as follows:

–	Category of call:	ACS
–	Message 1 first telecommand:	unable to comply
–	Message 1 second telecommand:	unable to use proposed channel
–	Message 2:	position if available, or no information

FIGURE A5-2

Flowchart for the working frequency identification and following ACS response for the called station when calling station is a coast station and called station is a ship station



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A5-2.4.2 Response to a ship station

A5-2.4.2.1 Response of a ship to a ship station

When the calling station is a ship station and the called station is a ship station, the ACS of the called station checks whether the proposed working frequency is suitable for the subsequent communication (e.g. the frequency is not busy) in the most appropriate frequency band recorded in § A5-2.3.1.

When the most appropriate band is a MF band and the proposed working frequency in the MF band is not suitable, ACS checks whether the proposed working frequency is appropriate for the type of communication in the second most appropriate frequency band (i.e. an HF band) as recorded in § A5-2.3.1. If the proposed working frequency in the HF band is not suitable, then ACS searches the HF band for another working frequency suitable for the type of communication.

NOTE – In MF band, ACS checks only proposed working frequency because frequencies are limited in MF band, therefore ACS does not search alternative working frequency in MF band.

When the most appropriate band is an HF band and the proposed working frequency in the HF band not suitable, ACS searches another working frequency suitable for the type of communication in the same frequency band. It should use the receiver which is handling communication.

When there is suitable working frequency in most or second most appropriate band for subsequent communication, ACS notifies operator of the identified working frequency with proposed mode and the operator can decide whether to accept the ACS call.

If the operator decides to accept the ACS call, ACS responds to the calling station on the most appropriate ACS frequency as recorded in § A5-2.3.1 including the working frequency or channel positively. Then the procedure goes to § A5-2.3.5.

The positive response from a ship station to a ship station with acceptance of the connection is composed as follows:

– Category of call: ACS
– Message 1 first telecommand: type of communication (e.g. J3E, F1B or Data)
– Message 1 second telecommand: no information
– Message 2: working frequency

If the operator decides to reject the ACS call, ACS responds to the calling station on the most appropriate ACS frequency as recorded in § A5-2.3.1 negatively and the procedure goes to restart scanning.

The negative response from a ship station to a ship station when the operator decides to reject the call is composed as follows:

– Category: ACS
– Message 1 first telecommand: unable to comply
– Message 1 second telecommand: no operator available or Operator temporarily unavailable
– Message 2: position if available, or no information

When there is no suitable working frequency in most and second most appropriate frequency bands ACS responds to reject the connection to the calling station on most appropriate ACS frequency as recorded in § A5-2.3.1.

The negative response from a ship station to a ship station when there is no identified working frequency is composed as follows:

– Category of call: ACS
– Message 1 first telecommand: unable to comply
– Message 1 second telecommand: unable to use proposed channel
– Message 2: position if available, or no information

When there is no identified working frequency, ACS responds for reject connection to the calling station on most appropriate ACS frequency as recorded in § A5-2.3.1 with the following conditions:

– when the most appropriate frequency band is MF band and the proposed working frequency is not suitable, and also there is no alternative suitable working frequency in the second most appropriate frequency band of HF; or

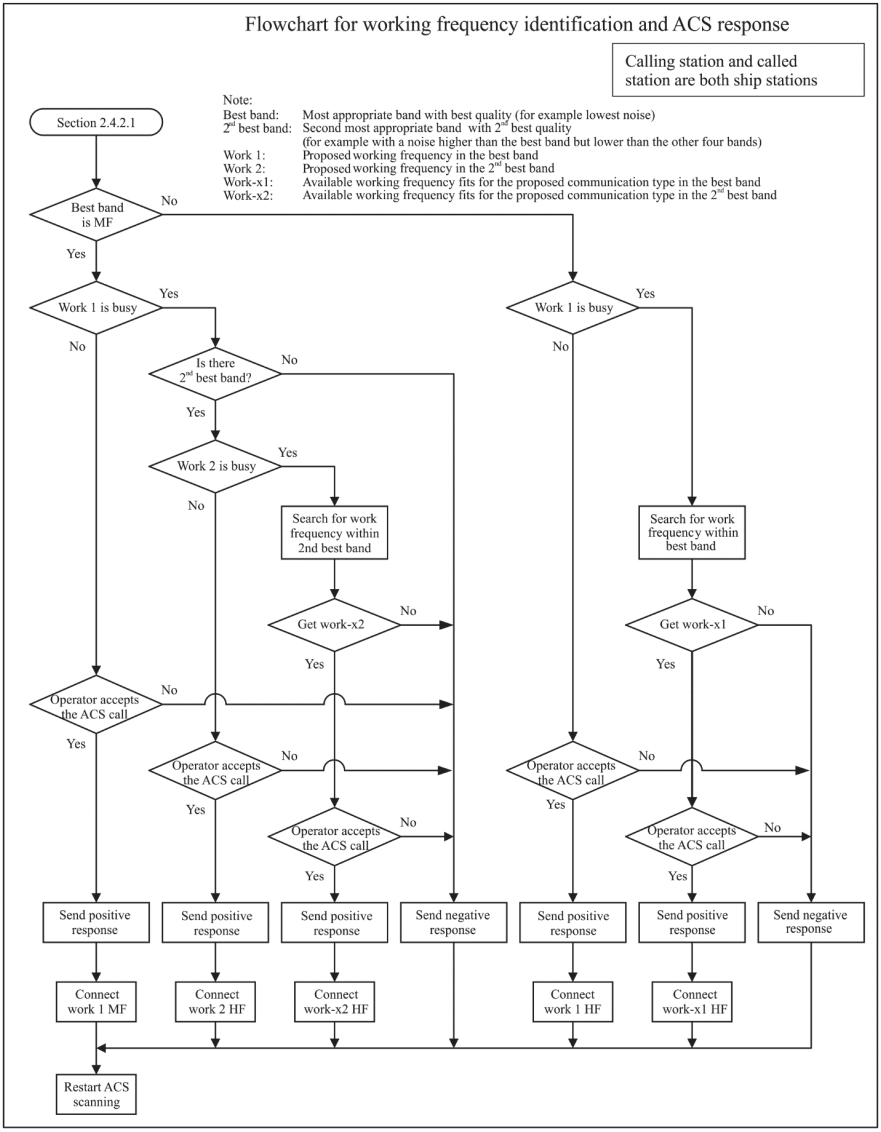
– when the most appropriate frequency band is HF band and the proposed working frequency is not suitable, and also there is no alternative suitable working frequency; or

– in the case of ACS for MF band only, the proposed working frequency is not suitable.

Then the receiver designated for ACS restarts scanning.

FIGURE A5-3

Flowchart for working frequency identification and following ACS response for the called station when calling station and called station are both ship stations



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A5-2.4.2.2 Response of a coast station to a ship station

When the calling station is a ship station and the called station is a coast station, the following procedure in Fig. A5-4 applies to the frequency identification and following ACS response.

When the most appropriate band is MF band, ACS searches the MF band for available working frequency (e.g. the frequency is not busy) for the proposed communication type. If no suitable frequency in the MF band is identified, ACS searches the second most appropriate band for available working frequency.

When the most appropriate band is a HF band, ACS searches the HF band for available working frequency (e.g. the frequency is not busy) for the proposed communication type.

When a suitable frequency is not identified according to Fig. A5-4, ACS responds to reject the connection to a calling station on most appropriate ACS frequency as recorded in § A5-2.3.1 and the receiver designated for ACS restarts scanning.

The negative response from a coast station to a ship station when there is no identified working frequency is composed as follows:

– Category of call: ACS
– Message 1 first telecommand: unable to comply
– Message 1 second telecommand: busy
– Message 2: position if available, or no information

When a suitable frequency is identified according to Fig. A5-4, ACS notifies operator of the identified working frequency with proposed mode and the operator can decide whether to accept the ACS call.

If the operator decides to accept the ACS call, ACS responds to the calling station on the most appropriate ACS frequency as recorded in § A5-2.3.1 including the working frequency or channel positively. Then the procedure goes to § A5-2.3.5.

The positive response from a coast station to a ship station with acceptance of the connection is composed as follows:

– Category of call: ACS
– Message 1 first telecommand: type of communication (e.g. J3E, F1B or Data)
– Message 1 second telecommand: no information
– Message 2: working frequency

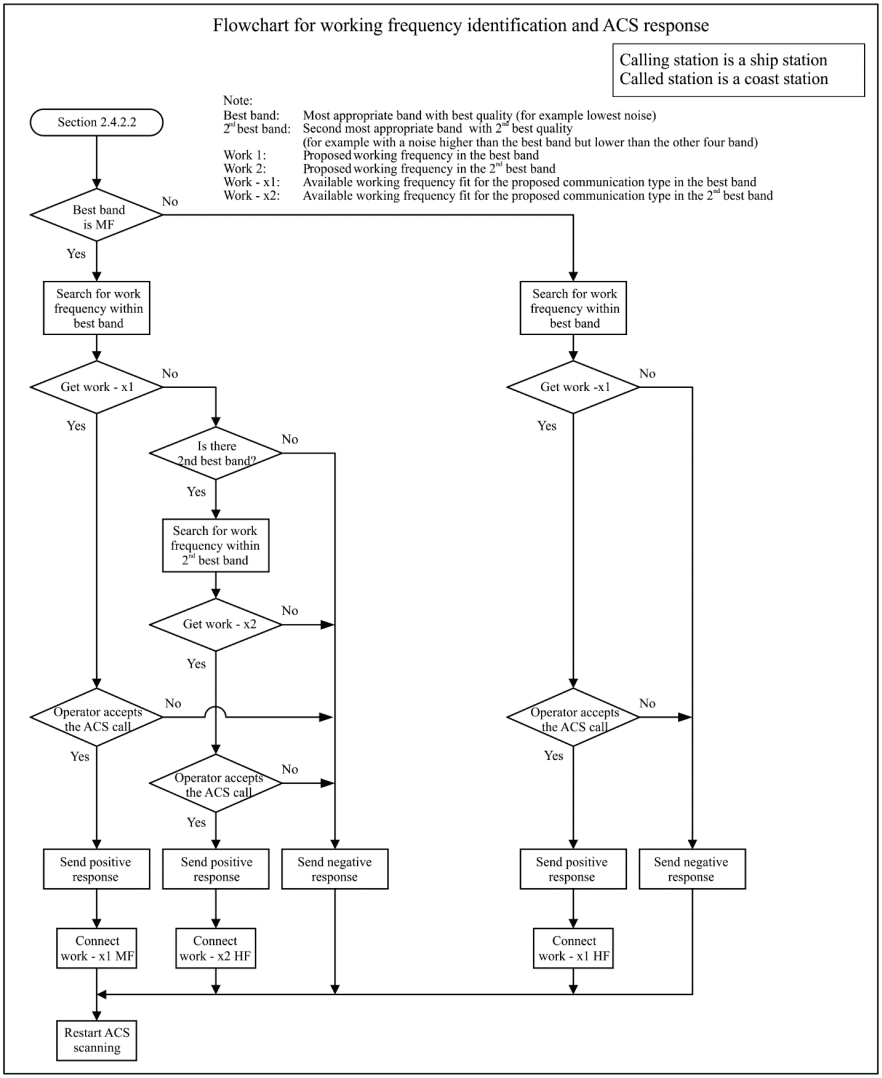
If the operator decides to reject the ACS call, ACS responds to the calling station on the most appropriate ACS frequency as recorded in § A5-2.3.1 negatively and the procedure goes to restart scanning.

The negative response from a coast station to a ship station when the operator decides to reject the call is composed as follows:

– Category: ACS
– Message 1 first telecommand: unable to comply
– Message 1 second telecommand: no operator available or operator temporarily unavailable
– Message 2: position if available, or no information

FIGURE A5-4

Flowchart for the working frequency identification and following ACS response for the called station when calling station is a ship station and called station is a coast station



M.0541-A5-04

A5-2.5 Selection of working frequency

A5-2.5.1 The pre-setting of working frequencies in each MF/HF band is the basis for the search for the available working frequency in §§ A5-2.2.3 and A5-2.4. The working frequency for

subsequent communication should be selected from Appendix **17** of the RR according to the type of subsequent communication. In radiotelephony, simplex operation using single frequency is recommended for ship-to-ship radiocommunication, however, duplex or semi-duplex operation using paired frequencies is recommended for public correspondence between coast station and ship station.

A5-2.5.2 If the subsequent type of communication is HF radiotelephony, the working frequency should be selected in the frequencies of section 1 of the RR Appendix **17**, Part B. However, the frequencies for the distress and safety traffic or frequencies for calling should be avoided.

A5-2.5.3 In radiotelephony between coast station and ship station, working frequency should be proposed always by the coast station. If the proposed working frequency is not available for ship station called, then the ship station responds with its position information and wait for another proposal of working frequency by the coast station.

A5-2.5.4 To minimize interference of working frequencies for duplex communications, if the last digit of MMSI of ship station called is an even number, then it is recommended to use working frequency of even channel number in each frequency band of the RR Appendix **17**. If the last digit of MMSI of ship station called is an odd number, then it is recommended to use working frequency of odd channel number in each frequency band.

Annex 6

Autonomous maritime radio devices Group A man overboard devices using VHF digital selective calling for alerting and automatic identification system technology for tracking

Introduction

AMRD Group A MOB devices operate on VHF channel 70 for alerting using VHF DSC and on automatic identification system (AIS) frequencies for tracking. The devices are fitted with a VHF DSC and an AIS transmitter. Technical characteristics are described in Recommendations ITU-R M.2135.

A6-1 Digital selective calling alert

AMRD Group A MOB devices may be activated manually or automatically if a person falls overboard. The device will transmit a DSC distress alert upon activation. The alert message is a distress alert with the nature of distress field set to *man overboard* and the subsequent communications field set to *no information*.

There are no voice communications from AMRD Group A MOB devices.

AMRD Group A MOB devices may operate in either:

– open loop mode, with the DSC distress alert addressed to all stations – i.e. a standard distress alert; or

– closed loop mode, with the DSC distress alert relay message addressed to a specific station or group of stations – normally the parent vessel.

In both cases, the AIS transmitter is activated and transmits AIS man overboard messages.

A6-2 Identification

AMRD Group A MOB devices are programmed with a distinctive maritime identifier, coded in accordance with Recommendation ITU-R M.585.

A6-3 Position updating

AMRD Group A MOB devices are fitted with an integrated electronic position fixing device. However, it should be noted that the initial distress alert from an AMRD Group A MOB device will not contain a position and time information, as the integrated electronic position fixing device will not have locked onto the satellite constellation.

As soon as the internal electronic position fixing device is able to provide an accurate position and time, the MOB device will transmit a further DSC distress alert and an AIS message with the position and time from the position fixing device automatically inserted.

A6-4 Acknowledgment

AMRD Group A MOB devices are fitted with a DSC receiver for reception of acknowledgment messages.

An acknowledgment message causes the AMRD Group A MOB device to stop transmitting DSC alerts. Accordingly, DSC acknowledgment messages should only be sent when the Master or person in charge of the recovery vessel considers it prudent to do so.

The AMRD Group A MOB device will continue transmitting its position using AIS functionality until manually turned off or the battery is exhausted.

As with other VHF DSC distress alerts, DSC acknowledgments to open loop AMRD Group A MOB devices alerts are normally only sent by coast stations, or under direction of a coast station. However, the recovery vessel may send a DSC acknowledgment message if the person in the water has been recovered.

Once the person in the water is recovered, the AMRD Group A MOB device should be switched off as soon as possible and an announcement cancelling the distress alert made on VHF channel 16 should be provided.

A6-5 Cancellation of an inadvertent distress alert

A station transmitting an inadvertent distress alert from an AMRD Group A MOB device should cancel the distress alert using the following procedure:

– immediately turn off the MOB device, which causes a DSC self-cancel message to be sent automatically;

– cancel the distress alert verbally on VHF channel 16 (see RR No. **32.53E**) by the associated station;

– monitor VHF channel 16, and respond to any communications concerning that distress alert as appropriate.

Annex 7

Frequencies used for digital selective calling

A7-1 The frequencies used for distress, urgency, and safety purposes using DSC are as follows (RR Appendix **15**):

2 187.5	kHz
4 207.5	kHz
6 312	kHz
8 414.5	kHz
12 577	kHz
16 804.5	kHz
156.525	MHz (Note 1)

NOTE 1 – The frequency 156.525 MHz may also be used for DSC purposes other than distress, urgency, and safety.

A7-2 The frequencies assignable on an international basis to ship and coast stations for DSC, for purposes other than distress, urgency, safety and ACS, are as follows (see Note 2):

A7-2.1 Ship stations (see Note 2)

2 177 (Note 3)	2 189.5		kHz
4 208	4 208.5	4 209	kHz
6 312.5	6 313	6 313.5	kHz
8 415	8 415.5	8 416	kHz
12 577.5	12 578	12 578.5	kHz
16 805	16 805.5	16 806	kHz
18 898.5	18 899	18 899.5	kHz
22 374.5	22 375	22 375.5	kHz
25 208.5	25 209	25 209.5	kHz
		156.525	MHz

A7-2.2 Coast stations (see Note 2)

2 177			kHz
4 219.5	4 220	4 220.5	kHz
6 331	6 331.5	6 332	kHz
8 436.5	8 437	8 437.5	kHz
12 657	12 657.5	12 658	kHz
16 903	16 903.5	16 904	kHz
19 703.5	19 704	19 704.5	kHz
22 444	22 444.5	22 445	kHz
26 121	26 121.5	26 122	kHz
		156.525	MHz

NOTE 2 – The following paired assigned frequencies (for ship/coast stations) 4 208/4 219.5 kHz, 6 312.5/6 331 kHz, 8 415/8 436.5 kHz, 12 577.5/12 657 kHz, 16 805/16 903 kHz, 18 898.5/19 703.5 kHz, 22 374.5/22 444 kHz and 25 208.5/26 121 kHz are the first choice international frequencies for DSC (see RR Appendix **17**).

NOTE 3 – The frequency 2 177 kHz is available to ship stations for intership calling only.

A7-2.3 Frequencies for automatic connection system using digital selective calling for ship and coast stations

ACS calling in the 2 MHz frequency band

ACS calling in the 4 MHz frequency band

ACS calling in the 6 MHz frequency band

ACS calling in the 8 MHz frequency band

ACS calling in the 12 MHz frequency band

ACS calling in the 16 MHz frequency band.

RECOMMENDATION ITU-R M.585-9*

Assignment and use of identities in the maritime mobile service

(1982-1986-1990-2003-2007-2009-2012-2015-2019-2022)

Scope

This Recommendation provides guidance to administrations for the assignment and conservation of identity resources for the maritime mobile service. The limitations which constrain assignments for ships which utilize the satellite services of the global maritime distress and safety system (GMDSS) are described in this Recommendation.

Annex 1 describes formats for maritime mobile service identities (MMSI) of ship stations, coast stations, aircraft participating in search and rescue operations and other safety-related communications, automatic identification system (AIS) aids to navigation, and craft associated with a parent ship.

Annex 2 describes formats for identification of other maritime devices, such as handheld VHF transceivers with digital selective calling (DSC) and integral global navigation satellite system (GNSS) receiver, AIS-search and rescue transmitter (AIS-SART), man overboard (MOB) and emergency position-indicating radio beacon (EPIRB)-AIS and autonomous maritime radio devices (AMRD).

Annex 3 provides specific guidance to administrations for the assignment, management and conservation of identity resources for the maritime mobile service. This guidance further instructs administrations on methods for the reuse of MMSI assignments, and devices using a freeform number identity.

Keywords

MMSI, identities, maritime mobile service

List of Abbreviations/Glossary

AIS:	Automatic identification system
AIS-SART	AIS search and rescue transmitter
AMRD	Autonomous maritime radio devices
AtoN	Aids to navigation
DSC	Digital selective calling
EPIRB	Emergency position-indicating radio beacon
GMDSS	Global maritime distress and safety system
GNSS	Global navigation satellite system
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
MARS	Maritime mobile Access and Retrieval System
MID	Maritime identification digit
MMS	Maritime mobile service
MMSI	Maritime mobile service identity

* This Recommendation should be brought to the attention of International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), International Civil Aviation Organization, International Hydrographic Organization, International Maritime Organization and Committee International Radio Maritime.

MOB	Man overboard
RCC	Rescue coordination centre
SAR	Search and rescue
VDL	VHF data link

Related ITU Resolutions, Recommendations and Reports

Resolutions

344 (Rev.WRC-19): Management of the maritime identity numbering resource

Recommendations

ITU-R M.493 – Digital selective-calling system for use in the maritime mobile service

ITU-R M.1080 – Digital selective calling system enhancement for multiple equipment installations

ITU-R M.1371 – Technical characteristics for an automatic identification system using time division multiple access in the VHF maritime mobile frequency band

ITU-R M.2135 – Technical characteristics of autonomous maritime radio devices operating in the frequency band 156-162.05 MHz

Report

ITU-R M.2285 – Maritime survivor locating systems and devices (man overboard systems) – An overview of systems and their mode of operation

ITU-T Recommendation

ITU-T E.217 (02/19): Maritime communications – Ship station identity

The ITU Radiocommunication Assembly,

considering

a) the need for structured identities for safety and telecommunication purposes in the maritime mobile service (MMS);

b) that the maritime identifier in the MMS is based on a 9-digit structure;

c) that the maritime mobile service identity (MMSI) is one type of 9-digit identifier;

d) that the identities designated for devices for special purposes consist of a second type of 9-digit identifier;

e) that the unique identity assigned to stations indicated in Annex 1 to this Recommendation should be the MMSI;

f) that the identities used for other maritime devices for special purposes indicated in Annex 2 to this Recommendation are not necessarily unique and are not MMSI assignments;

g) the need for all maritime identities to be usable with automated radiocommunication systems;

h) that the identities assigned to ship stations, coast stations, aircraft participating in search and rescue operations and other safety-related communications, aids to navigation, craft associated with a parent ship, and used for establishing group calls should be of a similar nature;

i) that it is possible to use the MMSI to establish a telephone call to a ship after routing through the public switched networks to an appropriate coast station;

j) that mobile-satellite systems enable the maritime community to participate in or interwork with international public correspondence telecommunication systems on a fully automatic basis, utilizing the identities, naming and addressing scheme;

k) that the numbering scheme specified for existing generations of mobile-satellite systems participating in the global maritime distress and safety system (GMDSS) is compatible with the international public correspondence service,

recommends

1 that ships complying with the International Convention for the Safety of Life at Sea, 1974, as amended, and other ships equipped with automated radiocommunication systems, including automatic identification system (AIS), digital selective calling (DSC), and/or carrying alerting devices of the GMDSS should be assigned maritime mobile service identities in accordance with Annex 1 to this Recommendation;

2 that maritime identities used for other maritime devices for special purposes should be assigned as specified in Annex 2;

3 that ship stations, including handheld VHF transceivers with DSC and integral global navigation satellite system (GNSS) receiver, coast stations, and aircraft participating in search and rescue operations using digital selective calling equipment in accordance with Recommendation ITU-R M.493 should use their 9-digit numerical identities transmitted as a 10-digit address/self-identity, normally with a digit 0 added at the end of the identity (see also Recommendation ITU-R M.1080);

4 that ship stations, coast stations, and non-shipborne stations using AIS equipment should use their 9-digit numerical identities in accordance with Recommendation ITU-R M.1371;

5 for the purpose of ensuring compatibility with the GMDSS, the numbers, names and addresses of ship earth stations participating in international telecommunication services should be made readily available to all authorized entities by the telecommunication service providers concerned;

6 that the guidance given in Annex 3 to this Recommendation should be consulted for the assignment, management and conservation of identities in the maritime mobile service.

Annex 1

Maritime mobile service identities

Section 1

Assignment of identification to ship station

1 Ships participating in the maritime radio services mentioned in recommends 1 should be assigned a 9-digit unique ship station identity in the format $M_1I_2D_3X_4X_5X_6X_7X_8X_9$ where in the first three digits represent the maritime identification digits (MID) and X is any figure from 0 to 9. The MID denotes the administration having jurisdiction over the ship station so identified.

2 Restrictions may apply with respect to the maximum number of digits, which can be transmitted on some national telex and/or telephone networks for the purpose of ship station identification.

3 The maximum number of digits that could be transmitted over the national networks of many countries for the purpose of determining ship station identity was six. The digits carried on the network to represent the ship station identity are referred to as the «ship station number» in this text and in the relevant ITU-R Recommendations.

4 Group ship station call identities for calling simultaneously more than one ship are formed as follows:

$$0_1M_2I_3D_4X_5X_6X_7X_8X_9$$

where the first figure is zero and X is any figure from 0 to 9. The MID represents only the territory or geographical area of the administration assigning the group ship station call identity and does not therefore prevent group calls to fleets containing more than one ship nationality.

5 With the evolution of global mobile-satellite systems, ships' earth stations are able to participate in international public correspondence telecommunication services. Ship earth stations having this functionality may be assigned international telecommunication numbers that have no direct correspondence with the ship station MMSI. Those authorized to assign the numbers, names and addresses associated with such ship earth stations should maintain a record of the cross-reference relationships with the MMSI, for example in an appropriate database. For the purposes of GMDSS the details of these relationships should be made available to authorized entities such as but not limited to the rescue coordination centres (RCCs)[1]. Such availability should be on an automatic basis, 24 hours per day 365 days per year.

[1] International Maritime Organisation Resolution A.1001(25) requires that distress priority communications in these systems should, as far as possible, be routed automatically to an RCC.

Section 2

Assignment of identification to coast station

1 Coast stations and other stations on land participating in the maritime radio services mentioned in *recommends* 3 should be assigned a 9-digit unique coast station identity in the format $0_1 0_2 M_3 I_4 D_5 X_6 X_7 X_8 X_9$ where the digits 3, 4 and 5 represent the MID and X is any figure from 0 to 9. The MID reflects the administration having jurisdiction over the coast station or coast earth station.

2 As the number of coast stations decreases in many countries, an administration may wish to assign MMSI of the format above to harbour radio stations, pilot stations, system identities and other stations participating in the maritime radio services. The stations concerned should be located on land or on an island in order to use the 00MIDXXXX format.

3 The administration may use the sixth digit to further differentiate between certain specific uses of this class of MMSI, as shown in the example applications below:

a) 00MID1XXX Coast stations

b) 00MID2XXX Port stations (harbour radio stations)

c) 00MID3XXX Pilot stations

d) 00MID4XXX AIS repeater stations

e) 00MID5XXX AIS base stations (VDL controlling stations)

4 This format scheme creates blocks of 999 numbers for each category of station, however the method is optional and should be used only as a guidance. Many other possibilities exist if the administration concerned wishes to augment the scheme.

5 Group coast station call identities for calling simultaneously more than one coast station are formed as a subset of coast station identities, as follows:

$$0_1 0_2 M_3 I_4 D_5 X_6 X_7 X_8 X_9$$

where the first two figures are zeroes and X is any figure from 0 to 9. The MID represents only the territory or geographical area of the administration assigning the group coast station call identity. The identity may be assigned to stations of one administration which are located in only one geographical region as indicated in the relevant ITU-T Recommendations.

6 The combination $0_1 0_2 M_3 I_4 D_5 0_6 0_7 0_8 0_9$ should be reserved for a Group Coast Station Identity and should address all 00MIDXXXX stations within the administration. The administration may further augment this use with additional group call identities, i.e. 00MID1111, etc.

7 For the purpose of the GMDSS the details of these MMSI assignments should be made available to authorized entities such as, but not limited to, RCC. Such availability should be on an automatic basis, 24 hours per day 365 days per year.

8 The combination $0_1 0_2 9_3 9_4 9_5 0_6 0_7 0_8 0_9$ is reserved for the all-coast stations identity and should address all VHF 00XXXXXXX stations. It is not applicable to MF or HF coast stations.

Section 3

Assignment of identification to aircraft

1 When an aircraft is required to use maritime mobile service identities for the purposes of search and rescue operations and other safety-related communications with stations in the maritime mobile service, the responsible administration should assign a 9-digit unique aircraft identity, in the format $1_1 1_2 1_3 M_4 I_5 D_6 X_7 X_8 X_9$ where the digits 4, 5 and 6 represent the MID and X is any figure from 0 to 9. The MID represents the administration having jurisdiction over the aircraft call identity.

2 The format shown above will accommodate 999 aircraft per MID. If the administration concerned has more search and rescue (SAR) aircraft than 999 they may use an additional country code (MID) if it is already assigned by the ITU.

3 The administration may use the seventh digit to differentiate between certain specific uses of this class of MMSI, as shown in the example applications below:

a) 111MID1XX Fixed-wing aircraft

b) 111MID5XX Helicopters

4 This format scheme creates blocks of 99 numbers for each of the category of stations, however, the method shown here is optional.

5 The combination $1_1 1_2 1_3 M_4 I_5 D_6 0_7 0_8 0_9$ should be reserved for a Group Aircraft Identity and should address all 111MIDXXX stations within the administration. The administration may further augment this with additional Group Call identities, i.e. 111MID111, etc.

6 For the purpose of search and rescue the details of these MMSI assignments should be made available to authorized entities such as, but not limited to, RCC. Such availability should be on an automatic basis, 24 hours per day 365 days per year.

7 The MMSI assigned to aircraft should also be available from the ITU Maritime mobile Access and Retrieval System (MARS) database (see RR No. **20.16**).

Section 4

Assignment of identification to automatic identification systems aids to navigation

1 When a means of automatic identification is required for a station aiding navigation at sea, the responsible administration should assign a 9-digit unique number in the format $9_1 9_2 M_3 I_4 D_5 X_6 X_7 X_8 X_9$ where the digits 3, 4 and 5 represent the MID and X is any figure from 0 to 9. The MID represents the administration having jurisdiction over the call identity for the navigational aid.

2 The format shown above applies to all types of aid to navigation (AtoN) as listed in the most recent version of Recommendation ITU-R M.1371, see AIS Message 21 parameter “Type of aids to navigation” and the associated table for this parameter. This format is used for all AIS stations for the transmission of messages that relate to AtoN. In the case where an AIS base station is collocated with an AIS AtoN station the messages related to the base station operation should be assigned an identification number in the format given in Annex 2.

3 The format scheme shown above will accommodate 10 000 AtoN per MID. If the administration concerned has more than 10 000, they may use an additional country code (MID) if it is already assigned by the ITU giving a further 10 000 identities.

4 The administration may use the sixth digit to differentiate between certain specific uses of the MMSI, as shown in the example applications below:

a) 99MID1XXX Physical AIS AtoN

b) 99MID6XXX Virtual AIS AtoN

c) 99MID8XXX Mobile AtoN

5 This format scheme creates blocks of 999 numbers for each category of station, however the method shown here is optional and should be used only as a guidance.

6 In addition to the use of the sixth digit to differentiate between specific navigational aids as explained above, the seventh digit may be used for national purposes, to define areas where the AIS AtoN are located or types of AIS AtoN to the discretion of the administration concerned.

7 The details of these MMSI assignments should be made available but not limited to the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) and appropriate national authorities.

8 The assigned MMSI to aids of navigation should also be available from the ITU MARS database (see RR No. **20.16**).

Section 5

Assignment of identification to craft associated with a parent ship

1 Craft associated with a parent ship, need unique identification. These craft which participate in the maritime mobile service should be assigned a 9-digit unique number in the format $9_1 8_2 M_3 I_4 D_5 X_6 X_7 X_8 X_9$ where the digits 3, 4 and 5 represent the MID and X is any figure from 0 to 9. The MID represents the administration having jurisdiction over the identity for the craft associated with a parent ship.

2 This numbering format is only valid for devices on board craft associated with a parent ship. A craft may carry multiple devices which would be identified by the MMSI assigned to the craft. These devices may be located in lifeboats, life-rafts, rescue-boats or other craft belonging to a parent ship but separate from search and rescue transmitters (AIS-SART).

3 A unique MMSI should be assigned for each craft associated with a parent ship and will have to be separately registered and linked to the MMSI of the parent ship.

4 The format scheme shown above will accommodate 10 000 craft associated with parent ships per MID. If the administration concerned has more than 10 000, they may use an additional country code (MID) if it is already assigned by the ITU giving a further 10 000 identities.

5 The assigned MMSI to these craft associated with a parent ship should also be available from the ITU MARS database (see RR No. **20.16**).

Annex 2

Maritime identities used for other maritime devices for special purposes

These identities use MID numbering resources, but have special uses defined in each of the sections below.

Section 1

Assignment of identities for handheld VHF transceivers with digital selective calling and integral global navigation satellite system receiver

1 A handheld VHF transceiver with DSC and integral GNSS receiver may require a unique identification showing that this device has restricted battery capacity and restricted coverage area. This may give additional information in an emergency case.

2 The handheld VHF transceiver with DSC and integral GNSS receiver should be used exclusively in the maritime mobile service.

3 Handheld VHF transceiver with DSC and integral GNSS receiver participating in the maritime mobile service should be assigned a unique 9-digit number in the format $8_1M_2I_3D_4X_5X_6X_7X_8X_9$ where digits 2, 3 and 4 represents the MID and X is any figure from 0 to 9. The MID represents the administration assigning the identity to the handheld transceiver.

$$8_1M_2I_3D_4X_5X_6X_7X_8X_9$$

4 The procedure and criteria for assignment and registration of these identities should be left to the administration concerned.

5 Some minimum of procedures for registration of this identity should be observed:

a) all identities in this category should be registered by the national authority concerned, and the local RCC or MRCC should be able to access the data on a 24 hour-per-day, 7 days-per-week basis. In systems that have automatic distress priority, this information should be automatically forwarded to an RCC;

b) the reuse of this identity should follow the guidance of Annex 3 of this Recommendation.

6 The administration may use the 5th digit to differentiate between certain specific uses/users of the maritime identity. However, this method is optional and for national use only.

Section 2

Devices using a freeform number identity

These identities, which use the 3-digit prefix (allocated from the table of maritime identification digits), are used to identify maritime radio equipment like the AIS-SART, man overboard (MOB) and emergency position-indicating radio beacon (EPIRB)-AIS and similar equipment needing identification.

1 Automatic identification system-search and rescue transmitter[2]

The AIS-SART should use an identity:

$$9_1 7_2 0_3 X_4 X_5 Y_6 Y_7 Y_8 Y_9$$

(where X_4X_5 = manufacturer ID 01 to 99; $Y_6Y_7Y_8Y_9$ = the sequence number 0000 to 9999. When reaching 9999 the manufacturer should restart the sequence numbering at 0000. Manufacturer ID ‘00’ is used for testing purposes.)

2 Man overboard

The MOB device which is classified as AMRD Group A according to the most recent version of Recommendation ITU-R M.2135 should use an identity:

$$9_1 7_2 2_3 X_4 X_5 Y_6 Y_7 Y_8 Y_9$$

(where X_4X_5 = manufacturer ID 01 to 99; $Y_6Y_7Y_8Y_9$ = the sequence number 0000 to 9999. When reaching 9999 the manufacturer should restart the sequence numbering at 0000. Manufacturer ID ‘00’ is used for testing purposes.)

3 Emergency position-indicating radio beacon-automatic identification system

The emergency position-indicating radio beacon-automatic identification system (EPIRB-AIS) should use an identity:

$$9_1 7_2 4_3 X_4 X_5 Y_6 Y_7 Y_8 Y_9$$

(where X_4X_5 = manufacturer ID 01 to 99; $Y_6Y_7Y_8Y_9$ = the sequence number 0000 to 9999. When reaching 9999 the manufacturer should restart the sequence numbering at 0000. Manufacturer ID ‘00’ is used for testing purposes.).

The user identity of the EPIRB-AIS indicates the identity of the homing device of the EPIRB-AIS, and not the MMSI of the ship.

4 Autonomous maritime radio devices[3]

4.1 Autonomous maritime radio devices Group A

AMRD Group A according to the most recent version of Recommendation ITU-R M.2135 which are identified as MOB (DSC Class M) should use the numbering scheme as described in Annex 2, § 2.

AMRD Group A, according to the most recent version of Recommendation ITU-R M.2135 which are identified as Mobile AtoN should use the numbering scheme as described in Annex 1, § 4.

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[2] The numbering format of AIS-SART should be separate from other multiple devices carried on board and which would be identified by the MMSI assigned to the craft. These devices may be located in lifeboats, life-rafts, rescue-boats or other craft belonging to a parent ship.

[3] AMRD Group A should operate on Channel 70 (DSC), AIS 1 and AIS 2.
AMRD Group B should operate on Channel 2006.

4.2 Autonomous maritime radio devices Group B

AMRD Group B devices based on AIS technology should use the identity according to the most recent version of Recommendation ITU-R M.2135:

$$9_1 7_2 9_3 Y_4 Y_5 Y_6 Y_7 Y_8 Y_9$$

AMRD Group B identities should be limited to the MID 979. Further identification on an individual equipment level should be achieved by additional information transmitted, as defined by the most recent version of Recommendation ITU-R M.2135. Duplication of numbers for AMRD Group B devices is acceptable.

($Y_4 Y_5 Y_6 Y_7 Y_8 Y_9$ = a pseudorandom number, to be determined by the manufacturer using a random permutation of the integers from 0-999999 without reuse of a number until all numbers have been used. Many numerical software packages have built-in methods for random permutations. Alternatively, a simple and suitable algorithm is known as Fisher-Yates-Shuffle. The algorithm should be seeded with a random number such as a timestamp, a sequence number, or some combination of these to reduce the possibility that two or more manufacturers generate the same number sequence.)

Annex 3

Assignment, management and conservation of maritime identities

Section 1

Maritime mobile service identities

Administrations should employ the following measures to manage the limited identity resource in order to avoid depletion of MID and the corresponding MMSI series:

a) implement effective national procedures for identity assignment and registration;

b) provide the Radiocommunication Bureau with regular updates of assigned MMSI numbers in conformity with RR No. **20.16**;

c) ensure that when ships move from the flag of registration of one administration to that of another administration, all of the assigned means of ship station identification, including the MMSI, are reassigned as appropriate and that the changes are notified to the Radiocommunication Bureau as soon as possible (see RR No. **20.16**);

d) an MMSI assignment could be considered for reuse after being absent from two successive editions of List V of the ITU service publications or after a period of two years, whichever is the greater.

Section 2

Maritime identities for handheld VHF transceiver with digital selective calling and integral global navigation satellite system receivers

Administrations, when assigning maritime identities to handheld VHF transceivers with DSC and integral GNSS receiver, should employ all available measures to effectively manage the limited identity resource.

a) The format scheme in Annex 2 Section 1, used for assigning VHF transceiver identities, will accommodate 100 000 VHF transceivers per MID. When the administration concerned has assigned identities to 100 000 VHF transceivers with DSC and integral GNSS receiver, it may use an additional country code (MID), if it is already assigned by the ITU, giving a further 100 000 identities.

b) When an administration determines it has a need for additional allocation of a MID, because it has exhausted more than 80% of its allocated MID resource, it should communicate a written formal application to the Director, Radiocommunication Bureau to request allocation of an additional MID.

Section 3

Devices using a freeform number identity

The entity responsible for assigning the two digit manufacturer IDs (X_4X_5 = 01 to 99), which are used to form the maritime freeform number identities for the devices listed in Section 2 of Annex 2, should employ the following measures to effectively manage this limited identity resource:

a) not to assign more than one ID to a manufacturer;

b) to take all possible measures to ensure that unused manufacturer IDs are returned to the responsible entity and reassigned as appropriate;

c) to provide the relevant ITU-R Working Party with regular updates, on an annual basis, concerning the use of manufacturer IDs and the remaining numbers of unused manufacturer IDs;

d) to immediately notify the Radiocommunication Bureau of any change in the assignments of manufacturer IDs for publication at the ITU MARS web page.

RECOMMENDATION ITU-R M.633-5*

Transmission characteristics of a satellite emergency position-indicating radio beacon (satellite EPIRB) operating through a satellite system in the 406.0-406.1 MHz band

(1986-1990-2000-2004-2010-2023)

Scope

This Recommendation provides transmission characteristics of a satellite emergency position-indicating radio beacon system (satellite EPIRBs) operating in the 406.0-406.1 MHz band.

Keywords

Satellite, EPIRB, beacon

Abbreviations/Glossary

SOLAS	Safety of Life at Sea
EPIRB	Emergency position-indicating radio beacon
ELT	Emergency locator transmitter
PLB	Personal locator beacon

Related ITU Recommendations, Reports

Recommendation ITU-R M.1478 – Protection criteria for Cospas-Sarsat search and rescue instruments in the band 406-406.1 MHz

Report ITU-R M.2359 – Protection of the 406-406.1 MHz band

The ITU Radiocommunication Assembly,

considering

a) that satellite EPIRBs can be used for distress alerting in the maritime, land and aeronautical environments;

b) that satellite EPIRBs with similar transmission characteristics (but other design differences) may be employed in diverse operating environments (where they may be known as EPIRBs in the maritime environment, emergency locator transmitters (ELTs) in the aviation environment, and personal locator beacons (PLBs) when designed for being carried on a person);

c) that satellite EPIRBs are one of the prime distress-alerting means in the Global Maritime Distress and Safety System (GMDSS) of the International Maritime Organization (IMO);

d) that all ships to which Chapter IV of the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended, applies, are required to carry a satellite EPIRB operating in the 406.0-406.1 MHz band;

* This Recommendation should be brought to the attention of the International Maritime Organization (IMO), the International Civil Aviation Organization (ICAO), the International Mobile Satellite Organization (IMSO) and the Cospas-Sarsat Secretariat.

e) that all aeroplanes and helicopters for which Parts I, II and III of Annex 6 of the Convention on International Civil Aviation apply, are required to carry at least one satellite EPIRB operating in the 406.0-406.1 MHz band (referred to as ELT in the ICAO documentation),

noting

a) the current and planned availability of operational Cospas-Sarsat satellites in orbit;

b) the current and projected availability of the Cospas-Sarsat ground system,

recommends

that the transmission characteristics and data formats for a satellite EPIRB operating through a satellite system in the 406.0-406.1 MHz band should be in accordance with either the Specification for Cospas-Sarsat 406 MHz Distress Beacons, as provided in Cospas-Sarsat document C/S T.001, as amended, or the Specification for Second-Generation Cospas-Sarsat 406 MHz Distress Beacons, as provided in Cospas-Sarsat document C/S T.018, as amended.

NOTE 1 – A copy of the latest version of amended documents C/S T.001 and/or C/S T.018 can be obtained free of charge from the Cospas-Sarsat Secretariat (mail@cospas-sarsat.int) or the Cospas-Sarsat website (http://www.cospas-sarsat.int).

RECOMMENDATION ITU-R S.672-4*

Satellite antenna radiation pattern for use as a design objective in the fixed-satellite service employing geostationary satellites

(1990-1992-1993-1995-1997)

The ITU Radiocommunication Assembly,

considering

a) that the use of space-station antennas with the best available radiation patterns will lead to the most efficient use of the radio-frequency spectrum and the geostationary orbit;

b) that both single feed elliptical (or circular) and multiple feed shaped beam antennas are used on operational space stations;

c) that although improvements are being made in the design of space-station antennas, further information is still required before a reference radiation pattern can be adopted for coordination purposes;

d) that the adoption of a design objective radiation pattern for space-station antennas will encourage the fabrication and use of orbit-efficient antennas;

e) that it is only necessary to specify space-station antenna radiation characteristics in directions of potential interference for coordination purposes;

f) that for wide applicability the mathematical expressions should be as simple as possible consistent with effective predictions;

g) that nevertheless, the expressions should account for the characteristics of practical antenna systems and be adaptable to emerging technologies;

h) that measurement difficulties lead to inaccuracies in the modelling of spacecraft antennas at large off-axis angles;

j) that the size constraints of launch vehicles lead to limitations in the D/λ values of spacecraft antennas, particularly at lower frequencies such as the 6/4 GHz band;

k) that space-station antenna pattern parameters such as reference point, coverage area, equivalent peak gain, that may be used to define a space-station reference antenna pattern, are found in Annex 1;

l) that two computer programs have been developed to generate coverage contours (see Annex 2),

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* Radiocommunication Study Group 4 made editorial amendments to this Recommendation in 2001 in accordance with Resolution ITU-R 44 (RA-2000).

recommends

1 that for single feed circular or elliptical beam spacecraft antennas in the fixed-satellite service (FSS), the following radiation pattern should be used as a design objective, outside the coverage area:

$$G(\psi) = G_m - 3\,(\psi/\psi_b)^{\alpha} \quad \text{dBi} \quad \text{for} \quad \psi_b \le \psi \le a\,\psi_b \tag{1}$$

$$G(\psi) = G_m + L_N + 20\log z \quad \text{dBi} \quad \text{for} \quad a\,\psi_b < \psi \le 0.5\,b\,\psi_b \tag{2a}$$

$$G(\psi) = G_m + L_N \quad \text{dBi} \quad \text{for } 0.5b\,\psi_b < \psi \le b\,\psi_b \tag{2b}$$

$$G(\psi) = X - 25\log\psi \quad \text{dBi} \quad \text{for} \quad b\,\psi_b < \psi \le Y \tag{3}$$

$$G(\psi) = L_F \quad \text{dBi} \quad \text{for} \quad Y < \psi \le 90° \tag{4a}$$

$$G(\psi) = L_B \quad \text{dBi} \quad \text{for} \quad 90° < \psi \le 180° \tag{4b}$$

where:

$$X = G_m + L_N + 25\log(b\,\psi_b) \qquad \text{and} \qquad Y = b\,\psi_b\,10^{0.04(G_m + L_N - L_F)}$$

$G(\psi)$: gain at the angle ψ from the main beam direction (dBi)

G_m: maximum gain in the main lobe (dBi)

ψ_b: one-half the 3 dB beamwidth in the plane of interest (3 dB below G_m) (degrees)

L_N: near-in-side-lobe level in dB relative to the peak gain required by the system design

L_F = 0 dBi far side-lobe level (dBi)

z: (major axis/minor axis) for the radiated beam

L_B: $15 + L_N + 0.25\,G_m + 5\log z$ dBi or 0 dBi whichever is higher.

NOTE 1 – Patterns applicable to elliptical beams require experimental verification. The values of a in Table 1 are provisional.

TABLE 1

L_N (dB)	a	b	α
–20	$2.58\sqrt{(1 - \log z)}$	6.32	2
–25	$2.58\sqrt{(1 - 0.8\log z)}$	6.32	2
–30	–	6.32	–

The numeric values of a, b, and α for $L_N = -20$ dB and –25 dB side-lobe levels are given in Table 1. The values of a and α for $L_N = -30$ dB require further study. Administrations are invited to provide data to enable the values of a and α for $L_N = -30$ dB to be determined;

2 that for multiple-feed, shaped beam, spacecraft antennas in the FSS, the radiation pattern to be used as a design objective shall be selected from the following formulae depending upon the class of antenna and the range of the scan ratio.

Definition of class of antennas

– Definition of class A antennas:

Class A antennas are those with the boresight location within the coverage area.

– Definition of class B antennas:

Class B antennas are those with the boresight location outside the coverage areas for one or more of the beams.

Definition of scan ratio

There are two definitions of the scan ratio:

The scan ratio δ in § 2.1 is defined as the angular distance between the centre of coverage (defined as the centre of the minimum area ellipse) and a point on the edge-of-coverage, divided by the beamwidth of the component beam.

Scan ratio S used in § 2.2 and 2.3 is defined as the angular distance between the antenna boresight and a point on the edge-of-coverage, divided by the beamwidth of the component beam.

In the initial determination of which *recommends* is applicable to a specific class A antenna, the δ scan ratio definition should be used;

2.1 for class A antennas with scan ratio values $\delta \leq 3.5$:

$$G_{\mathrm{dBi}}(\Delta\psi) = \begin{cases} G_{ep} + 0.256 - 13.065\left(\dfrac{\Delta\psi}{Q\,\psi_0} + 0.5\right)^2 & \text{for} \quad 0 \leq \dfrac{\Delta\psi}{\psi_0} \leq 0.8904\,Q \\ G_{ep} - 25 & \text{for} \quad 0.8904\,Q < \dfrac{\Delta\psi}{\psi_0} \leq 1.9244\,Q \\ G_{ep} - 25 + 20\log\left(\dfrac{1.9244\,Q\,\psi_0}{\Delta\psi}\right) & \text{for} \quad 1.9244\,Q < \dfrac{\Delta\psi}{\psi_0} \leq 18/\psi_0 \end{cases}$$

where:

$\Delta\psi$: angle (degrees) from the convex coverage contour to a point outside the coverage region in a direction normal to the sides of the contour

G_{ep}: equivalent peak gain (dBi)

$= G_e + 3.0$

ψ_0: the half-power beamwidth of component beams (degrees)

$= 72\,(\lambda/D)$

λ: wavelength (m)

D: physical diameter of the reflector (m)

$$Q = 10^{\left(\dfrac{0.000075\,(\delta - 1/2)^2}{[(F/D_p)^2 + 0.02)]^2}\right)}$$

δ: scan ratio as defined in § 2

F/D_p: ratio of the reflector focal length F to parent parabola diameter D_p

$D_p = 2(d + h)$

d: projected aperture diameter of the offset paraboloid

h: offset height to the edge of the reflector;

2.2 that for class A antennas with scan ratio values $S \geq 5$:

$$G_{\text{dBi}}(\Delta\psi) = \begin{cases} G_e - B\left[\left(1 + \dfrac{\Delta\psi}{\psi_b}\right)^2 - 1\right] & \text{for} \quad 0^\circ \leq \Delta\psi \leq C\,\psi_b \\ G_e - 22 & \text{for} \quad C\,\psi_b < \Delta\psi \leq (C + 4.5)\,\psi_b \\ G_e - 22 + 20\log_{10}\left[\dfrac{(C + 4.5)\,\psi_b}{\Delta\psi}\right] & \text{for} \quad (C + 4.5)\,\psi_b < \Delta\psi \leq 18^\circ \end{cases}$$

where:

$\Delta\psi$: angle (degrees) from the convex coverage contour in a direction normal to the sides of the contour

G_e: gain at the edge-of-coverage (dBi)

$B = B_0 - (S - 1.25)\,\Delta B$ for $S \geq 5$

$B_0 = 2.05 + 0.5\,(F/D - 1) + 0.0025\,D/\lambda$

$\Delta B = 1.65\,(D/\lambda)^{-0.55}$

ψ_b: beamlet radius

$= 36\,\lambda/D$

λ: wavelength (m)

D: physical diameter of the reflector (m)

$$C = \sqrt{1 + \frac{22}{B}} - 1$$

S: scan ratio as defined in § 2

F/D: ratio of focal length over the physical diameter of the antenna;

2.3 that for class B antennas, which only use scan ratio S (for $S \geq 0$):

$$G_{\text{dBi}}(\Delta\psi) = \begin{cases} G_e - B\left[\left(1 + \dfrac{\Delta\psi}{\psi_b}\right)^2 - 1\right] & \text{for} \quad 0^\circ \leq \Delta\psi \leq C\,\psi_b \\ G_e - 17 + 18.7012\log_{10}\left(\cos\left[\dfrac{\Delta\psi - C\,\psi_b}{\psi_b}\right]\right) & \text{for} \quad C\,\psi_b < \Delta\psi \leq (C+1)\,\psi_b \\ G_e - 22 & \text{for} \quad (C+1)\,\psi_b < \Delta\psi \leq (C+4.5)\,\psi_b \\ G_e - 22 + 20\log_{10}\left[\dfrac{(C+4.5)\psi_b}{\Delta\psi}\right] & \text{for} \quad (C+4.5)\,\psi_b < \Delta\psi \leq 18^\circ \end{cases}$$

where:

$\Delta\psi$: angle (degrees) from the convex coverage contour in a direction normal to the sides of the contour

G_e: gain at the edge-of-coverage (dBi)

$B = B_0 - (S - 1.25)\,\Delta B$ for $S \geq 0$

$B_0 = 2.05 + 0.5\,(F/D - 1) + 0.0025\,D/\lambda$

$\Delta B = 1.65\,(D/\lambda)^{-0.55}$

ψ_b: beamlet radius

$= 36\ \lambda/D$

λ: wavelength (m)

D: physical diameter of the reflector (m)

$$C = \sqrt{1 + \frac{17}{B}} - 1$$

S: scan ratio as defined in § 2

F/D: ratio of focal length over the physical diameter of the antenna;

2.4 that for class A antennas with scan ratio values $\delta > 3.5$ and $S < 5$, the design objective is still under study. In particular, studies are required on the extension of the equations given in § 2.1 and 2.2 into this region. One possible method of extending the design objective into this region is described in Annex 1. For the definition of scan ratios δ and S and their application, see § 2;

2.5 that the following Notes shall be considered part of § 2.1 and 2.2:

NOTE 1 – The coverage area shall be defined as the contour constructed from the polygon points surrounding the service area, using the method given in Annex 2.

NOTE 2 – For the cuts, where the –3 dB gain contour is outside of the constructed coverage contour, the design objective pattern should originate from the –3 dB contour.

NOTE 3 – This Recommendation should be applied only in the direction of an interference sensitive system. That is, it need not be applied in directions where the potential for interference to other networks does not exist (e.g. off the edge of the Earth, unpopulated ocean regions). 10% of the cuts may exceed the design objective pattern.

NOTE 4 – This Recommendation does not apply to dual frequency band antennas. Antennas using the reflector induced phase error for beam broadening belong to this category and require further study.

ANNEX 1

Satellite antenna patterns in the fixed-satellite service

1 Satellite antenna reference radiation patterns

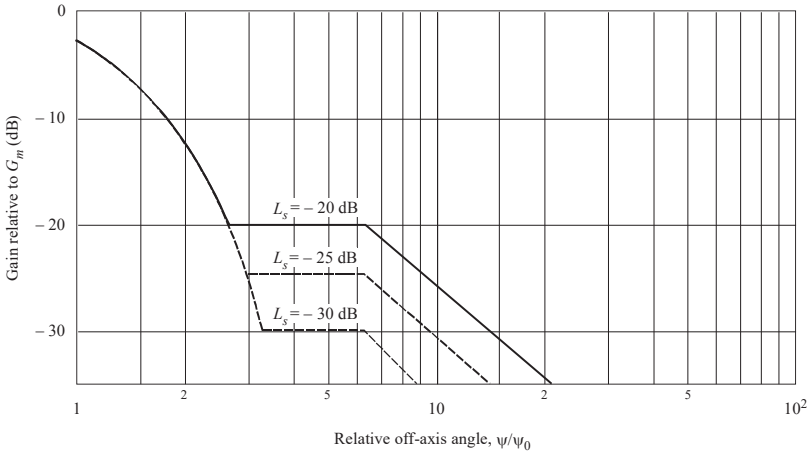
1.1 Single feed circular beams

The radiation pattern of the satellite antenna is important in the region of the main lobe as well as the farther side lobes. Thus, the possible patterns commencing at the –3 dB contour of the main lobe are divided into four regions. These are illustrated in Fig. 1.

Difficulties arise, however, in attempting to apply the postulated pattern to a non-circular beam. Administrations are therefore requested to submit measured radiation patterns for antennas with other than simple circular beams.

FIGURE 1

Radiation pattern envelope functions



$G(\psi) = G_m - 3\,(\psi/\psi_0)^2$	dBi	for	$\psi_0 \le \psi \le a\,\psi_0$	(I)
$G(\psi) = G_m + L_s$	dBi	for	$a\,\psi_0 < \psi \le b\,\psi_0$	(II)
$G(\psi) = G_m + L_s + 20 - 25 \log (\psi/\psi_0)$	dBi	for	$b\,\psi_0 < \psi \le \psi_1$	(III)
$G(\psi) = 0$	dBi	for	$\psi_1 < \psi$	(IV)

where:

$G(\psi)$: gain at the angle (ψ) from the axis (dBi)

G_m: maximum gain in the main lobe (dBi)

ψ_0: one-half the 3 dB beamwidth in the plane of interest (3 dB below G_m) (degrees)

ψ_1: value of (ψ) when $G(\psi)$ in equation (III) is equal to 0 dBi

L_s: the required near-in-side-lobe level (dB) relative to peak gain

a, b: the numeric values are given below:

L_s	a	b
– 20	2.58	6.32
– 25	2.88	6.32
– 30	3.16	6.32

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1.2 Single feed elliptical beams

The functions in Fig. 1 define a maximum envelope for the first side lobes at a level of –20 dB relative to peak gain and this pattern applies to antennas of fairly simple designs. However, in the interest of a better utilization of the orbit capacity, it may be desirable to reduce this level to –30 dB and to use antennas of more sophisticated design. The pattern adopted by the World Administrative Radio Conference for the Planning of the Broadcasting-Satellite Service, Geneva, 1977 (WARC BS-77) for broadcasting satellite antennas meets this requirement and is now being achieved and

should therefore apply in that case. Additional studies may be desirable to ascertain the feasibility of achieving these reduced side-lobe levels in common practice, particularly with respect to the 6/4 GHz bands.

1.3 Multiple feed shaped beams

A similar pattern applicable to shaped beams must be based on analysis of several shaped beams and also on theoretical considerations. Additional parameters must be specified, such as the diameter of the elemental beamlet and the level of the first side lobe. In addition the cross-section and means of measuring angles form part of the pattern definition.

The important consideration in producing such a reference is the discrimination to be achieved from the edge of coverage of all types of antenna, including the most complex shaped beam antenna, as a function of angular separation of the coverage areas as seen from the orbit. The radiation pattern of a shaped beam antenna is unique and it is mainly determined by the following operational and technical factors:

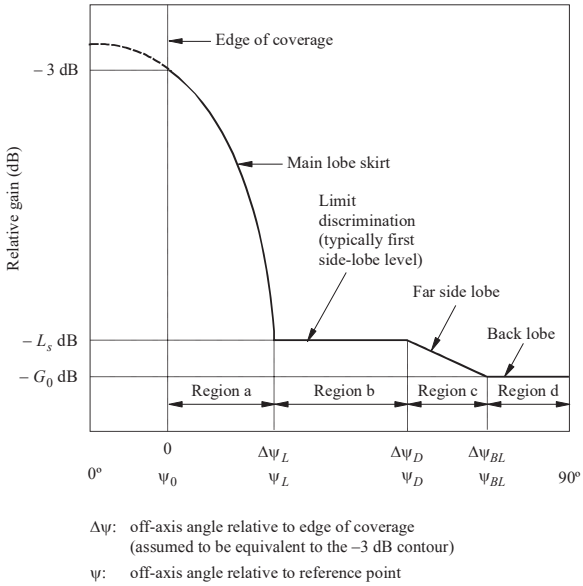
– shape of the coverage area;
– satellite longitude;
– maximum antenna aperture;
– feed design and illumination taper;
– normalized reflector aperture diameter (D/λ);
– focal length to aperture diameter ratio (F/D);
– number of frequency re-use and independent beam ports;
– number of feed elements utilized;
– bandwidths;
– polarization orthogonality requirements;
– total angular coverage region provided;
– stability of feed element phase and amplitude excitations;
– reconfigurability requirements;
– number of orbital positions from which beam coverages must be provided;
– reflector surface tolerances achieved;
– beam pointing (i.e. derived from satellite or independent beam positioning via earth-based tracking beacons);
– component beam degradations due to scan aberrations that are related to the specific reflector or antenna configuration (i.e. single reflector, dual reflector, shaped reflector systems without a focal axis, direct radiating array, etc.).

In view of this, there may be some difficulties in developing a single reference radiation pattern for shaped beam antennas.

The reference pattern of Fig. 1 is unsatisfactory for shaped beam antennas, since a key parameter to the reference pattern is ψ_0, the –3 dB half-beamwidth, whereas the beam centre of a shaped beam is ill-defined and largely irrelevant to the out-of-beam response. A simple reference pattern consisting of four segments, as illustrated in Fig. 2 might be more satisfactory for the basis of a reference pattern. The slope of the skirt of this pattern would be a function of the angular distance outside the average contour.

FIGURE 2

Possible form of reference radiation pattern



The particular direction in which to measure this angular distance is also a parameter which needs definition. One method is to measure this angle orthogonally from the constant gain contour which corresponds most closely to the coverage area. Difficulties arise with this method where portions of the gain contours are concave such as occurs with crescent-shaped patterns. For this type of pattern, the orthogonal direction away from a contour could intersect the coverage area again. From an antenna design standpoint, the difficulty in achieving good discrimination in the concave portion of a pattern increases with the degree of concavity. An alternative method which could circumvent these problems is to circumscribe the coverage area by a contour which has no concavity and then measure the angles orthogonally from this contour; this contour being considered as edge of coverage. Other methods of defining the direction of measurement are possible, e.g. the centre of a circumscribing ellipse could be used as a reference point (see § 2.1 and 2.2), but an unambiguous definition is needed for any reference pattern.

Once the direction is defined, the radiation pattern can be separated into four regions of interest:

Region a: Main lobe skirt (edge of coverage to angle of limit discrimination)

This region is assumed to cover what is considered to be adjacent coverage regions. The required isolation between satellite networks would be obtained from a combination of satellite antenna discrimination and orbital separation.

A simple function which could be applied to this region could be in a form similar to that given in equation (I) of Fig. 1.

Region b: Non-adjacent coverage region

This region begins where the radiation pattern yields sufficient discrimination to allow nearly co-located satellites to serve non-adjacent areas ($\Delta\psi_L$ in Fig. 2). The limit discrimination (L_s) may be between –20 and –30 dB.

Region c: Far side-lobe region

Region d: Back-lobe region

Each of these regions covers the higher order side lobes and is applicable to very widely spaced service areas and, in those frequency bands used bidirectionally, to parts of the orbit. In the latter case, care must be exercised when considering very large off-axis angles since unpredictable reflections from the spacecraft bus and spill-over from the main reflector might have significant effect. A minimum gain envelope of 0 dBi is suggested pending more information (Region d in Fig. 2).

2 Shaped beam radiation pattern models

For shaped beam modelling purposes, prior to the actual design of an antenna, a simplified reference pattern might be used. Two models which can generate such patterns and their associated parameters are presented below. Both models are suitable for computer-aided interference studies and, in conjunction with satellite centred maps, for manual application. The models form the basis of a recommended pattern or patterns. However, it would be advisable to only apply the resultant pattern "profiles" in the direction of an interference sensitive system. That is, they should not be applied in directions where the potential for interference to other networks does not exist (i.e. off the edge of the Earth, unpopulated ocean regions, etc.).

2.1 Representation of coverage area

Various methods have been proposed in the past for the service area representation of FSS antennas. In one method, the angular distance outside the coverage area is measured in a direction normal to the service area geography (constant gain contour) as seen from the satellite. In practice, the gain contour is designed to fit the service area as closely as possible and therefore the difference between using the service area and the constant gain contour is expected to be very small. However, difficulties will arise with this method in certain cases where portions of gain contours are concave such as with crescent shaped patterns. For such patterns, the orthogonal direction away from the contour could intersect the coverage area again thereby causing ambiguity (see Fig. 3a)). Another difficulty with this representation is that for a given location outside the coverage area, there could be more than one point on the service area at which the line joining the observation location to the point on the service area is normal to the service area contour at that point (see Fig. 3a)).

However, a method has been developed which circumvents the difficulties cited above using angular measurements normal to the coverage area and patterns containing concavities. This method involves a number of graphical constructions and is described in a set of step-by-step procedures in Annex 2.

In addition, these step-by-step procedures can be simplified by use of a convex-only coverage contour. To produce a convex-only coverage contour, the same procedure as described in Annex 2 is undertaken, except that only convex corners, i.e. those in which the circle lies inside the coverage contour are considered. The resultant coverage contour is illustrated in Fig. 3b).

Another way of representing the shaped beam patterns is by circumscribing the actual coverage area by a minimum area ellipse. The angular distance is measured from the edge of the ellipse in a direction normal to the periphery of the ellipse. This has the advantage that it is relatively easy to write highly efficient computer programs to define such an angular measurement procedure. However, this representation tends to considerably overestimate the area defined by the actual service area.

Another method is a hybrid approach which gives an unambiguous definition for representing the shaped beam coverage area. In this method a minimum area ellipse circumscribing the geographic coverage is used to define the centre of coverage area. The centre of coverage area does not necessarily represent the beam centre and is used only to define the axis of pattern cuts. Once the centre of coverage area is defined, the minimum area ellipse has no further significance.

A convex polygon is then used to define the coverage area boundary. The number of sides forming the polygon are determined based on the criteria that it should circumscribe the coverage area as closely as possible and should be of convex shape. A typical example is shown in Fig. 3c) for the service area representation. The angular directions are radial from the centre of the coverage area.

For an observation location outside the coverage area, the direction of applying the template and the angular distances are unambiguously defined with reference to the centre of coverage area. However, this method tends to underestimate the angular spacing between the gain contours outside the coverage area when the angle of the radial with respect to the coverage contour significantly departs from normal.

In summary, it would appear that the most acceptable method, both in accuracy and ease of construction, is the use of the convex-only coverage contour with the angular distances measured along directions normal to the sides of the contour, as shown in Fig. 3b).

2.2 Equivalent peak gain

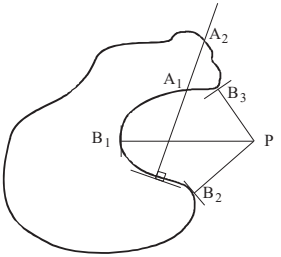
In situations where it is not necessary to tailor the beam to compensate for the variation in propagation conditions across the service area, the minimum coverage area gain achieved at the coverage area contour is considered to be 3 dB less than the equivalent peak gain (G_{ep}). In practice the actual peak gain may be higher or lower than the equivalent peak gain and may not necessarily occur on-axis.

In some situations there could be a large variation of propagation conditions over the service area or service requirements may warrant special beam tailoring within the service area. In these cases the minimum required relative gain (relative to the average gain on the coverage area contour) at each polygon vertex is computed and linear interpolation based on the azimuth from the beam axis may then be used to determine the relative gain at intermediate azimuths. Under this scenario the gain at the coverage area contour is direction dependent.

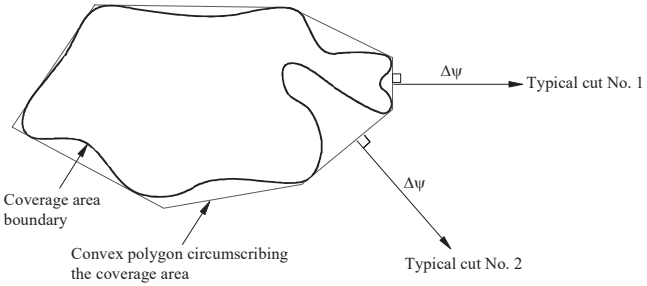
Note that for a shaped beam, the gain variation within the coverage area is not related to the roll-off of gain beyond the edge of coverage. The antenna performance within the coverage area, including the gain, is not related to the interference introduced into adjacent systems. The gain variation within the coverage area, therefore, need not be characterized in shaped beam reference patterns.

FIGURE 3

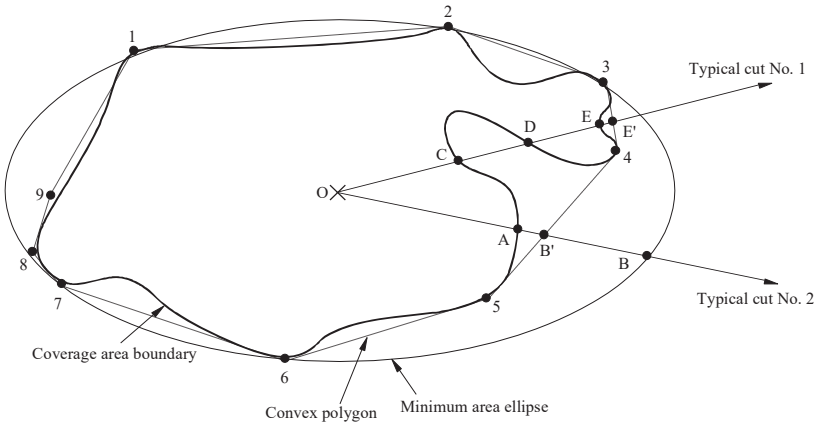
Different representation of coverage area



a)



b) Measurement of the angle, Δψ, from the (convex) coverage contour



c)

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2.3 Elemental beamlet size

The side-lobe levels are determined by the aperture illumination function. Considering an illumination function of the form:

$$f(x) = \cos^N \left(\frac{\pi}{2} \cdot x \right) \qquad |x| \leq 1 \tag{5}$$

which is zero at the aperture edge for $N > 0$. The elemental beamlet radius, as a function of the side-lobe level (dB) and the D/λ ratio, is, over the range of interest, approximately given by:

$$\psi_b = (16.56 - 0.775\, L_s)\, \lambda/D \qquad \text{degrees} \tag{6}$$

where L_s is the relative level of the first side lobe (dB).

This expression illustrates the trade-off between antenna diameter, side-lobe level and steepness of the main lobe skirt regions. It is derived by curve fitting the results obtained from calculations for different side-lobe levels. This relationship has been used as a starting point in the models described below.

2.4 Development of co-polar pattern models

Generalized co-polar patterns for future shaped beam antennas based on measurements on several operational shaped beam antennas (Brazilsat, Anik-C, Anik-E, TDRSS, Intelsat-V, G-Star, Intelsat-VI, Intelsat-VII, Cobra) and on theoretical considerations are given in this section.

Previous modelling did not appear to quantify the beam broadening effects. The following models include two separate approaches which deal with these effects, which are essential to predicting shaped beam antenna performance accurately.

2.4.1 First model

The shaped beam pattern given in this section is in terms of the primary as well as the secondary parameters. The primary parameters are the beamlet size, coverage area width in the direction of interest and the peak side-lobe level. Secondary parameters are the blockage parameter, surface deviation and the number of beamwidths scanned. The effect of secondary parameters on the antenna radiation is to broaden the main beam and increase the side-lobe level. Although the dominant parameter in the beam broadening is the number of beamwidths scanned, the effects of the other two parameters are given here for completeness. However, the effect of blockage on side-lobe level should not be overlooked. Though it is true that, due to practical limitations, even for a satellite antenna design which calls for maintaining the blockage free criteria, there is normally a small amount of edge blockage. In particular, edge blockage is quite likely to occur for linear dual-polarization antennas employing a common aperture as is the case of dual gridded reflectors used for Anik-E, G-Star, Anik-C, Brazilsat, etc. This is because of the required separation between the foci of the two overlapped reflectors for the isolation requirements and for the volume needed for accommodating two sets of horns.

In the far side-lobe regions there is very little measured information available on which to base a model. Reflections from the spacecraft structure, feed array spill-over, and direct radiation from the feed cluster can introduce uncertainties at large off-axis angles and may invalidate theoretical

projections. Measurement in this region is also extremely difficult and therefore further study is required to gain confidence in the model in this region. In the interim, a minimum gain plateau of 0 dBi is suggested.

It should be noted that the suggested pattern is only intended to apply in directions where side-lobe levels are of concern. In uncritical directions, e.g. towards ocean regions or beyond the limb of the Earth or in any direction in which interference is not of concern, this pattern need not be a representative model.

General co-polar Model 1

The following three-segment model representing the envelope of a satellite shaped beam antenna radiation pattern outside of the coverage area, is proposed:

Main lobe skirt region:

$$G_{\mathrm{dBi}}(\Delta\psi) = G_{ep} + U - 4V\left(\frac{\Delta\psi}{Q\,\psi_0} + 0.5\right)^2 \qquad \text{for} \qquad 0 \le \Delta\psi \le W \cdot Q \cdot \psi_0$$

Near-in side-lobe region:

$$G_{\mathrm{dBi}}(\Delta\psi) = G_{ep} + SL \qquad \text{for} \quad W \cdot Q \cdot \psi_0 \le \Delta\psi \le Z \cdot Q \cdot \psi_0$$

Far side-lobe region:

$$G_{\mathrm{dBi}}(\Delta\psi) = G_{ep} + SL + 20\log(Z \cdot Q \cdot \psi_0 / \Delta\psi) \qquad \text{for} \qquad Z \le \Delta\psi \le 18$$

where:

$\Delta\psi$: angle from the edge of coverage (degrees)

$G_{\mathrm{dBi}}(\Delta\psi)$: gain at $\Delta\psi$ (dBi)

G_{ep}: equivalent peak gain

$G_{ep} = G_e + 3.0$ (dBi)

ψ_0: half-power diameter of the beamlet (degrees)

$\psi_0 \approx (33.12 - 1.55\,SL)\,\lambda/D$

λ: wavelength (m)

D: diameter of the reflector (m)

SL: side-lobe level relative to the peak (dB)

$U = 10\log A$, $V = 4.3429\,B$ are the main beam parameters

$B = \left[\ln(0.5/10^{0.1SL})\right] / \left[[(16.30 - 3.345\,SL) / (16.56 - 0.775\,SL)]^2 - 1\right]$

$A = 0.5\exp(B)$

$W = (-0.26 - 2.57\,SL) / (33.12 - 1.55\,SL)$

$Z = (77.18 - 2.445\,SL) / (33.12 - 1.55\,SL)$

Q: beam broadening factor due to the secondary effects:

$$Q = \exp\left[(8\pi^2(\varepsilon/\lambda)^2\right] \cdot [\eta_i(\Delta)]^{-0.5} \cdot 10^{\left(\frac{0.000075(\delta - 1/2)^2}{[(F/D_p)^2 + 0.02]^2}\right)} \qquad (7)$$

The variables in equation (7) are defined as:

ε: r.m.s. surface error

Δ: blockage parameter (square root of the ratio between the area blocked and the aperture area)

δ: number of beamwidths scanned away from the axial direction

$= \theta_0 / \psi_0$

θ_0: angular separation between the centre of coverage, defined as the centre of the minimum area ellipse, to the edge of the coverage area

$$\eta_i(\Delta) = 1 - \Delta^2 \qquad \text{for central blockage}$$

$$= [1 - [1 - A(1 - \Delta)^2]\,\Delta^2]^2 \qquad \text{for edge blockage} \qquad (8)$$

A in equation (8) is the pedestal height in the primary illumination function $(1 - Ar^2)$ on the reflector and r is the normalized distance from the centre in the aperture plane of the reflector ($r = 1$ at the edge). F/D_p in equation (7) is the ratio of the focal length to the parent parabola diameter. For a practical satellite antenna design this ratio varies between 0.35 and 0.45.

The far-out side-lobe gain depends on the feed-array spillover, reflection and diffraction effects from the spacecraft structure. These effects depend on individual designs and are therefore difficult to generalize.

As given in equation (7), the beam broadening factor Q depends on the r.m.s. surface error ε, the blockage parameter Δ, number of beams scanned δ, and F/D_p ratio. In practice, however, the effect of ε and Δ on beam broadening is normally small and can be neglected. Thus, equation (7) can be simplified to:

$$Q = 10^{\left(\frac{0.000075\,(\delta - 1/2)^2}{[(F/D_p)^2 + 0.02]^2}\right)} \qquad (9)$$

where:

$D_p = 2(d + h)$

d: projected aperture diameter of the offset paraboloid

h: offset height to the edge of the reflector.

Equation (9) clearly demonstrates the dependence of beam broadening on number of beams scanned and the satellite antenna F/D_p ratio. This expression is valid for δ as high as nine beamwidths, which is more than sufficient for global coverage even at 14/11 GHz band; for service areas as large as Canada, United States or China the value of δ is generally one to two beams at 6/4 GHz band and about four beams at 14/11 GHz band, in the application of this model. Thus, for most of the systems the value of Q is normally less than 1.1. That is, the beam broadening effect is generally about 10% of the width of the elemental beamlet of the shaped-beam antenna.

Neglecting the main beam broadening due to blockage and reflector surface error, and assuming a worst-case value of 0.35 for F/D_p ratio of the reflector, the beam broadening factor Q can be simplified as:

$$Q = 10^{0.0037\,(\delta - 1/2)^2}$$

In the 6/4 GHz band, a –25 dB side-lobe level can be achieved with little difficulty using a multi-horn solid reflector antenna of about 2 m in diameter, consistent with a PAM-D type launch. To achieve 30 dB discrimination, a larger antenna diameter could be required if a sizeable angular

range is to be protected or controlled. In the 14/11 GHz fixed-satellite bands, 30 dB discrimination can generally be achieved with the 2 m antenna and the use of a more elaborate feed design.

The above equations for the reference pattern are dependent upon the scan angle of the component beam at the edge of coverage in the direction of each individual cut for which the pattern is to be applied. For a reference pattern to be used as a design objective, a simple pattern with minimum parametric dependence is desirable. Hence, a value or values of Q which cover typically satellite coverages should be selected and incorporated in the above equations.

A steeper main beam fall-off rate can be achieved for a typical domestic satellite service area as compared to very large regional coverage areas; and conversely a reference pattern satisfying a regional coverage will be too relaxed for domestic satellite coverages.

Therefore it is proposed to simplify Model 1 into the following two cases for the FSS antennas. For these cases a –25 dB side-lobe plateau level is assumed.

a) Small coverage regions ($\delta < 3.5$)

Most of the domestic satellite coverage areas fall under this category. The beam broadening factor Q is taken as 1.10 to represent reference patterns of modest scan degradations for small coverage regions as:

$$G_{\mathrm{dBi}}(\Delta\psi) = \begin{cases} G_{ep} + 0.256 - \dfrac{10.797}{\psi_0^2}(\Delta\psi + 0.55\,\psi_0)^2 & \text{for} \quad 0 \le \Delta\psi \le 0.9794\,\psi_0 \\ G_{ep} - 25 & \text{for} \quad 0.9794\,\psi_0 < \Delta\psi \le 2.1168\,\psi_0 \\ G_{ep} - 25 + 20\log(2.1168\,\psi_0/\Delta\psi) & \text{for} \quad 2.1168\,\psi_0 < \Delta\psi \le 18 \end{cases}$$

b) Wide coverage regions ($\delta > 3.5$)

Examples for wide coverage regions are the hemi-beam and global coverages of INTELSAT and INMARSAT. In order to represent the pattern degradation due to large scan, a value of 1.3 is taken for the Q factor. The reference patterns applicable to these coverages ($\delta > 3.5$) are defined as:

$$G_{\mathrm{dBi}}(\Delta\psi) = \begin{cases} G_{ep} + 0.256 - \dfrac{7.73}{\psi_0^2}(\Delta\psi + 0.65\,\psi_0)^2 & \text{for} \quad 0 \le \Delta\psi \le 1.1575\,\psi_0 \\ G_{ep} - 25 & \text{for} \quad 1.1575\,\psi_0 < \Delta\psi \le 2.5017\,\psi_0 \\ G_{ep} - 25 + 20\log(2.5017\,\psi_0/\Delta\psi) & \text{for} \quad 2.5017\,\psi_0 < \Delta\psi \le 18 \end{cases}$$

2.4.2 Second model

There will be many difficulties in providing a relatively simple pattern that could be applied to a range of different satellite antennas without prejudice to any particular design or system. With this thought the template presented here by Model 2 does not intend to describe a single unique envelope, but a general shape. The template may be considered not only for a single antenna application, but as an overall representation of a family of templates describing antennas suitable for many different applications.

In the development of the model, an attempt has been made to take full account of the beam broadening that results from component beams scanned away from boresight of a shaped-beam antenna. A careful attempt has been made to encompass the effects of interference and mutual

coupling between adjacent beamlets surrounding the component beamlet under consideration. To avoid complexity in the formulation, two additional adjacent beamlets along the direction of scan of the component beamlets have been considered. The variation in beam broadening with F/D ratio has also been taken into account, the results have been tested over the range $0.70 \leq F/D \leq 1.3$ and modelled for an average scan plane between the elevation plane and azimuth plane. If the modelling had been done for the azimuth plane only, sharper characteristics than predicted might be expected. Other assumptions made in the model are as follows:

– the boundary of the component beams corresponding to the individual array elements has been assumed to correspond to the ideal –3 dB contour of the shaped coverage beam;

– the component beamlet radius, ψ_b, is given by equation (6) and corresponds to an aperture edge taper of –4 dB;

– the value of B which controls the main beam region, is directly modelled as a function of the scan angle of the component beam, the antenna diameter D and the F/D ratio of the antenna reflector.

The value of F/D used in this model is the ratio of focal length to the physical diameter of the reflector. The model is valid for reflector diameters up to 120 λ, beam scanning of up to 13 beam widths and has shown good correlation to some 34 pattern cuts taken from four different antennas.

Recognizing that at some future date it may be desirable to impose a tighter control on antenna performance, this model provides two simple improvement factors, K_1 and K_2, to modify the overall pattern generated at present.

General co-polar Model 2

The equations to the various regions and the corresponding off-axis gain values are described below. Those gain values are measured normal to the coverage area at each point and this technique is allied to the definition of coverage area described in Annex 2.

At present, the values of K_1 and K_2 should be taken as unity, $K_1 = K_2 = 1$.

The equations used in this model are normalized to a first side lobe (L_s) of –20 dB. Ultimately, the particular value of the first side-lobe level chosen for the given application would be substituted.

a) The main lobe skirt region: ($0° \leq \Delta\psi < C\psi_b$)

In this region the gain function is given by:

$$G(\Delta\psi) = G_e - K_1 B \left[\left(1 + \frac{\Delta\psi}{\psi_b} \right)^2 - 1 \right] \quad \text{dBi} \qquad (10)$$

where:

$G(\Delta\psi)$: reference pattern gain (dBi)

G_e: gain at the edge of coverage (dBi)

$\Delta\psi$: angle (degrees) from the (convex) coverage contour in a direction normal to the sides of the contour

$\psi_b = 32\,\lambda/D$ is the beamlet radius (degrees) (corresponding to $L_s = -20$ dB in equation (6))

$B = B_0 - (S - 1.25)\,\Delta B$ for $S \geq 1.25$ and

$$B = B_0 \qquad \text{for } S < 1.25$$

$$B_0 = 2.05 + 0.5\,(F/D - 1) + 0.0025\,D/\lambda$$

$$\Delta B = 1.65\,(D/\lambda)^{-0.55}.$$

Equations for both the elevation and azimuth planes are given here in order to maintain generality.

azimuth plane: $B_0 = 2.15 + T$

elevation plane: $B_0 = 1.95 + T$

where $T = 0.5\,(F/D - 1) + 0.0025\,D/\lambda$

azimuth plane: $\Delta B = 1.3\,(D/\lambda)^{-0.55}$

elevation plane: $\Delta B = 2.0\,(D/\lambda)^{-0.55}$

D: physical antenna diameter (m)

λ: wavelength (m)

S: angular displacement A between the antenna boresight and the point of the edge-of-coverage, in half-power beamwidths of the component beam, as shown in Fig. 4, i.e. $S_1 = A_1 / 2\psi_b$ and $S_2 = A_2 / 2\psi_b$

$$C = \sqrt{1 + \frac{(20\,K_2 - 3)}{K_1\,B}} - 1$$

and corresponds to the limit where $G(\Delta\psi)$ corresponds to a $-20\,K_2$ (dB) level with respect to equivalent peak gain G_{ep}, i.e. $G(\Delta\psi) = G_e + 3 - 20\,K_2$.

b) Near side-lobe region: $C\,\psi_b \le \Delta\psi < (C + 0.5)\,\psi_b$

This region has been kept deliberately very narrow for the following reasons. High first lobes of the order of –20 dB occur only in some planes and are followed by monotonically decreasing side lobes. In regions where beam broadening occurs, the first side lobe merges with the main lobe which has already been modelled by B for the beam skirt. Hence it is necessary to keep this region very narrow in order not to over-estimate the level of radiation. (For class B antennas this region has been slightly broadened and the gain function modified.) The gain function in this region is constant and is given by:

$$G\,(\Delta\psi) = G_e + 3 - 20\,K_2 \tag{11}$$

c) Intermediate side-lobe region: $(C + 0.5)\,\psi_b \le \Delta\psi < (C + 4.5)\,\psi_b$

This region is characterized by monotonically decreasing side lobes. Typically, the envelope decreases by about 10 dB over a width of 4 ψ_b. Hence this region is given by:

$$G\,(\Delta\psi) = G_e + 3 - 20\,K_2 + 2.5\left[(C + 0.5) - \frac{\Delta\psi}{\psi_b}\right] \qquad \text{dBi} \tag{12}$$

The above expression decreases from $G_e + 3 - 20\,K_2$ at $(C + 0.5)\,\psi_b$ to $G_e + 3 - 10 - 20\,K_2$ at $(C + 4.5)\,\psi_b$.

d) Wide-angle side-lobe region: $(C + 4.5)\,\psi_b \le \Delta\psi < (C + 4.5)\,\psi_b\,D$,

where $D = 10^{[(G_e - 27)/20]}$

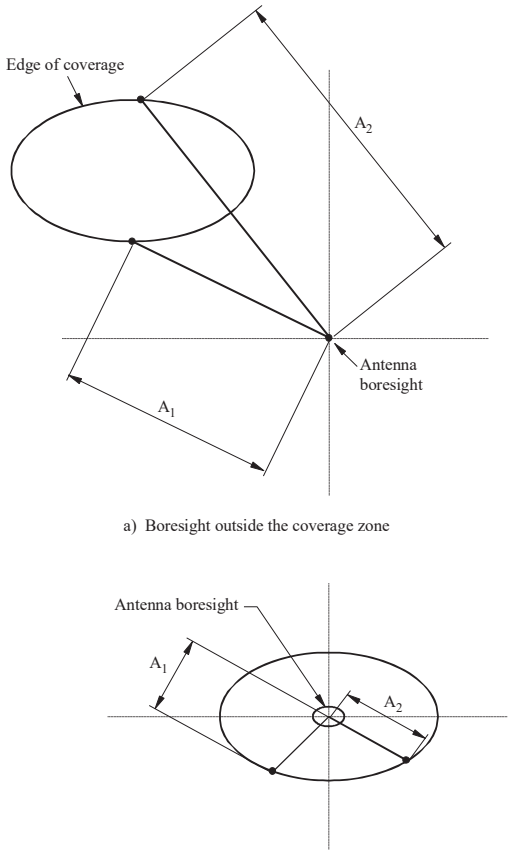
This corresponds to the region which is dominated by the edge diffraction from the reflector and it decreases by about 6 dB per octave. This region is then described by:

$$G(\Delta\psi) = G_e + 3 - 10 - 20\,K_2 + 20 \log \left[\frac{(C + 4.5)\,\psi_b}{\Delta\psi} \right] \quad \text{dBi} \qquad (13)$$

In this region $G(\Delta\psi)$ decreases from $G_e + 3 - 10 - 20\,K_2$ at $(C + 4.5)\,\psi_b$ to $G_e + 3 - 16 - 20\,K_2$ at $2\,(C + 4.5)\,\psi_b$. The upper limit corresponds to where $G(\Delta\psi) = 3$ dBi.

FIGURE 4

A schematic of a coverage zone



A_1, A_2: angular deviation (degrees) of the two points on the edge of coverage from the antenna boresight

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e) **Far-out side-lobe region:** $(C + 4.5)\ \psi_b\ D \leq \Delta\psi \leq 90$,

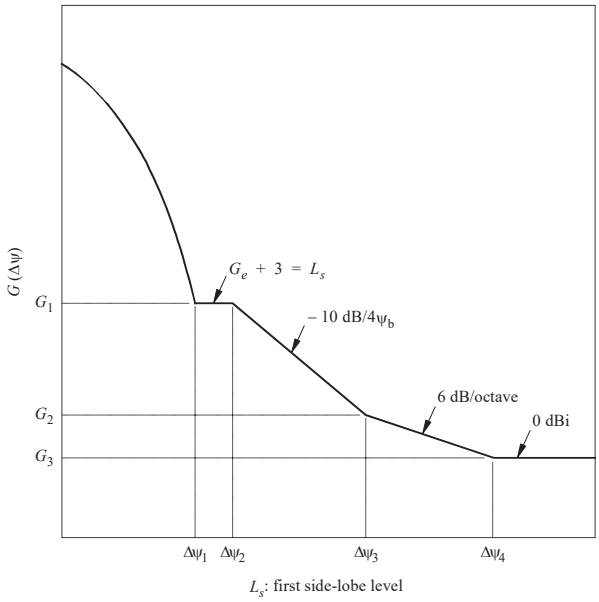
where $D = 10^{[(G_e - 27)/20]}$

$$G(\Delta\psi) = 3 \quad \text{dBi} \tag{14}$$

These regions are depicted in Fig. 5.

FIGURE 5

Different regions in the proposed model 2



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The model can also be extended to the case of simple circular beams, elliptical beams and to shaped-reflector antennas. These cases are covered by adjustment to the value of B in the above general model:

– for simple circular and elliptical beams B is modified to a value, $B = 3.25$

– for shaped-reflectors the following parameters are modified to:

$$B = \begin{cases} 1.3 & \text{for} \quad 0.5 \leq S \leq 0.75 \\ 1.56 - 0.34\,S & \text{for} \quad 0.75 < S \leq 2.75 \\ 0.62 & \text{for} \quad S > 2.75 \end{cases}$$

where:

S: (angular displacement from the centre of coverage) / $2\psi_b$

$\psi_b = 40\ \lambda/D$

$K_2 = 1.25$

It should be noted that the values proposed for shaped-reflector antennas correspond to available information on simple antenna configurations. This new technology is rapidly developing and therefore these values should be considered tentative. Furthermore, additional study may be needed to verify the achievable side-lobe plateau levels.

Use of improvement factors K_1 and K_2

The improvement factors K_1 and K_2 are not intended to express any physical process in the model, but are simple constants to make adjustments to the overall shape of the antenna pattern without changing its substance.

Increasing the value of K_1 from its present value of 1, will lead to an increase in the sharpness of the main beam roll-off.

Parameter K_2 can be used to adjust the levels of the side-lobe plateau region by increasing K_2 from its value of unity.

2.5 Shaped beam pattern roll-off characteristics

The main beam roll-off characteristics of shaped beam antennas depend primarily on the antenna size. The angular distance $\Delta\psi_L$ from the edge of coverage area to the point where the gain has decreased by 22 dB (relative to edge gain) is a useful parameter for orbit planning purposes: it is related to the antenna size as:

$$\Delta\psi_L = C\,(\lambda/D)$$

For central beams with little or no shaping, the value of C is 64 for –25 dB peak side-lobe level. However, for scanned beams C is typically in the range 64 to 80 depending on the extent of main beam broadening.

2.6 Reference pattern for intermediate scan ratios

recommends 2.1 and 2.2 have two reference patterns for the satellite antennas in the FSS, one for small coverage areas with scan ratios less than 3.5 and the other for wide coverage areas with scan ratios greater than 5.0. However, the radiation patterns for intermediate scan ratios ($3.5 < \delta < 5.0$) of satellite antennas have not been defined.

In order to fully utilize the Recommendation the radiation pattern for antennas with intermediate scan ratios between 3.5 and 5.0 should be defined. One approach would be to redefine either of the two models to cover the other region. However, as an interim solution it is proposed to connect the two models with a reference pattern defined by parameters similar to those used in *recommends* 2.1 and 2.2.

Based on this approach a new reference pattern, which is applicable only to Class A antennas, has been developed which satisfies the existing patterns for the small coverage and the wide coverage areas at $\delta = 3.5$ and $\delta = 5.0$ respectively. It is defined as a function of the beam-broadening factor Q_i

which is the ratio of upper limits of the main beam fall-off regions of the shaped beam ($\delta > 1/2$) and the pencil beam ($\delta = 1/2$). For intermediate scan ratios in the range $3.5 < \delta < 5.0$, the value of Q_i is interpolated as:

$$Q_i = Q + \left(\frac{C}{1.7808} - Q\right)\left(\frac{\delta - 3.5}{1.5}\right)$$

where:

$$Q = 10^{\left(\frac{0.000075\,(\delta - 1/2)^2}{[(F/D_p)^2 + 0.02]^2}\right)}$$

$$C = \sqrt{1 + \frac{22}{B}} - 1$$

$$B = 2.05 + 0.5\,(F/D - 1) + 0.0025\,D/\lambda - (\delta - 1.25)\,1.65\,(D/\lambda)^{-0.55}$$

The reference pattern for intermediate scan ratios ($3.5 < \delta < 5.0$) is defined as:

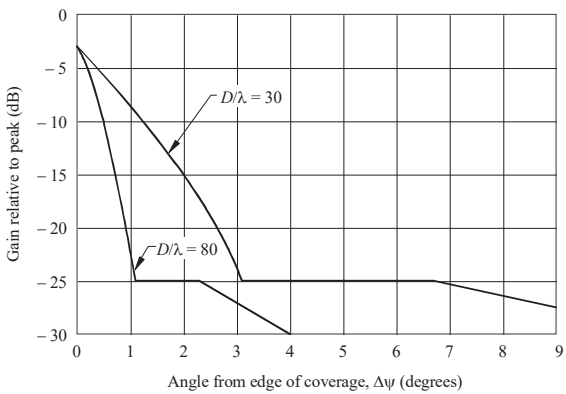
$$G_{\text{dBi}}\,(\Delta\psi) = \begin{cases} G_{ep} + 0.256 - 13.065\left(\dfrac{\Delta\psi}{Q_i\,\psi_0} + 0.5\right)^2 & \text{for} \quad 0 \le \dfrac{\Delta\psi}{\psi_0} \le 0.8904\,Q_i \\ G_{ep} - 25 & \text{for} \quad 0.8904\,Q_i < \dfrac{\Delta\psi}{\psi_0} \le 1.9244\,Q_i \\ G_{ep} - 25 + 20\log\left(\dfrac{1.9244\,Q_i}{\Delta\psi}\right) & \text{for} \quad 1.9244\,Q_i < \dfrac{\Delta\psi}{\psi_0} \le \dfrac{18}{\psi_0} \end{cases}$$

The variables in the above equations have been defined in *recommends* 2.1 and 2.2.

Figure 6 shows an example of the new reference pattern for $\delta = 4.25$ and for two different values of D/λ.

FIGURE 6

Proposed reference patterns for intermediate scan ratios ($3.5 < \delta < 5.0$)



D/λ : parameter of the curves
$\delta = 1.25$
$F/D = 1$, $F/D_p = 0.35$

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Further study is needed to validate this model for the intermediate scan ratio region.

ANNEX 2

1 Defining coverage area contours and gain contours about the coverage area

1.1 Defining coverage area contours

A coverage area can be defined by a series of geographic points as seen from the satellite. The number of points needed to reasonably define the coverage area is a function of the complexity of the area. These points can be displaced to account for antenna pointing tolerances and variations due to service arc considerations. A polygon is formed by connecting the adjacent points. A coverage area contour is constructed about this polygon by observing two criteria:

– the radius of the curvature of the coverage area contour should be $\geq \psi_b$;

– the separation between straight segments of the coverage area contour should be $> 2\psi_b$ (see Fig. 7).

If the coverage polygon can be included in a circle of radius ψ_b, this circle is the coverage area contour. The centre of this circle is the centre of a minimum radius circle which will just encompass the coverage area contour. If the coverage polygon cannot be included in a circle of radius ψ_b, then proceed as follows:

Step 1: For all interior coverage polygon angles < 180°, construct a circle of radius ψ_b with its centre at a distance (ψ_b) on the internal bisector of the angle. If all angles are less than 180° (no concavities) Steps 2 and 4 which follow are eliminated.

Step 2: a) For all interior angles > 180°, construct a circle of radius ψ_b which is tangent to the lines connected to the coverage point whose centre is on the exterior bisector of the angle.

b) If this circle is not wholly outside the coverage polygon, then construct a circle of radius ψ_b which is tangent to the coverage polygon at its two nearest points and wholly outside the coverage polygon.

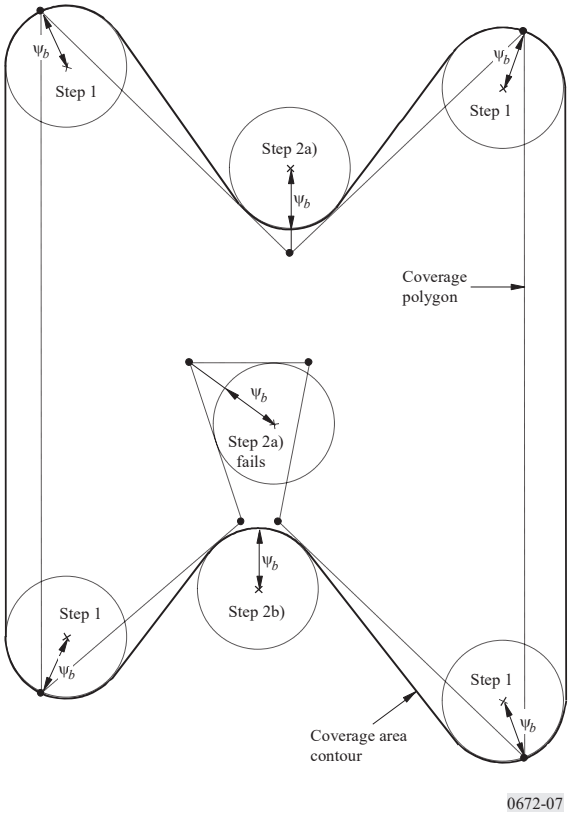
Step 3: Construct straight line segments which are tangent to the portions of the circles of Steps 1 and 2 which are closest to, but outside the coverage polygon.

Step 4: If the interior distance between any two straight line segments from Step 3 is less than $2\psi_b$, the controlling points on the coverage polygon should be adjusted such that reapplying Steps 1 through 3 results in an interior distance between the two straight line segments equal to $2\psi_b$.

An example of this construction technique is shown in Fig. 7.

FIGURE 7

Construction of a coverage area contour



1.2 Gain contours about the coverage area contours

As also noted in Annex 1, difficulties arise where the coverage area contour exhibits concavities. Using a $\Delta\psi$ measured normal to the coverage area contour will result in intersections of the normals and could result in intersections with the coverage area contour.

In order to circumvent this problem, as well as others, a two step process is proposed. If there are no concavities in the coverage contours, the following Step 2 is eliminated.

Step 1: For each $\Delta\psi$, construct a contour such that the angular distance between this contour and the coverage area contour is never less than $\Delta\psi$.

This can be done by constructing arcs of $\Delta\psi$ dimension from points on the coverage area contour. The outer envelope of these arcs is the resultant gain contour.

Where the coverage area contour is straight or convex, this condition is satisfied by measuring normal to the coverage area contour. No intersections of normals will occur for this case.

Using the process described in Step 1 circumvents these construction problems in areas of concavity. However, from a realistic standpoint some problem areas remain. As noted in Annex 1, side-lobe control in regions of concavity can become more difficult as the degree of concavity increases, the pattern cross-section tends to broaden and using the Step 1 process, discontinuities in the slope of the gain contour can exist.

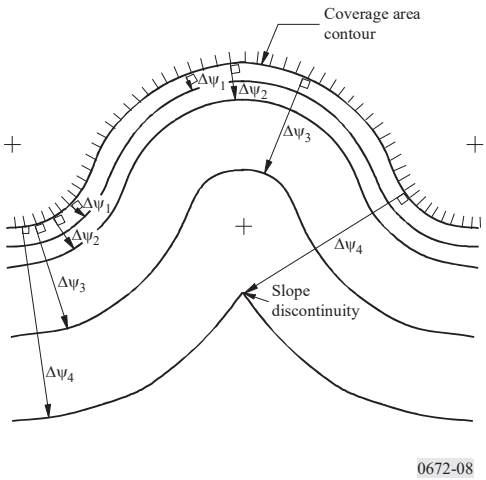
It would appear reasonable to postulate that gain contours should have radii of curvature which are never less than $(\psi_b + \Delta\psi)$ as viewed from inside and outside the gain contour. This condition is satisfied by the Step 1 process where the coverage area contour is straight or convex, but not in areas of concavity in the coverage area contour. The focal points for radii of curvature where the coverage area contour is straight or convex are within the gain contour. In areas of concavity, the use of Step 1 can result in radii of curvature as viewed from outside the gain contour which are less than $(\psi_b + \Delta\psi)$.

Figure 8 shows an example of the Step 1 process in an area of concavity. Semi-circular segments are used for the coverage area contour for construction convenience. Note the slope discontinuity.

To account for the problems enumerated above and to eliminate any slope discontinuity, a Step 2 is proposed where the concavities exist.

FIGURE 8

Gain contours from Step 1 in a concave coverage area contour



Step 2: In areas of the gain contour determined by Step 1 where the radius of curvature as viewed from outside this contour is less than $(\psi_b + \Delta\psi)$ this portion of the gain contour should be replaced by a contour having a radius equal to $(\psi_b + \Delta\psi)$.

Figure 9 shows an example of the Step 2 process applied to concavity of Fig. 8. For purposes of illustration, values of the relative gain contours are shown, assuming ψ_b as shown and a value of $B = 3$ dB.

This method of construction has no ambiguities and results in contours in areas of concavities which might reasonably be expected. However, difficulties occur in generating software to implement the method, and furthermore it is not entirely appropriate for small coverage areas. Further work will continue to refine the method.

To find the gain values at specific points without developing contours the following process is used.

Gain values at points which are not near an area of concavity can be found by determining the angle $\Delta\psi$ measured normal to the coverage area contour and computing the gain from the appropriate equation: (10), (11), (12), (13) or (14). The gain at a point in concavity can be determined as follows.

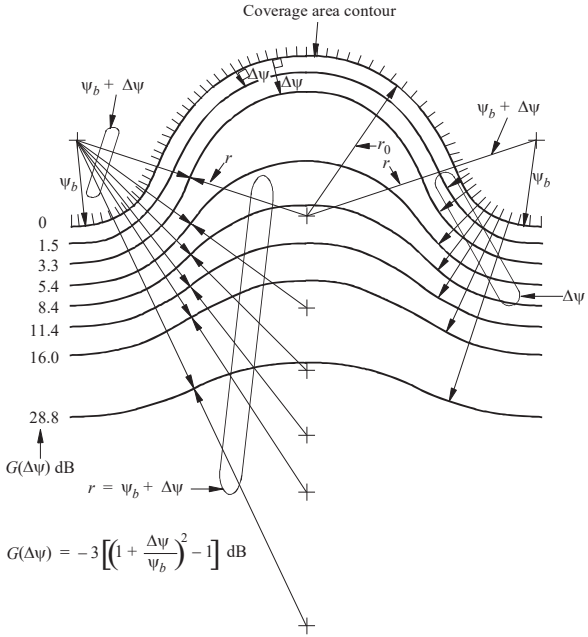
First a simple test is applied. Draw a straight line across the coverage concavity so that it touches the coverage edge at two points without crossing it anywhere. Draw normals to the coverage contour at the tangential points. If the point under consideration lies outside the coverage area between the two normals, the antenna discrimination at that point may be affected by the coverage concavity. It is then necessary to proceed as follows:

Determine the smallest angle $\Delta\psi$ between the point under consideration and the coverage area contour. Construct a circle with radius $(\psi_b + \Delta\psi)$, whose circumference contains the point, in such a way that its angular distance from any point on the coverage area contour is maximized when the circle lies entirely outside the coverage area; call this maximum angular distance $\Delta\psi'$. The value of $\Delta\psi'$ may be any angle between 0 and $\Delta\psi$; it cannot be greater than but may be equal to $\Delta\psi$. The antenna discrimination for the point under consideration is then obtained from equations (10), (11), (12), (13) or (14) as appropriate using $\Delta\psi'$ instead of $\Delta\psi$.

Two computer programs for generating the coverage area contours based on the above method have been developed and are available at the Radiocommunication Bureau.

FIGURE 9

Construction of gain contours in a concave coverage area contour – Step 1 plus Step 2



$r = \psi_b + \Delta\psi$

$r_0 = 1.9\ \psi_b$

r_0: radius of curvature of coverage contour concavity

r: radius of curvature

0672-09

RECOMMENDATION ITU-R M.690-3

Technical characteristics of emergency position-indicating radio beacons operating on the carrier frequencies of 121.5 MHz and 243 MHz

(1990-1995-2012-2015)

Scope

This Recommendation contains technical characteristics to which emergency position-indicating radio beacons (EPIRBs) intended to operate on the carrier frequency of 121.5 MHz and 243 MHz should conform.

Additional characteristics for EPIRBs intended for carriage on aircraft are specified in relevant annexes to the Convention on International Civil Aviation.

Keywords

Maritime, EPIRB, 121.5 MHz, 243 MHz, characteristics

Abbreviations/Glossary

EPIRB Emergency position-indicating radio beacon

ICAO International Civil aviation Organization.

The ITU Radiocommunication Assembly,

considering

a) that the Radio Regulations define the purpose of emergency position-indicating radio beacon (EPIRB) signals;

b) that administrations authorizing the use of EPIRBs operating on carrier frequencies of 121.5 MHz and 243 MHz should ensure that such EPIRBs comply with relevant ITU-R Recommendations and the standards and recommended practices of ICAO,

recommends

1 that the technical characteristics of EPIRBs operating on the carrier frequencies of 121.5 MHz and 243 MHz should be in accordance with Annex 1.

Annex 1

Technical characteristics of emergency position-indicating radio beacons operating on the carrier frequencies of 121.5 MHz and 243 MHz

EPIRBs operating on the carrier frequencies of 121.5 MHz and 243 MHz should fulfil the following conditions (see Note 1):

a) emission in normal antenna conditions and positions should be vertically polarized and be essentially omnidirectional in the horizontal plane;

b) carrier frequencies should be amplitude-modulated (minimum duty cycle of 33%), with a minimum depth of modulation of 0.85;

c) the emission should consist of a characteristic audio-frequency signal obtained by amplitude modulation of the carrier frequencies with an upward or a downward audio-frequency sweep within a range of not less than 700 Hz between 300 Hz and 1 600 Hz and with a sweep repetition rate of two to four times per second;

d) the emission should include a clearly defined carrier frequency distinct from the modulation sideband components; in particular, at least 30% of the power should be contained at all times within:

±30 Hz of the carrier frequency on 121.5 MHz;

±60 Hz of the carrier frequency on 243 MHz;

e) the class of emission should be A3X; however, any type of modulation which satisfies the requirements laid down in b), c) and d) above may be used, provided it does not impair the precise locating of the radio beacon.

NOTE 1 – Additional characteristics for EPIRBs aboard aircraft are specified in the relevant annexes to the Convention on International Civil Aviation.

RECOMMENDATION ITU-R RA.769-2

Protection criteria used for radio astronomical measurements

(Question ITU-R 145/7)

(1992-1995-2003)

The ITU Radiocommunication Assembly,

considering

a) that many of the most fundamental astronomical advances made in the past five decades, (e.g. the discovery of radio galaxies, quasars, and pulsars, the direct measurement of neutral hydrogen, the direct measurement of distances of certain external galaxies, and establishment of a positional reference frame accurate to ~20 arc μs) have been made through radio astronomy, and that radio astronomical observations are expected to continue making fundamental contributions to our understanding of the Universe, and that they provide the only way to investigate some cosmic phenomena;

b) that the development of radio astronomy has also led to major technological advances, particularly in receiving and imaging techniques, and to improved knowledge of fundamental radio-noise limitations of great importance to radiocommunication, and promises further important results;

c) that radio astronomers have made useful astronomical observations from the Earth's surface in all available atmospheric windows ranging from 2 MHz to 1 000 GHz and above;

d) that the technique of space radio astronomy, which involves the use of radio telescopes on space platforms, provides access to the entire radio spectrum above about 10 kHz, including parts of the spectrum not accessible from the Earth due to absorption in atmosphere;

e) that protection from interference is essential to the advancement of radio astronomy and associated measurements;

f) that radio astronomical observations are mostly performed with high-gain antennas or arrays, to provide the highest possible angular resolution, and consequently main beam interference does not need to be considered in most situations, except when there is the possibility of receiver damage;

g) that most interference that leads to the degradation of astronomical data is received through the far side lobes of the telescope;

h) that the sensitivity of radio astronomical receiving equipment, which is still steadily improving, particularly at millimetre wavelengths, and that it greatly exceeds the sensitivity of communications and radar equipment;

j) that typical radio astronomical observations require integration times of the order of a few minutes to hours, but that sensitive observations, particularly of spectral lines, may require longer periods of recording, sometimes up to several days;

k) that some transmissions from spacecraft can introduce problems of interference to radio astronomy and that these cannot be avoided by choice of site for an observatory or by local protection;

l) that interference to radio astronomy can be caused by terrestrial transmissions reflected by the Moon, by aircraft, and possibly by artificial satellites;

m) that some types of high spatial-resolution interferometric observations require simultaneous reception, at the same radio frequency, by widely separated receiving systems that may be located in different countries, on different continents, or on space platforms;

n) that propagation conditions at frequencies below about 40 MHz are such that a transmitter operating anywhere on the Earth might cause interference detrimental to radio astronomy;

o) that some degree of protection can be achieved by appropriate frequency assignments on a national rather than an international basis;

p) that WRCs have made improved allocations for radio astronomy, particularly above 71 GHz, but that protection in many bands, particularly those shared with other radio services, may still need careful planning;

q) that technical criteria concerning interference detrimental to the radio astronomy service (RAS) have been developed, which are set out in Tables 1, 2, and 3,

recommends

1 that radio astronomers should be encouraged to choose sites as free as possible from interference;

2 that administrations should afford all practicable protection to the frequencies and sites used by radio astronomers in their own and neighbouring countries and when planning global systems, taking due account of the levels of interference given in Annex 1;

3 that administrations, in seeking to afford protection to particular radio astronomical observations, should take all practical steps to reduce all unwanted emissions falling within the band of the frequencies to be protected for radio astronomy to the absolute minimum. Particularly those emissions from aircraft, high altitude platform stations, spacecraft and balloons;

4 that when proposing frequency allocations, administrations take into account that it is very difficult for the RAS to share frequencies with any other service in which direct line-of-sight paths from the transmitters to the observatories are involved. Above about 40 MHz sharing may be practicable with services in which the transmitters are not in direct line-of-sight of the observatories, but coordination may be necessary, particularly if the transmitters are of high power.

Annex 1

Sensitivity of radio astronomy systems

1 General considerations and assumptions used in the calculation of interference levels

1.1 Detrimental-level interference criterion

The sensitivity of an observation in radio astronomy can be defined in terms of the smallest power level change ΔP in the power level P at the radiometer input that can be detected and measured. The sensitivity equation is:

$$\frac{\Delta P}{P} = \frac{1}{\sqrt{\Delta f_0 t}} \tag{1}$$

where:

P and ΔP: power spectral density of the noise

Δf_0: bandwidth

t: integration time. P and ΔP in equation (1) can be expressed in temperature units through the Boltzmann's constant, k:

$$\Delta P = k\ \Delta T; \quad \text{also} \quad P = k\ T \tag{2}$$

Thus we may express the sensitivity equation as:

$$\Delta T = \frac{T}{\sqrt{\Delta f_0 t}} \tag{3}$$

where:

$$T = T_A + T_R$$

This result applies for one polarization of the radio telescope. T is the sum of T_A (the antenna noise temperature contribution from the cosmic background, the Earth's atmosphere and radiation from the Earth) and T_R, the receiver noise temperature. Equations (1) or (3) can be used to estimate the sensitivities and interference levels for radio astronomical observations. The results are listed in Tables 1 and 2. An observing (or integration) time, t, of 2 000 s is assumed, and interference threshold levels, ΔP_H, given in Tables 1 and 2 are expressed as the interference power within the bandwidth Δf that introduces an error of 10% in the measurement of ΔP (or ΔT), i.e.:

$$\Delta P_H = 0.1\, \Delta P\, \Delta f \tag{4}$$

In summary, the appropriate columns in Tables 1 and 2 may be calculated using the following methods:

– ΔT, using equation (3),

– ΔP, using equation (2),

– ΔP_H, using equation (4).

The interference can also be expressed in terms of the pfd incident at the antenna, either in the total bandwidth or as a spectral pfd, S_H, per 1 Hz of bandwidth. The values given are for an antenna having a gain, in the direction of arrival of the interference, equal to that of an isotropic antenna (which has an effective area of $c^2/4\pi f^2$, where c is the speed of the light and f the frequency). The gain of an isotropic radiator, 0 dBi, is used as a general representative value for the side-lobe level, as discussed under § 1.3.

Values of $S_H \Delta f$ (dB(W/m^2)), are derived from ΔP_H by adding:

$$20 \log f - 158.5 \qquad \text{dB} \tag{5}$$

where f (Hz). S_H is then derived by subtracting 10 log Δf (Hz) to allow for the bandwidth.

1.2 Integration time

The calculated sensitivities and interference levels presented in Tables 1 and 2 are based on assumed integration times of 2 000 s. Integration times actually used in astronomical observations cover a wide range of values. Continuum observations made with single-antenna telescopes (as distinct from interferometric arrays) are well represented by the integration time of 2 000 s, typical of good quality observations. On the other hand 2 000 s is less representative of spectral line observations. Improvements in receiver stability and the increased use of correlation spectrometers have allowed more frequent use of longer integration times required to observe weak spectral lines, and spectral line observations lasting several hours are quite common. A more representative integration time for these observations would be 10 h. For a 10 h integration, the threshold interference level is 6 dB more stringent than the values given in Table 2. There are also certain observations of time varying phenomena, e.g. observations of pulsars, stellar or solar bursts, and interplanetary scintillations for which much shorter time periods may be adequate.

1.3 Antenna response pattern

Interference to radio astronomy is almost always received through the antenna side lobes, so the main beam response to interference need not be considered.

The side-lobe model for large paraboloid antennas in the frequency range 2 to 30 GHz, given in Recommendation ITU-R SA.509 is a good approximation of the response of many radio astronomy antennas and is adopted throughout this Recommendation as the radio astronomy reference antenna. In this model, the side-lobe level decreases with angular distance (degrees) from the main beam axis and is equal to 32 – 25 log φ (dBi) for 1° < φ < 48°. The effect of an interfering signal clearly depends upon the angle of incidence relative to the main beam axis of the antenna, since the side-lobe gain, as represented by the model, varies from 32 to –10 dBi as a function of this angle. However, it is useful to calculate the threshold levels of interference strength for a particular value of side-lobe gain, that we choose as 0 dBi, and use in Tables 1 to 3. From the model, this side-lobe level occurs at an angle of 19.05° from the main beam axis. Then a signal at the detrimental threshold level defined for 0 dBi side-lobe gain will exceed the criterion for the detrimental level at the receiver input if it is incident at the antenna at an angle of less than 19.05°. The solid angle

within a cone of angular radius 19.05° is 0.344 sr, which is equal to 5.5% of the 2π sr of the sky above the horizon that a radio telescope is able to observe at any given time. Thus if the probability of the angle of incidence of interference is uniformly distributed over the sky, about 5.5% of interfering signals would be incident within 19.05° of the main beam axis of an antenna pointed towards the sky. Note also that the 5.5% figure is in line with the recommended levels of data loss to radio astronomy observations in percentage of time, specified in Recommendation ITU-R RA.1513.

The particular case of non-GSO satellites presents a dynamic situation, that is, the positions of the satellites relative to the beam of the radio astronomy antenna show large changes within the time scale of the 2 000 s integration time. Analysis of interference in this case requires integrating the response over the varying side-lobe levels, for example, using the concept of epfd defined in No. 22.5C of the Radio Regulations (RR). In addition it is usually necessary to combine the responses to a number of satellites within a particular system. In such calculations it is suggested that the antenna response pattern for antennas of diameter greater than 100 λ in Recommendation ITU-R S.1428 be used to represent the radio astronomy antenna, until a model based specifically on radio astronomy antennas is available; see § 2.2 for further discussion.

1.4 Bandwidth

Equation (1) shows that observations of the highest sensitivity are obtained when radio astronomers make use of the widest possible bandwidth. Consequently, in Table 1 (continuum observations), Δf is assumed to be the width of the allocated radio astronomy bands for frequencies up to 71 GHz. Above 71 GHz a value of 8 GHz is used, which is a representative bandwidth generally used on radio astronomy receivers in this range. In Table 2 (spectral line observations) a channel bandwidth Δf equal to the Doppler shift corresponding to 3 km/s in velocity is used for entries below 71 GHz. This value represents a compromise between the desired high spectral resolution and the sensitivity. There are a very large number of astrophysically important lines above 71 GHz, as shown in Recommendation ITU-R RA.314 and only a few representative values for the detrimental levels are given in Table 2 for the range 71-275 GHz. The channel bandwidth used to compute the detrimental levels above 71 GHz is 1 000 kHz (1 MHz) in all cases. This value was chosen for practical reasons. While it is slightly wider than the spectral channel width customary in radio astronomy receivers at these frequencies, it is used as the standard reference bandwidth for space services above 15 GHz.

1.5 Receiver noise temperature and antenna temperature

The receiver noise temperatures in Tables 1 and 2 are representative of the systems in use in radio astronomy. For frequencies above 1 GHz these are cryogenically cooled amplifiers or mixers. The quantum effect places a theoretical lower limit of hf/k on the noise temperature of such devices, where h and k are Planck's and Boltzmann's constants, respectively. This limit becomes important at frequencies above 100 GHz, where it equals 4.8 K. Practical mixers and amplifiers for bands at 100 GHz and higher provide noise temperatures greater than hf/k by a factor of about four. Thus, for frequencies above 100 GHz, noise temperatures equal to $4hf/k$ are used in Tables 1 and 2.

The antenna temperatures in the Tables are also representative of practical systems in use in radio astronomy. They include the effects of the ionosphere or the neutral atmosphere, ground pickup in side lobes resulting from spillover or scattering, ohmic losses, and the cosmic microwave background. At frequencies above 100 GHz the atmospheric losses due to water vapour in the neutral atmosphere become very important. For these frequencies the values given are typical of the terrestrial sites used for major millimetric-wave radio astronomy facilities, such as Mauna Kea, Hawaii, or the Llano de Chajnantor at an elevation of 5 000 m in Chile, which is the site chosen for a major international radio astronomy array for frequencies in the range 30 GHz to 1 THz.

2 Special cases

The levels given in Tables 1 and 2 are applicable to terrestrial sources of interfering signals. The detrimental pfd and spectral pfd shown in Tables 1 and 2 assume that interference is received through a 0 dBi side lobe, and should be regarded as the general interference criteria for high sensitivity radio astronomy observations, when the interference does not enter the near side lobes.

2.1 Interference from GSO satellites

Interference from GSO satellites is a case of particular importance. Because the power levels in Tables 1 and 2 were calculated based on a 0 dBi antenna gain, interference detrimental to radio astronomy will be encountered when a reference antenna, such as described in Recommendation ITU-R SA.509, is pointed within 19.05° of a satellite radiating at levels in accordance with those listed in the Tables. A series of such transmitters located around the GSO would preclude radio astronomy observations with high sensitivity from a band of sky 38.1° wide and centred on the orbit. The loss of such a large area of sky would impose severe restrictions on radio astronomy observations.

In general, it would not be practical to suppress the unwanted emissions from satellites to below the detrimental level when the main beam of a radio telescope is pointed directly towards the satellite. A workable solution is suggested by observing the projection of the GSO in celestial coordinates as viewed from the latitudes of a number of major radio astronomy observations (see Recommendation ITU-R RA.517). If it were possible to point a radio telescope to within 5° of the GSO without encountering detrimental interference, then for that telescope a band of sky 10° wide would be unavailable for high-sensitivity observations. For a given observatory this would be a serious loss. However, for a combination of radio telescopes located at northern and southern latitudes, operating at the same frequencies, the entire sky would be accessible. A value of 5° should therefore be regarded as the requirement for minimum angular spacing between the main beam of a radio astronomy antenna and the GSO.

In the model antenna response of Recommendation ITU-R SA.509, the side-lobe level at an angle of 5° from the main beam is 15 dBi. Thus, to avoid interference detrimental to a radio telescope meeting the antenna side-lobe performance of Recommendation ITU-R SA.509, pointed to within 5° of the transmitter, it is desirable that the satellite emissions be reduced 15 dB below the pfd given in Tables 1 and 2. When satellites are spaced at intervals of only a few degrees along the GSO, the emission levels associated with the individual transmitters must be even lower to meet the requirement that the sum of the powers of all the interfering signals received should be 15 dB below ΔP_H in Tables 1 and 2.

It is recognized that the emission limitations discussed above cannot, in practice, be achieved so as to enable sharing of the same frequency band between radio astronomy and down-link transmissions from satellites to take place. The limitations are, however, applicable to unwanted emission from the satellite transmitters, which fall within the radio astronomy bands listed in Tables 1 and 2. These emission limitations have implications for the space services responsible for the interference, which require careful evaluation. Furthermore, the design of new radio astronomy antennas should strive to minimize the level of side-lobe gain near the main beam as an important means of reducing interference from transmitters in the GSO.

2.2 Interference from non-GSO satellites

In the case of non-GSO satellites, and in particular for low-Earth orbit satellites, the systems usually involve constellations of many individual satellites. Thus determination of interference levels requires analysis of the combined effect of many signals, most of which are received through far side lobes of the radio astronomy antenna. A more detailed side-lobe model than that of Recommendation ITU-R SA.509 is therefore desirable, and it is proposed that the model in Recommendation ITU-R S.1428 be used until such time as a more representative model for radio astronomy antennas is obtained. In using this proposed model the case for antennas with diameter greater than 100 λ is generally appropriate for radio astronomy applications. It should be noted that Note 1 of Recommendation ITU-R S.1428, which allows cross-polarized components to be ignored, cannot be applied since radio astronomy antennas generally receive signals in two orthogonal polarizations simultaneously. The motion of non-GSO satellites across the sky during a 2 000 s integration period requires that the interference level be averaged over this period, that is, the response to each satellite must be integrated as the satellite moves through the side-lobe pattern. One system of analysis that includes these requirements is the epfd method described in RR No. 22.5C. Values of epfd represent the pfd of a signal entering the antenna through the centre of the main beam that would produce an equivalent level of interference power. Since the threshold levels of detrimental interference in Tables 1 and 2 correspond to pfd received with an antenna gain of 0 dBi, it is necessary to compare them with values of ($epfd + G_{mb}$), where G_{mb} is the main beam gain, to determine whether the interference exceeds the detrimental level. Making use of the epfd method, Recommendation ITU-R S.1586 has recently been developed for interference calculations between radio astronomy telescopes and FSS non-GSO satellite systems. A similar Recommendation, Recommendation ITU-R M.1583 was developed for interference calculations between radio astronomy telescopes and MSS and radionavigation-satellite service non-GSO satellite systems. The applicability of the protection criteria given in Tables 1 and 2 is described in Recommendation ITU-R RA.1513.

2.3 The response of interferometers and arrays to radio interference

Two effects reduce the response to interference. These are related to the frequency of the fringe oscillations that are observed when the outputs of two antennas are combined, and to the fact that the components of the interfering signal received by different and widely-spaced antennas will suffer different relative time delays before they are recombined. The treatment of these effects is more complicated than that for single antennas in § 1. Broadly speaking, if the strength of the received interfering signal remains constant, the effect is reduced by a factor roughly equal to the

mean time of one natural fringe oscillation divided by the data averaging time. This typically ranges from some seconds for a compact array with the longest projected spacing $L' \sim 10^3\ \lambda$, where λ is the wavelength, to less than 1 ms for intercontinental arrays with $L' \sim 10^7\ \lambda$. Thus, compared to a single radio telescope, the interferometer has a degree of immunity to interference which, under reasonable assumptions increases with the array size expressed in wavelengths.

The greatest immunity from interference occurs for interferometers and arrays in which the separation of the antennas is sufficiently great that the chance of occurrence of correlated interference is very small (e.g. for very long baseline interferometry (VLBI)). In this case, the above considerations do not apply. The tolerable interference level is determined by the requirement that the power level of the interfering signal should be no more than 1% of the receiver noise power to prevent serious errors in the measurement of the amplitude of the cosmic signals. The interference levels for typical VLBI observations are given in Table 3, based on the values of T_A and T_R given in Table 1.

It must be emphasized that the use of large interferometers and arrays is generally confined to studies of discrete, high-brightness sources, with angular dimensions no more than a few tenths of a second of arc for VLBI. For more general studies of radio sources, the results in Tables 1 and 2 apply and are thus appropriate for the general protection of radio astronomy.

TABLE 1

Threshold levels of interference detrimental to radio astronomy continuum observations

Centre frequency (1) f_c (MHz)	Assumed bandwidth Δf (MHz)	Minimum antenna noise temperature T_A (K)	Receiver noise temperature T_R (K)	System sensitivity(2) (noise fluctuations)		Threshold interference levels(2) (3)		
				Temperature ΔT (mK)	Power spectral density ΔP (dB(W/Hz))	Input power ΔP_H (dBW)	pfd $S_H \Delta f$ (dB(W/m²))	Spectral pfd S_H (dB(W/(m² · Hz)))
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
13.385	0.05	50 000	60	5 000	–222	–185	–201	–248
25.610	0.12	15 000	60	972	–229	–188	–199	–249
73.8	1.6	750	60	14.3	–247	–195	–196	–258
151.525	2.95	150	60	2.73	–254	–199	–194	–259
325.3	6.6	40	60	0.87	–259	–201	–189	–258
408.05	3.9	25	60	0.96	–259	–203	–189	–255
611	6.0	20	60	0.73	–260	–202	–185	–253
1 413.5	27	12	10	0.095	–269	–205	–180	–255
1 665	10	12	10	0.16	–267	–207	–181	–251
2 695	10	12	10	0.16	–267	–207	–177	–247
4 995	10	12	10	0.16	–267	–207	–171	–241
10 650	100	12	10	0.049	–272	–202	–160	–240
15 375	50	15	15	0.095	–269	–202	–156	–233
22 355	290	35	30	0.085	–269	–195	–146	–231
23 800	400	15	30	0.050	–271	–195	–147	–233
31 550	500	18	65	0.083	–269	–192	–141	–228
43 000	1 000	25	65	0.064	–271	–191	–137	–227
89 000	8 000	12	30	0.011	–278	–189	–129	–228
150 000	8 000	14	30	0.011	–278	–189	–124	–223
224 000	8 000	20	43	0.016	–277	–188	–119	–218
270 000	8 000	25	50	0.019	–276	–187	–117	–216

(1) Calculation of interference levels is based on the centre frequency shown in this column although not all regions have the same allocations.

(2) An integration time of 2 000 s has been assumed; if integration times of 15 min, 1 h, 2 h, 5 h or 10 h are used, the relevant values in the Table should be adjusted by +1.7, –1.3, –2.8, –4.8 or –6.3 dB respectively.

(3) The interference levels given are those which apply for measurements of the total power received by a single antenna. Less stringent levels may be appropriate for other types of measurements, as discussed in § 2.2. For transmitters in the GSO, it is desirable that the levels be adjusted by –15 dB, as explained in § 2.1.

TABLE 2*

Threshold levels of interference detrimental to radio astronomy spectral-line observations

Frequency f (MHz)	Assumed spectral line channel bandwidth Δf (kHz)	Minimum antenna noise temperature T_A (K)	Receiver noise temperature T_R (K)	System sensitivity(2) (noise fluctuations)		Threshold interference levels(1) (2)		
				Temperature ΔT (mK)	Power spectral density ΔP_S (dB(W/Hz))	Input power ΔP_H (dBW)	pfd $S_H \Delta f$ (dB(W/m²))	Spectral pfd S_H (dB(W/(m² · Hz)))
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
327	10	40	60	22.3	–245	–215	–204	–244
1 420	20	12	10	3.48	–253	–220	–196	–239
1 612	20	12	10	3.48	–253	–220	–194	–238
1 665	20	12	10	3.48	–253	–220	–194	–237
4 830	50	12	10	2.20	–255	–218	–183	–230
14 488	150	15	15	1.73	–256	–214	–169	–221
22 200	250	35	30	2.91	–254	–210	–162	–216
23 700	250	35	30	2.91	–254	–210	–161	–215
43 000	500	25	65	2.84	–254	–207	–153	–210
48 000	500	30	65	3.00	–254	–207	–152	–209
88 600	1 000	12	30	0.94	–259	–209	–148	–208
150 000	1 000	14	30	0.98	–259	–209	–144	–204
220 000	1 000	20	43	1.41	–257	–207	–139	–199
265 000	1 000	25	50	1.68	–256	–206	–137	–197

* This Table is not intended to give a complete list of spectral-line bands, but only representative examples throughout the spectrum.

(1) An integration time of 2 000 s has been assumed; if integration times of 15 min, 1 h, 2 h, 5 h or 10 h are used, the relevant values in the Table should be adjusted by +1.7, –1.3, –2.8, –4.8 or –6.3 dB respectively.

(2) The interference levels given are those which apply for measurements of the total power received by a single antenna. Less stringent levels may be appropriate for other types of measurements, as discussed in § 2.2. For transmitters in the GSO, it is desirable that the levels need to be adjusted by –15 dB, as explained in § 2.1.

COLUMN DESCRIPTIONS FOR TABLES 1 AND 2

Column

(1) Centre frequency of the allocated radio astronomy band (Table 1) or nominal spectral line frequency (Table 2).

(2) Assumed or allocated bandwidth (Table 1) or assumed typical channel widths used for spectral line observations (Table 2).

(3) Minimum antenna noise temperature includes contributions from the ionosphere, the Earth's atmosphere and radiation from the Earth.

(4) Receiver noise temperature representative of a good radiometer system intended for use in high sensitivity radio astronomy observations.

(5) Total system sensitivity (mK) as calculated from equation (1) using the combined antenna and receiver noise temperatures, the listed bandwidth and an integration time of 2 000 s.

(6) Same as (5) above, but expressed in noise power spectral density using the equation $\Delta P = k\,\Delta T$, where $k = 1.38 \times 10^{-23}$ (J/K) (Boltzmann's constant). The actual numbers in the Table are the logarithmic expression of ΔP.

(7) Power level at the input of the receiver considered harmful to high sensitivity observations, ΔP_H. This is expressed as the interference level which introduces an error of not more than 10% in the measurement of ΔP; $\Delta P_H = 0.1\ \Delta P\ \Delta f$: the numbers in the Table are the logarithmic expression of ΔP_H.

(8) pfd in a spectral line channel needed to produce a power level of ΔP_H in the receiving system with an isotropic receiving antenna. The numbers in the Table are the logarithmic expression of $S_H\,\Delta f$.

(9) Spectral pfd needed to produce a power level ΔP_H in the receiving system with an isotropic receiving antenna. The numbers in the Table are the logarithmic expression of S_H. To obtain the corresponding power levels in a reference bandwidth of 4 kHz or 1 MHz add 36 dB or 60 dB, respectively.

TABLE 3

Threshold interference levels for VLBI observations

Centre frequency (MHz)	**Threshold level (dB(W/m^2 · Hz)))**
325.3	–217
611	–212
1 413.5	–211
2 695	–205
4 995	–200
10 650	–193
15 375	–189
23 800	–183
43 000	–175
86 000	–172

RECOMMENDATION ITU-R P.838-3

Specific attenuation model for rain for use in prediction methods

(Question ITU-R 201/3)

(1992-1999-2003-2005)

The ITU Radiocommunication Assembly,

considering

a) that there is a need to calculate the attenuation due to rain from a knowledge of rain rates,

recommends

1 that the following procedure be used.

The specific attenuation γ_R (dB/km) is obtained from the rain rate R (mm/h) using the power-law relationship:

$$\gamma_R = kR^{\alpha} \tag{1}$$

Values for the coefficients k and α are determined as functions of frequency, f (GHz), in the range from 1 to 1 000 GHz, from the following equations, which have been developed from curve-fitting to power-law coefficients derived from scattering calculations:

$$\log_{10} k = \sum_{j=1}^{4} a_j \exp\left[-\left(\frac{\log_{10} f - b_j}{c_j}\right)^2\right] + m_k \log_{10} f + c_k \tag{2}$$

$$\alpha = \sum_{j=1}^{5} a_j \exp\left[-\left(\frac{\log_{10} f - b_j}{c_j}\right)^2\right] + m_\alpha \log_{10} f + c_\alpha \tag{3}$$

where:

f: frequency (GHz)

k: either k_H or k_V

α: either α_H or α_V.

Values for the constants for the coefficient k_H for horizontal polarization are given in Table 1 and for the coefficient k_V for vertical polarization in Table 2. Table 3 gives the values for the constants for the coefficient α_H for horizontal polarization, and Table 4 gives the values for the constants for the coefficient α_V for vertical polarization.

TABLE 1

Coefficients for k_H

j	a_j	b_j	c_j	m_k	c_k
1	–5.33980	–0.10008	1.13098	–0.18961	0.71147
2	–0.35351	1.26970	0.45400		
3	–0.23789	0.86036	0.15354		
4	–0.94158	0.64552	0.16817		

TABLE 2

Coefficients for k_V

j	a_j	b_j	c_j	m_k	c_k
1	–3.80595	0.56934	0.81061	–0.16398	0.63297
2	–3.44965	–0.22911	0.51059		
3	–0.39902	0.73042	0.11899		
4	0.50167	1.07319	0.27195		

TABLE 3

Coefficients for α_H

j	a_j	b_j	c_j	m_α	c_α
1	–0.14318	1.82442	–0.55187	0.67849	–1.95537
2	0.29591	0.77564	0.19822		
3	0.32177	0.63773	0.13164		
4	–5.37610	–0.96230	1.47828		
5	16.1721	–3.29980	3.43990		

TABLE 4

Coefficients for α_V

j	a_j	b_j	c_j	m_α	c_α
1	–0.07771	2.33840	–0.76284	–0.053739	0.83433
2	0.56727	0.95545	0.54039		
3	–0.20238	1.14520	0.26809		
4	–48.2991	0.791669	0.116226		
5	48.5833	0.791459	0.116479		

For linear and circular polarization, and for all path geometries, the coefficients in equation (1) can be calculated from the values given by equations (2) and (3) using the following equations:

$$k = [k_H + k_V + (k_H - k_V)\cos^2 \theta \cos 2\tau]/2 \tag{4}$$

$$\alpha = [k_H \alpha_H + k_V \alpha_V + (k_H \alpha_H - k_V \alpha_V)\cos^2 \theta \cos 2\tau]/2k \tag{5}$$

where θ is the path elevation angle and τ is the polarization tilt angle relative to the horizontal ($\tau = 45°$ for circular polarization).

For quick reference, the coefficients k and α are shown graphically in Figs. 1 to 4, and Table 5 lists numerical values for the coefficients at given frequencies.

FIGURE 1

k coefficient for horizontal polarization

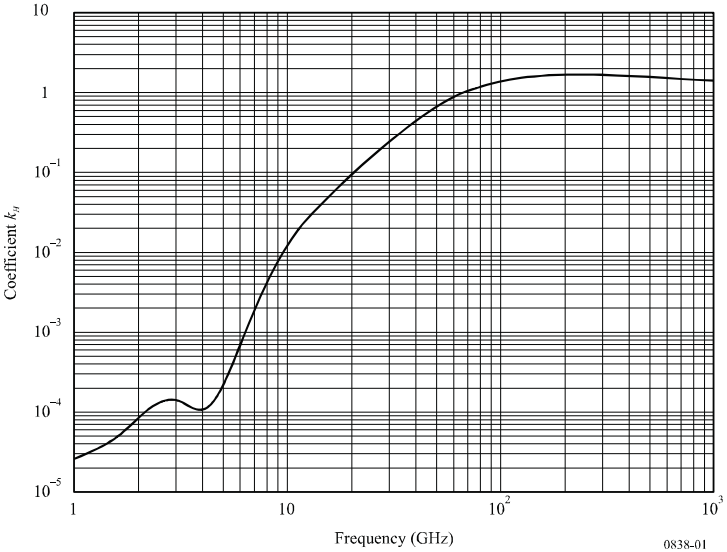


FIGURE 2

α coefficient for horizontal polarization

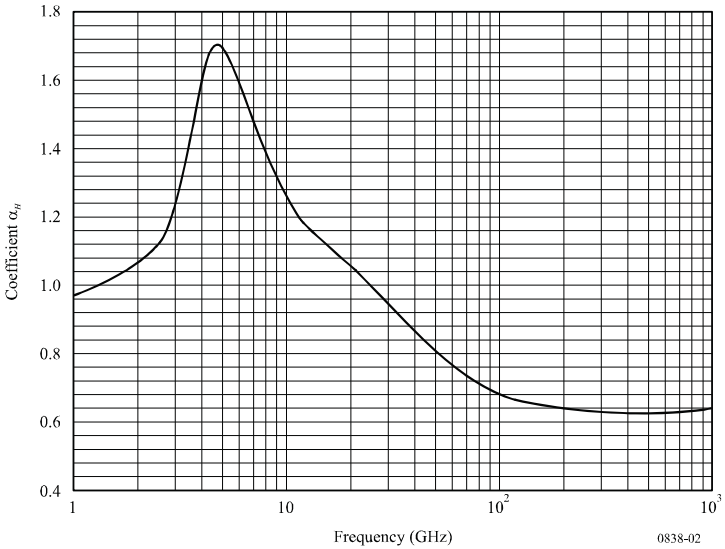


FIGURE 3

***k* coefficient for vertical polarization**

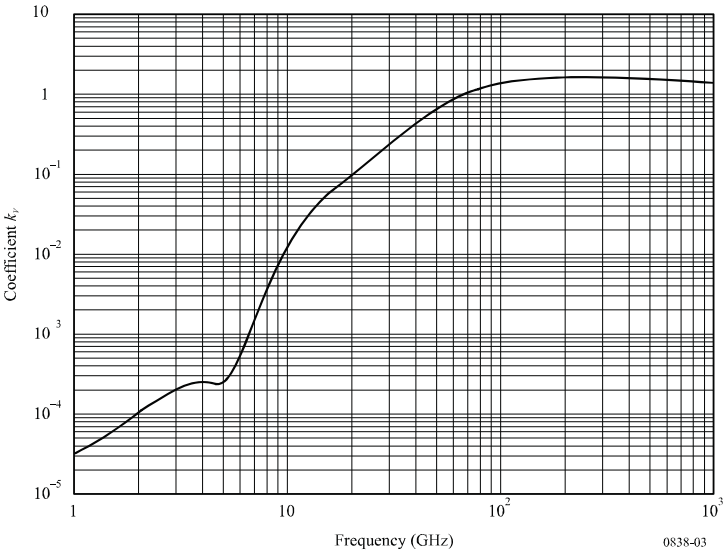


FIGURE 4

α coefficient for vertical polarization

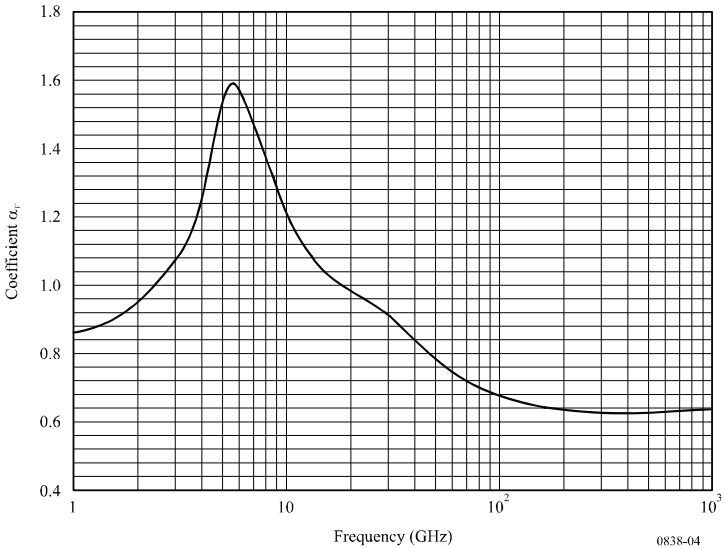


TABLE 5

Frequency-dependent coefficients for estimating specific rain attenuation using equations (4), (5) and (1)

Frequency (GHz)	k_H	α_H	k_V	α_V
1	0.0000259	0.9691	0.0000308	0.8592
1.5	0.0000443	1.0185	0.0000574	0.8957
2	0.0000847	1.0664	0.0000998	0.9490
2.5	0.0001321	1.1209	0.0001464	1.0085
3	0.0001390	1.2322	0.0001942	1.0688
3.5	0.0001155	1.4189	0.0002346	1.1387
4	0.0001071	1.6009	0.0002461	1.2476
4.5	0.0001340	1.6948	0.0002347	1.3987
5	0.0002162	1.6969	0.0002428	1.5317
5.5	0.0003909	1.6499	0.0003115	1.5882
6	0.0007056	1.5900	0.0004878	1.5728
7	0.001915	1.4810	0.001425	1.4745
8	0.004115	1.3905	0.003450	1.3797
9	0.007535	1.3155	0.006691	1.2895
10	0.01217	1.2571	0.01129	1.2156

TABLE 5 (*continued*)

Frequency (GHz)	k_H	α_H	k_V	α_V
11	0.01772	1.2140	0.01731	1.1617
12	0.02386	1.1825	0.02455	1.1216
13	0.03041	1.1586	0.03266	1.0901
14	0.03738	1.1396	0.04126	1.0646
15	0.04481	1.1233	0.05008	1.0440
16	0.05282	1.1086	0.05899	1.0273
17	0.06146	1.0949	0.06797	1.0137
18	0.07078	1.0818	0.07708	1.0025
19	0.08084	1.0691	0.08642	0.9930
20	0.09164	1.0568	0.09611	0.9847
21	0.1032	1.0447	0.1063	0.9771
22	0.1155	1.0329	0.1170	0.9700
23	0.1286	1.0214	0.1284	0.9630
24	0.1425	1.0101	0.1404	0.9561
25	0.1571	0.9991	0.1533	0.9491
26	0.1724	0.9884	0.1669	0.9421
27	0.1884	0.9780	0.1813	0.9349
28	0.2051	0.9679	0.1964	0.9277
29	0.2224	0.9580	0.2124	0.9203
30	0.2403	0.9485	0.2291	0.9129
31	0.2588	0.9392	0.2465	0.9055
32	0.2778	0.9302	0.2646	0.8981
33	0.2972	0.9214	0.2833	0.8907
34	0.3171	0.9129	0.3026	0.8834
35	0.3374	0.9047	0.3224	0.8761
36	0.3580	0.8967	0.3427	0.8690
37	0.3789	0.8890	0.3633	0.8621
38	0.4001	0.8816	0.3844	0.8552
39	0.4215	0.8743	0.4058	0.8486
40	0.4431	0.8673	0.4274	0.8421
41	0.4647	0.8605	0.4492	0.8357
42	0.4865	0.8539	0.4712	0.8296
43	0.5084	0.8476	0.4932	0.8236
44	0.5302	0.8414	0.5153	0.8179
45	0.5521	0.8355	0.5375	0.8123
46	0.5738	0.8297	0.5596	0.8069
47	0.5956	0.8241	0.5817	0.8017
48	0.6172	0.8187	0.6037	0.7967

TABLE 5 (*continued*)

Frequency (GHz)	k_H	α_H	k_V	α_V
49	0.6386	0.8134	0.6255	0.7918
50	0.6600	0.8084	0.6472	0.7871
51	0.6811	0.8034	0.6687	0.7826
52	0.7020	0.7987	0.6901	0.7783
53	0.7228	0.7941	0.7112	0.7741
54	0.7433	0.7896	0.7321	0.7700
55	0.7635	0.7853	0.7527	0.7661
56	0.7835	0.7811	0.7730	0.7623
57	0.8032	0.7771	0.7931	0.7587
58	0.8226	0.7731	0.8129	0.7552
59	0.8418	0.7693	0.8324	0.7518
60	0.8606	0.7656	0.8515	0.7486
61	0.8791	0.7621	0.8704	0.7454
62	0.8974	0.7586	0.8889	0.7424
63	0.9153	0.7552	0.9071	0.7395
64	0.9328	0.7520	0.9250	0.7366
65	0.9501	0.7488	0.9425	0.7339
66	0.9670	0.7458	0.9598	0.7313
67	0.9836	0.7428	0.9767	0.7287
68	0.9999	0.7400	0.9932	0.7262
69	1.0159	0.7372	1.0094	0.7238
70	1.0315	0.7345	1.0253	0.7215
71	1.0468	0.7318	1.0409	0.7193
72	1.0618	0.7293	1.0561	0.7171
73	1.0764	0.7268	1.0711	0.7150
74	1.0908	0.7244	1.0857	0.7130
75	1.1048	0.7221	1.1000	0.7110
76	1.1185	0.7199	1.1139	0.7091
77	1.1320	0.7177	1.1276	0.7073
78	1.1451	0.7156	1.1410	0.7055
79	1.1579	0.7135	1.1541	0.7038
80	1.1704	0.7115	1.1668	0.7021
81	1.1827	0.7096	1.1793	0.7004
82	1.1946	0.7077	1.1915	0.6988
83	1.2063	0.7058	1.2034	0.6973
84	1.2177	0.7040	1.2151	0.6958
85	1.2289	0.7023	1.2265	0.6943
86	1.2398	0.7006	1.2376	0.6929

TABLE 5 (*end*)

Frequency (GHz)	k_H	α_H	k_V	α_V
87	1.2504	0.6990	1.2484	0.6915
88	1.2607	0.6974	1.2590	0.6902
89	1.2708	0.6959	1.2694	0.6889
90	1.2807	0.6944	1.2795	0.6876
91	1.2903	0.6929	1.2893	0.6864
92	1.2997	0.6915	1.2989	0.6852
93	1.3089	0.6901	1.3083	0.6840
94	1.3179	0.6888	1.3175	0.6828
95	1.3266	0.6875	1.3265	0.6817
96	1.3351	0.6862	1.3352	0.6806
97	1.3434	0.6850	1.3437	0.6796
98	1.3515	0.6838	1.3520	0.6785
99	1.3594	0.6826	1.3601	0.6775
100	1.3671	0.6815	1.3680	0.6765
120	1.4866	0.6640	1.4911	0.6609
150	1.5823	0.6494	1.5896	0.6466
200	1.6378	0.6382	1.6443	0.6343
300	1.6286	0.6296	1.6286	0.6262
400	1.5860	0.6262	1.5820	0.6256
500	1.5418	0.6253	1.5366	0.6272
600	1.5013	0.6262	1.4967	0.6293
700	1.4654	0.6284	1.4622	0.6315
800	1.4335	0.6315	1.4321	0.6334
900	1.4050	0.6353	1.4056	0.6351
1 000	1.3795	0.6396	1.3822	0.6365

RECOMMENDATION ITU-R M.1084-5*, **

Interim solutions for improved efficiency in the use of the band 156-174 MHz by stations in the maritime mobile service

(1994-1995-1997-1998-2001-2012)

Scope

This Recommendation provides ways to improve efficiency in the used of the band 156-174 MHz by stations in the maritime mobile service; specifically describes technical characteristics when using channels spaced by 12.5 kHz, migration to narrow-band channels, an example method for implementing interleaved narrow-band channels at 12.5 kHz offset spacing and assignment of channels numbers to interleaved channels and simplex operation of duplex channels.

The ITU Radiocommunication Assembly,

considering

a) that a common international system is essential for maritime communications to ensure the safety of life at sea;

b) that the greatest long-term benefits in spectrum efficiency are gained by using the latest digital or narrow-band transmission techniques;

c) that the introduction of new technology or replanning of frequency bands is a significant exercise involving a long period of transition;

d) that any new equipment needs to be compatible or be able to co-exist with existing equipment conforming to Recommendation ITU-R M.489;

e) that the introduction of new technology should not interrupt the continuous availability of RR Appendix 18 maritime mobile distress and safety communications in the VHF bands for all users;

f) that congestion in the VHF maritime mobile band has become a serious problem in some parts of the world and is continuing to grow;

g) that because of this need administrations may decide to take measures to solve their local congestion problem;

h) that RR Appendix 18 makes provision for administrations to apply 12.5 kHz channel interleaving, subject to coordination with affected administrations;

j) that the implementation of 12.5 kHz channels requires a standard channel numbering plan;

k) that some administrations have implemented single frequency operation of two frequency channels as a means of alleviating current congestion;

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* This Recommendation should be brought to the attention of the International Maritime Organization (IMO).

** Radiocommunication Study Group 5 made editorial amendments to this Recommendation in November 2010.

l) that these interim solutions are used by the standard automatic identification system developed in accordance with Recommendation ITU-R M.1371 to meet IMO vessel carriage requirements,

recommends

1 that administrations having an urgent need to resolve congestion, should implement single frequency operation of two frequency channels as an interim expedient measure;

2 that, for administrations having an urgent need to resolve congestion, changing to 12.5 kHz analogue frequency modulation (FM) as an interim expedient may be used to improve spectrum utilization but should consider the impact on current operations, especially where it involved international shipping using 25 kHz channel spacing;

3 that administrations, when employing 12.5 kHz analogue FM channels as an interim measure, should take appropriate means to avoid interference to the distress and safety channels and channels affecting the safety of international shipping;

4 that the interim arrangements referred to in *recommends* 2 and 3 should not prejudice the implementation of the longer term solution resulting from the ongoing studies which may result in the use of advanced technologies and channelling of bandwidth other than 12.5 kHz;

5 that the interim arrangements referred to in *recommends* 2 and 3 shall not prejudice the implementation of a single international system for distress and safety communications by the international community in the longer term;

6 that administrations intending to resolve current congestion problems through the use of narrow-band channels should consider Annex 2 as a guide to migration from 25 kHz channels to narrower bands;

7 that administrations intending to resolve current congestion problems through the use of narrow-band channels should use equipment conforming to the technical parameters given at Annex 1, whilst taking into account the provisions of RR Appendix 18;

8 that administrations implementing interleaved narrow-band channels at 12.5 kHz offset spacing on an interim basis should consider Annex 3 as an example of a possible implementation method (different example methods are available with other characteristics than those described in Annex 3);

9 that administrations implementing narrow-band channels at 12.5 kHz should consider Annex 4 for numbering the new channels;

10 that administrations implementing single frequency operation of two frequency channels should consider Annex 4, § 3, for numbering the channels;

11 that administrations should, as far as possible, look to the implementation of the latest digital or narrow-band techniques to meet future operational requirements and achieve the efficient use of the band 156-174 MHz.

Annex 1

Technical characteristics for equipment designed to operate in channels spaced by 12.5 kHz

Use of equipment implementing these parameters listed below (see Note 1) should only be in accordance with the provisions of RR Appendix 18:

– the frequency tolerance for coast and ship station transmitters should not exceed 5 parts in 10^6;

– the frequency deviation should not exceed ±2.5 kHz.

NOTE 1 – For information, other characteristics are based on European Telecommunications Standard (ETS) 301 925 published by the European Telecommunications Standards Institute (ETSI).

Annex 2

Migration to narrow-band channels in the maritime mobile service

1 Introduction

This Annex considers how in future the maritime-mobile service might migrate to narrow-band channels spaced at 5 kHz or 6.25 kHz apart, using linear or digital modulation. Consideration is given to migration from 25 kHz channel spacing as used at present, and from 12.5 kHz if the latter was to be implemented as an interim measure by some administrations.

2 Implications of migration to narrow-band channels

2.1 Migration

The most practicable and least disruptive method of migrating from 25 kHz or 12.5 kHz to 5 kHz or 6.25 kHz would be by interleaving the narrow-band channels with the wider ones and a similar technique can be used in all cases. However because the linear and digital modulation techniques using 5 kHz and/or 6.25 kHz are incompatible with current FM equipment, dual mode or additional equipment would be required during the change-over period.

2.2 Interleaving

2.2.1 Interleaving with 25 kHz channels

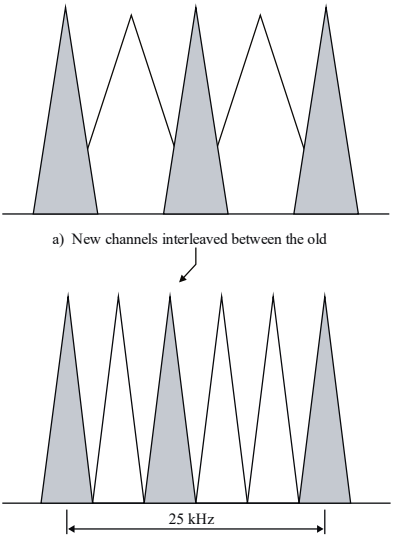
Figures 1 and 2 illustrate how 5 kHz and 6.25 kHz channels could be interleaved with the existing 25 kHz ones. During the change-over period, coast stations and ships would be required to equip with narrow-band equipment and move to the new narrow-band channels as they became available. The numbers of new narrow-band channels would be gradually increased during the transition period with the number of 25 kHz channels available correspondingly decreasing.

On a specified date all remaining 25 kHz channels would be withdrawn to be replaced by new ones.

The migration from 25 kHz channels is fairly straightforward but some realignment of channel or band edges is likely to be required.

FIGURE 1

Migration from 25 kHz to 5 kHz channelling

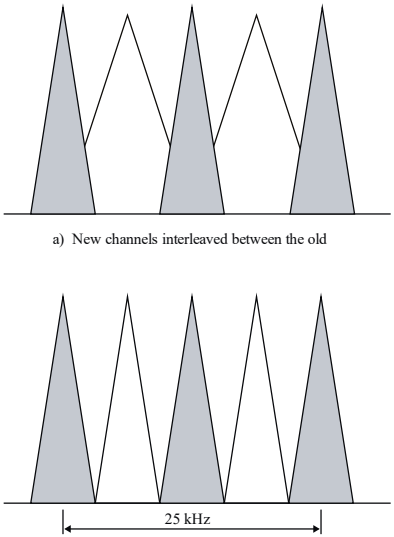


a) New channels interleaved between the old

b) All new channels after changeover with readjustment of channel frequencies

FIGURE 2

Migration from 25 kHz to 6.25 kHz channelling



a) New channels interleaved between the old

b) All new channels after changeover

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2.2.2 Interleaving with 12.5 kHz channels

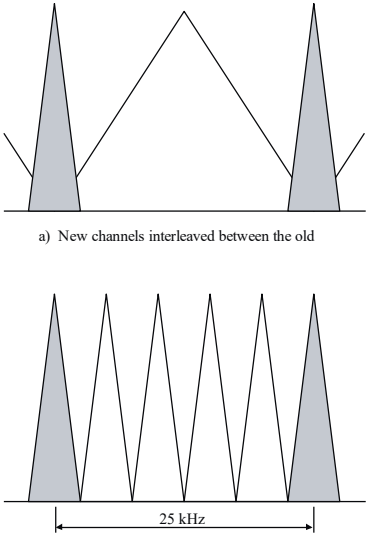
Figures 3 and 4 show that the principle for interleaving 5 kHz or 6.25 kHz channels with any interim 12.5 kHz channels is exactly the same as for 25 kHz. However, the final transition is made more complicated in the case of 5 kHz as the channel initially interleaved on the centre of the 25 kHz band would have to be moved by 2.5 kHz.

2.2.3 Interleaving with 25 kHz and 12.5 kHz channels

If some administrations were to move to 12.5 kHz channel spacing as an interim measure, and if the 12.5 kHz channels were interleaved with the 25 kHz channels, future migration to 5 kHz or 6.25 kHz channels would be significantly more complicated. As shown in Fig. 5, the 5 kHz or 6.25 kHz channel would overlap one or other of the wider bandwidth channels.

FIGURE 3

Migration from 12.5 kHz to 5 kHz channelling

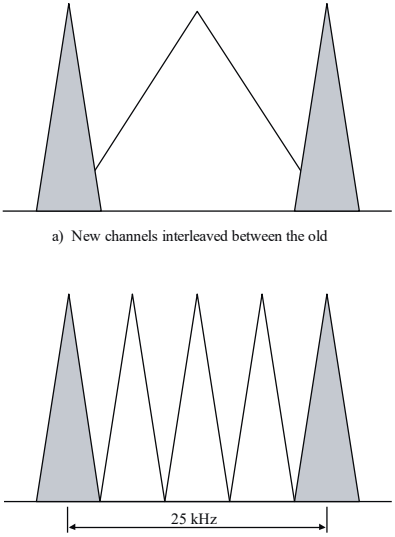


a) New channels interleaved between the old

b) All new channels after changeover

FIGURE 4

Migration from 12.5 kHz to 6.25 kHz channelling



a) New channels interleaved between the old

b) All new channels after changeover

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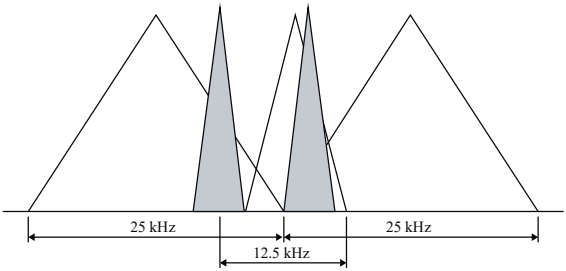
FIGURE 5

Inserting a new channel, 5 or 6.25 kHz, on top of 12.5 kHz channels already interleaved between 25 kHz channels, increases the overlap of transmissions. Two alternative cases are shown



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3 Interference

The interleaving process has to be done so as to minimize mutual interference. Some measurements of the interference and co-channel performance between interleaved linear modulation and 12.5 kHz FM have been made. No similar published information has been identified for narrow-band digital speech. It is however reasonable to assume that interleaving 5 kHz or 6.25 kHz channels between 25 kHz channels will lead to less interference and better co-channel performance than between 12.5 kHz channels.

4 Conclusions

The migration path to either 5 kHz or 6.25 kHz channels would be similar. However, a direct transition from 25 kHz rather than via an interim step of 12.5 kHz would be simpler in that:

– it would require less channel planning and realignment of centre frequencies;

– it would avoid channel overlap if 12.5 kHz channels were interleaved, as an interim measure, with 25 kHz ones; and

– the interference potential is likely to be less.

Clearly interleaving of channels will need to be carefully planned and the use of frequency planning tools will be important. Further field measurements and studies will be needed to provide the necessary information.

Annex 3

An example method for implementing interleaved narrow-band channels at 12.5 kHz offset spacing

This method could be used when 12.5 kHz operation is included along with digital selective-calling (DSC) operation (see Note 1) and 25 kHz in a single equipment.

NOTE 1 – DSC operation in this implementation is in full accordance with Recommendations ITU-R M.493, ITU-R M.541, ITU-R M.821 and ITU-R M.825.

1 Receiver performance

1.1 The sensitivity should be equal to or less than 0.3 μV for a 12 dB signal plus noise plus distortion to noise plus distortion (SINAD) ratio at the output of the receiver for a 1 kHz narrow band frequency modulation (NBFM) modulation tone at 2 kHz peak deviation.

1.2 Adjacent channel rejection should be at least 70 dB for a 12.5 kHz spaced adjacent channel.

1.3 The spurious response and out-of-band rejection ratio should be at least 75 dB.

1.4 The radio-frequency intermodulation rejection ratio should be at least 75 dB.

1.5 The power of any conducted spurious emission, measured at the antenna terminals, should not exceed 2.0 nW at any discrete frequency.

1.6 The effective radiated power (e.r.p.) of any cabinet radiated spurious emission on any frequency up to ±70 MHz removed from the carrier should not exceed 10 nW. More than 70 MHz removed from the carrier, the spurious emissions should not exceed 10 nW plus an additional –6 dB/octave in frequency up to 1 000 MHz.

1.7 For receivers with DSC and C4FM capability. C4FM (constant envelope four-level FM) digital modulation in this implementation is compatible with CQPSK (compatible quadrature phase-shift key) modulation for both transmission and reception.

1.7.1 For DSC operation on 25 kHz channels, the receiver must be capable of error-free reception of any DSC data packet at 0.3 μV.

1.7.2 For DSC operation on interleaved (12.5 kHz offset) channels, the receiver must be capable of error-free reception of a DSC data packet at 0.3 μV at a reduced maximum deviation of ±2.5 kHz.

1.7.3 For C4FM operation at 9 600 bit/s, the receiver must be capable of error-free reception of a data packet of 512 characters at 0.5 μV. Forward error correction (FEC) may be applied to accomplish the error-free reception.

2 Transmitter performance

2.1 The frequency tolerance for coast station transmitters should not exceed one part in 10^6 and that for ship station transmissions should not exceed five parts in 10^6.

2.2 Spurious emissions on discrete frequencies, when measured in a non-reactive load equal to the nominal output impedance of the transmitter, should be in accordance with the provisions of RR Appendix 3.

2.3 The carrier power for coast station transmitters should normally not exceed 50 W (e.r.p.).

2.4 The carrier power for ship stations transmitters should not exceed 25 W and means should be provided to readily reduce this to 1 W or less for use at short ranges.

2.5 The frequency deviation should not exceed ±2.5 kHz when transmitting on NBFM 12.5 kHz channels. The occupied bandwidth on these channels should not exceed 11 kHz. Deviation limiting circuits should be employed such that the maximum frequency deviation attainable should be independent of the input audio frequency. If a modulation switch is employed, ±5 kHz deviation should be allowed for use on the wideband frequency modulation (WBFM) 25 kHz channels.

2.6 The upper limit of the audio-frequency band should not exceed 3 kHz.

2.7 The cabinet radiated power should not exceed 25 μW.

2.8 Voice transmissions should be by means of standard maritime VHF FM with a 6 dB/octave pre-emphasis. This is necessary to ensure reliable, safe, interoperable communications on the high seas and in the waterways.

2.9 For transmitters with DSC and C4FM capability

2.9.1 Transmitters with DSC capability should comply with the requirements of Recommendations ITU-R M.493, ITU-R M.541, and IMO A.803 (19) with amendments by MSC.68(68) as a minimum. Stations should have provision for monitoring the VHF channel used for DSC purposes to determine the presence of a signal and, except for distress and safety calls, provide facilities for automatically preventing the transmission of a DSC call until the channel is free.

2.9.2 DSC (1 200 bit/s) operation should be used at all times when operating on channel 70. Channel 70 should not be used as a working channel for any purposes. This channel should be kept as an international distress and calling channel. Passing of data for all other purposes such as data messaging, security monitoring, vessel tracking, and automated dependent surveillance (ADS) should be accomplished on another working channel.

2.9.3 General purpose data transmission should be performed on both wideband 25 kHz channels and narrow-band interleaved (12.5 kHz offset) channels and should utilize the DSC protocol to the fullest extent practicable. Enhancements to the DSC protocol should be developed as needed and coordinated in order to maintain regulatory control and thus ensure interoperability between equipments from various manufacturers.

2.9.4 DSC (1 200 bit/s) operation on narrow-band interleaved (12.5 kHz offset) channels should be at a reduced maximum deviation of ±2.5 kHz.

2.9.5 High speed (9 600 bit/s) data transmissions should be performed using C4FM modulation with baseband filter shaping.

2.9.5.1 C4FM modulation on 12.5 kHz offset frequency channels

The C4FM modulator consists of a Nyquist raised cosine filter, cascaded with a shaping filter, cascaded with a frequency modulator.

2.9.5.2 C4FM Nyquist filter

The dibits of information (i.e., 4 800 symbols/s) are filtered with a raised cosine filter which satisfies the Nyquist criterion minimizing inter-symbol interference. The group delay of the filter is flat over the passband for $|f| < 2\,880$ Hz. The magnitude response of the filter is:

approximately 1	for	$|f| < 1\,920$ Hz
$0.5 + 0.5 \cos(2\pi f / 1\,920)$	for	$1\,920 \text{ Hz} < |f| < 2\,880$ Hz
0	for	$|f| \geq 2\,880$ Hz

2.9.5.3 C4FM shaping filter

The shaping filter has a flat group delay over the band-pass for $|f| < 2\,880$ Hz. The magnitude response of the filter for $|f| < 2\,880$ Hz is $(\pi f / 4\,800)/\sin(\pi f / 4\,800)$.

2.9.5.4 C4FM frequency modulator

The deviation is +1.8 kHz for dibit 01, +0.6 kHz for dibit 00, –0.6 kHz for dibit 10, and –1.8 kHz for dibit 11.

Annex 4

Assignment of channel numbers to interleaved channels and simplex operation of duplex channels in the VHF maritime band

1 For channel number assignments to interleaved narrow-band channels at 12.5 kHz offsets:

CHANNEL NUMBER			SHIP	SHIP & COAST	COAST
First 25 kHz Channel	Interleaved 12.5 kHz Channel	Second 25 kHz Channel			
		60	156.025		160.625
	260		156.0375		160.6375
01			156.050		160.650
	201		156.0625		160.6625
		61	156.075		160.675
	261		156.0875		160.6875
02			156.100		160.700
	202		156.1125		160.7125
		62	156.125		160.725
	262		156.1375		160.7375
03			156.150		160.750
	203		156.1625		160.7625
		63	156.175		160.775
	263		156.1875		160.7875
04			156.200		160.800
	204		156.2125		160.8125
		64	156.225		160.825
	264		156.2375		160.8375
05			156.250		160.850
	205		156.2625		160.8625
		65	156.275		160.875
	265		156.2875		160.8875
06				156.300	
	206		156.3125		160.9125
		66	156.325		160.925
	266		156.3375		160.9375
07			156.350		160.950
	207		156.3625		160.9625
		67		156.375	
	267			156.3875	
08				156.400	
	208			156.4125	
		68		156.425	
	268			156.4375	

CHANNEL NUMBER			SHIP	SHIP & COAST	COAST
First 25 kHz Channel	Interleaved 12.5 kHz Channel	Second 25 kHz Channel			
09				156.450	
	209			156.4625	
		69		156.475	
	269			156.4875	
10				156.500	
	210			156.5125	DSC Guardband
		70		156.525	**DSC Calling, distress & safety**
	270			156.5375	DSC Guardband
11				156.550	
	211			156.5625	
		71		156.575	
	271			156.5875	
12				156.600	
	212			156.6125	
		72		156.625	
	272			156.6375	
13				156.650	
	213			156.6625	
		73		156.675	
	273			156.6875	
14				156.700	
	214			156.7125	
		74		156.725	
	274			156.7375	
15				156.750	
	215			156.7625	
		75		156.775	Guardband
	275			156.7875	Guardband
16				**156.800**	**Calling, distress & safety**
	216			156.8125	Guardband
		76		156.825	Guardband
	276			156.8375	
17				156.850	
	217			156.8625	
		77		156.875	
	277			156.8875	
18			156.900		161.500
	218		156.9125		161.5125
		78	156.925		161.525
	278		156.9375		161.5375
19			156.950		161.550
	219		156.9625		161.5625

CHANNEL NUMBER			SHIP	SHIP & COAST	COAST
First 25 kHz Channel	Interleaved 12.5 kHz Channel	Second 25 kHz Channel			
		79	156.975		161.575
	279		156.9875		161.5875
20			157.000		161.600
	220		157.0125		161.6125
		80	157.025		161.625
	280		157.0375		161.6375
21			157.050		161.650
	221		157.0625		161.6625
		81	157.075		161.675
	281		157.0875		161.6875
22			157.100		161.700
	222		157.1125		161.7125
		82	157.125		161.725
	282		157.1375		161.7375
23			157.150		161.750
	223		157.1625		161.7625
		83	157.175		161.775
	283		157.1875		161.7875
24			157.200		161.800
	224		157.2125		161.8125
		84	157.225		161.825
	284		157.2375		161.8375
25			157.250		161.850
	225		157.2625		161.8625
		85	157.275		161.875
	285		157.2875		161.8875
26			157.300		161.900
	226		157.3125		161.9125
		86	157.325		161.925
	286		157.3375		161.9375
27			157.350		161.950
	227		157.3625		161.9625
		87	157.375		161.975
	287		158.3875		161.9875
28			157.400		162.000
	228		157.4125		162.0125
		88	157.425		162.025

2 Extension of channel number assignments for migration to 6.25 kHz channel spacing from the current 25 kHz channel spacing with interleaved 12.5 kHz offset frequencies channels: (This channel numbering sequence is provided as an example.)

CHANNEL No. (6.25 kHz spacing)	SHIP	SHIP & COAST	COAST
60	156.025		160.625
160	156.03125		160.63125
260	156.0375		160.6375
360	156.04375		160.64375
01	156.050		160.650
101	156.05625		160.65625
201	156.0625		160.6625
301	156.06875		160.66875
61	156.075		160.675

3 For channel number assignments to simplex operation of duplex channels: (This channel numbering sequence is provided as an example.)

CHANNEL No.	SHIP	SHIP & COAST	COAST
For normal duplex operation:			
60	156.025	–	160.625
For simplex operation of ship station frequency:			
1 060 (see Note 1)	–	156.025	–
For simplex operation of coast station frequency:			
2 060 (see Note 1)	–	160.625	–

NOTE 1 – This method of numbering a duplex channel used for simplex operation is in accordance with Recommendation ITU-R M.493.

4 For channel number assignments to narrow-band operation (12.5 kHz) on 25 kHz channels: (This channel numbering sequence is provided as an example.)

CHANNEL No.	SHIP	SHIP & COAST	COAST
For normal channel operation:			
60	156.025	–	160.625
For 12.5 kHz operation on 25 kHz channel:			
460	156.025	–	160.625

RECOMMENDATION ITU-R SM.1138-3

Determination of necessary bandwidths including examples for their calculation and associated examples forthe designation of emissions

(1995-2007-2008-2019)

Scope

This Recommendation serves as a basis for the determination of necessary bandwidths of emissions under amplitude, frequency and pulse modulation by various types of signals. Sample calculations and designation of emissions are also provided.

Keywords

Necessary bandwidth, automated spectrum management system, calculation

The ITU Radiocommunication Assembly,

considering

a) that the assignment of frequencies requires the determination of the necessary bandwidth of emissions;

b) that necessary bandwidth is a key data element of all automated spectrum-management systems,

recommends

that the formulae given in Annex 1 shall be used to calculate the necessary bandwidth when required by the Radio Regulations (RR).

Annex 1

Determination of necessary bandwidths, including examples for their calculation and associated examples for the designation of emissions

1 The necessary bandwidth is not the only characteristic of an emission to be considered in evaluating the interference that may be caused by that emission.

2 In the formulation of the table, the following terms have been employed:

B_n: necessary bandwidth (Hz)

B: modulation rate (Bd)

N: maximum possible number of black plus white elements to be transmitted per second, in facsimile

M: maximum modulation frequency (Hz)

C: sub-carrier frequency (Hz)

D: peak deviation, i.e. half the difference between the maximum and minimum values of the instantaneous frequency. The instantaneous frequency (Hz) is the time rate of change in phase (rad) divided by 2π

t: pulse duration (s) at half-amplitude

t_r: pulse rise time (s) between 10% and 90% amplitude

K: an overall numerical factor which varies according to the emission and which depends upon the allowable signal distortion. In the case of orthogonal frequency division multiplexed multi-carrier signal, K is the number of active sub-carriers as defined by equation (52) in Recommendation ITU-R SM.328

N_c: number of baseband channels in radio systems employing multichannel multiplexing

f_p: continuity pilot sub-carrier frequency (Hz) (continuous signal utilized to verify performance of frequency-division multiplex systems)

N_s: frequency separation between two sub-carriers (kHz).

Description of emission	Necessary bandwidth		Designation of emission
	Formula	Sample calculation	
I. NO MODULATING SIGNAL			
Continuous wave emission	–	–	NONE
II. AMPLITUDE MODULATION			
1. Signal with quantized or digital information			
Continuous wave telegraphy, Morse code	$B_n = BK$ $K = 5$ for fading circuits $K = 3$ for non-fading circuits	25 words per minute $B = 20$, $K = 5$ Bandwidth: 100 Hz	100HA1AAN
Telegraphy by on-off keying of a tone modulated carrier, Morse code	$B_n = BK + 2M$ $K = 5$ for fading circuits $K = 3$ for non-fading circuits	25 words per minute $B = 20$, $M = 1\,000$, $K = 5$ Bandwidth: 2 100 Hz = 2.1 kHz	2K10A2AAN
Selective calling signal using sequential single frequency code, single-sideband full carrier	$B_n = M$	Maximum code frequency is: 2 110 Hz $M = 2\,110$ Bandwidth: 2 110 Hz = 2.11 kHz	2K11H2BFN
Direct-printing telegraphy using a frequency shifted modulating sub-carrier, with error-correction, single-sideband, suppressed carrier (single channel)	$B_n = 2M + 2DK$ $M = \frac{B}{2}$	$B = 50$ $D = 35$ Hz (70 Hz shift) $K = 1.2$ Bandwidth: 134 Hz	134HJ2BCN
Telegraphy, multichannel with voice frequency, error-correction, some channels are time-division multiplexed, single-sideband, reduced carrier	B_n = highest central frequency + $M + DK$ $M = \frac{B}{2}$	15 channels; highest central frequency is: 2 805 Hz $B = 100$ $D = 42.5$ Hz (85 Hz shift) $K = 0.7$ Bandwidth: 2 885 Hz = 2.885 kHz	2K89R7BCW
2. Telephony (commercial quality)			
Telephony, double-sideband (single channel)	$B_n = 2M$	$M = 3\,000$ Bandwidth: 6 000 Hz = 6 kHz	6K00A3EJN
Telephony, single-sideband, full carrier (single channel)	$B_n = M$	$M = 3\,000$ Bandwidth: 3 000 Hz = 3 kHz	3K00H3EJN
Telephony, single-sideband, suppressed carrier (single channel)	$B_n = M$ – lowest modulation frequency	$M = 3\,000$ lowest modulation frequency = 300 Hz Bandwidth: 2 700 Hz = 2.7 kHz	2K70J3EJN

Description of emission	Necessary bandwidth		Designation of emission
	Formula	Sample calculation	
2. Telephony (commercial quality) (*cont.*)			
Telephony with separate frequency modulated signal to control the level of demodulated speech signal, single-sideband, reduced carrier (Lincompex) (single channel)	$B_n = M$	Maximum control frequency = 2 990 Hz M = 2 990 Bandwidth: 2 990 Hz = 2.99 kHz	2K99R3ELN
Telephony with privacy, single-sideband, suppressed carrier (two or more channels)	$B_n = N_c M$ – lowest modulation frequency in the lowest channel	$N_c = 2$ M = 3 000 lowest modulation frequency = 250 Hz Bandwidth: 5 750 Hz = 5.75 kHz	5K75J8EKF
Telephony, independent sideband (two or more channels)	B_n = sum of M for each sideband	2 channels M = 3 000 Bandwidth: 6 000 Hz = 6 kHz	6K00B8EJN
3. Sound broadcasting			
Sound broadcasting, double-sideband	$B_n = 2M$ M may vary between 4 000 and 10 000 depending on the quality desired	Speech and music M = 4 000 Bandwidth: 8 000 Hz = 8 kHz	8K00A3EGN
Sound broadcasting, single-sideband, reduced carrier (single channel)	$B_n = M$ M may vary between 4 000 and 10 000 depending on the quality desired	Speech and music M = 4 000 Bandwidth: 4 000 Hz = 4 kHz	4K00R3EGN
Sound broadcasting, single-sideband, suppressed carrier	$B_n = M$ – lowest modulation frequency	Speech and music M = 4 500 lowest modulation frequency = 50 Hz Bandwidth: 4 450 Hz = 4.45 kHz	4K45J3EGN
4. Television			
Television, vision and sound	Refer to relevant ITU-R documents for the bandwidths of the commonly used television systems	Number of lines: 625 Nominal video bandwidth = 5 MHz Sound carrier relative to video carrier: 5.5 MHz Total vision Bandwidth: 6.25 MHz FM sound bandwidth including guardbands: 750 kHz RF channel Bandwidth: 7 MHz	6M25C3F -- 750KF3EGN
5. Facsimile			
Analogue facsimile by sub-carrier frequency modulation of a single-sideband emission with reduced carrier, monochrome	$B_n = C + \frac{N}{2} + DK$ $K = 1.1$ (typically)	N = 1 100 corresponding to an index of cooperation of 352 and a cycler rotation speed of 60 rpm. Index of cooperation is the product of the drum diameter and number of lines per unit length. C = 1 900 D = 400 Hz Bandwidth: 2 890 Hz = 2.89 kHz	2K89R3CMN
Analogue facsimile; frequency modulation of an audio frequency sub-carrier which modulates the main carrier, single-sideband suppressed carrier	$B_n = 2M + 2DK$ $M = \frac{N}{2}$ $K = 1.1$ (typically)	N = 1 100 D = 400 Hz Bandwidth: 1 980 Hz = 1.98 kHz	1K98J3C --

Description of emission	Necessary bandwidth		Designation of emission
	Formula	Sample calculation	
6. Composite emissions			
Double-sideband, television relay	$B_n = 2C + 2M + 2D$	Video limited to 5 MHz, audio on 6.5 MHz, frequency modulated sub-carrier, sub-carrier deviation = 50 kHz: $C = 6.5 \times 10^6$ $D = 50 \times 10^3$ Hz $M = 15\ 000$ Bandwidth: 13.13×10^6 Hz = 13.13 MHz	13M1A8W --
Double-sideband radio-relay system, frequency division multiplex	$B_n = 2M$	10 voice channels occupying baseband between 1 kHz and 164 kHz $M = 164\ 000$ Bandwidth: 328 000 Hz = 328 kHz	328KA8E --
Double-sideband emission of VOR with voice (VOR: VHF omnidirectional radio range)	$B_n = 2C_{max} + 2M + 2DK$ $K = 1$ (typically)	The main carrier is modulated by: – a 30 Hz sub-carrier – a carrier resulting from a 9 960 Hz tone – a telephone channel – a 1 020 Hz keyed tone for continual Morse identification $C_{max} = 9\ 960$ $M = 30$ $D = 480$ Hz Bandwidth: 20 940 Hz = 20.94 kHz	20K9A9WWF
Independent sidebands; several telegraph channels with error-correction together with several telephone channels with privacy; frequency division multiplex	B_n = sum of M for each sideband	Normally composite systems are operated in accordance with standardized channel arrangements (e.g. Rec. ITU-R F.348). 3 telephone channels and 15 telegraphy channels require the bandwidth: 12 000 Hz = 12 kHz	12K0B9WWF
7. Standard frequency and time signals 7.1 High frequency (voice)			
Voice announcements, double-sideband	$B_n = 2M$	Speech $M = 4\ 000$ Bandwidth: 8 000 Hz = 8 kHz	8K00A3XGN
7.2. High frequency (time code)			
Time code as telegraphy	$B_n = BK + 2M$	$B = 1$/s $M = 1$ $K = 5$ Bandwidth: 7 Hz	7H00A2XAN
7.3. Low frequency (time code)			
Time code as telegraphy	$B_n = BK + 2M$	$B = 1$/s $M = 1$ $K = 3$ Bandwidth: 5 Hz	5H00A2XAN

Description of emission	Necessary bandwidth		Designation of emission
	Formula	Sample calculation	
III-A. FREQUENCY MODULATION			
1. Signal with quantized or digital information			
Telegraphy without error-correction (single channel)	$B_n = 2M + 2DK$ $M = \frac{B}{2}$ $K = 1.2$ (typically)	$B = 100$ $D = 85$ Hz (170 Hz shift) Bandwidth: 304 Hz	304HF1BBN
Telegraphy, narrow-band direct-printing with error-correction (single channel)	$B_n = 2M + 2DK$ $M = \frac{B}{2}$ $K = 1.2$ (typically)	$B = 100$ $D = 85$ Hz (170 Hz shift) Bandwidth: 304 Hz	304HF1BCN
Selective calling signal	$B_n = 2M + 2DK$ $M = \frac{B}{2}$ $K = 1.2$ (typically)	$B = 100$ $D = 85$ Hz (170 Hz shift) Bandwidth: 304 Hz	304HF1BCN
Four-frequency duplex telegraphy	$B_n = 2M + 2DK$ B: modulation rate (Bd) of the faster channel. If the channels are synchronized: $M = \frac{B}{2}$ (otherwise, $M = 2B$) $K = 1.1$ (typically)	Spacing between adjacent frequencies = 400 Hz Synchronized channels $B = 100$ $M = 50$ $D = 600$ Hz Bandwidth: 1 420 Hz = 1.42 kHz	1K42F7BDX
2. Telephony (commercial quality)			
Commercial telephony	$B_n = 2M + 2DK$ $K = 1$ (typically, but under certain conditions a higher value of K may be necessary)	For an average case of commercial telephony, $D = 5\,000$ Hz $M = 3\,000$ Bandwidth: 16 000 Hz = 16 kHz	16K0F3EJN
3. Sound broadcasting			
Sound broadcasting	$B_n = 2M + 2DK$ $K = 1$ (typically)	Monaural $D = 75\,000$ Hz $M = 15\,000$ Bandwidth: 180 000 Hz = 180 kHz	180KF3EGN
4. Facsimile			
Facsimile by direct frequency modulation of the carrier; black and white	$B_n = 2M + 2DK$ $M = \frac{N}{2}$ $K = 1.1$ (typically)	$N = 1\,100$ elements/s $D = 400$ Hz Bandwidth: 1 980 Hz = 1.98 kHz	1K98F1C --
Analogue facsimile	$B_n = 2M + 2DK$ $M = \frac{N}{2}$ $K = 1.1$ (typically)	$N = 1\,100$ elements/s $D = 400$ Hz Bandwidth: 1 980 Hz = 1.98 kHz	1K98F3C --

Description of emission	Necessary bandwidth		Designation of emission
	Formula	Sample calculation	
5. Composite emissions (see Table III-B)			
Radio-relay system, frequency division multiplex	$B_n = 2f_p + 2DK$ $K = 1$ (typically)	60 telephone channels occupying baseband between 60 kHz and 300 kHz; rms per-channel deviation: 200 kHz; continuity pilot at 331 kHz produces 100 kHz rms deviation of main carrier. $D = 200 \times 10^3 \times 3.76 \times 2.02$ $= 1.52 \times 10^6$ Hz $f_p = 0.331 \times 10^6$ Hz Bandwidth: 3.702×10^6 Hz $= 3.702$ MHz	3M70F8EJF
Radio-relay system, frequency division multiplex	$B_n = 2M + 2DK$ $K = 1$ (typically)	960 telephone channels occupying baseband between 60 kHz and 4 028 kHz; rms per-channel deviation: 200 kHz; continuity pilot at 4 715 kHz produces 140 kHz rms deviation of main carrier. $D = 200 \times 10^3 \times 3.76 \times 5.5$ $= 4.13 \times 10^6$ Hz $M = 4.028 \times 10^6$ $f_p = 4.715 \times 10^6$ $(2M + 2DK) > 2 f_p$ Bandwidth: 16.32×10^6 Hz = 16.32 MHz	16M3F8EJF
Radio-relay system, frequency division multiplex	$B_n = 2f_p$	600 telephone channels occupying baseband between 60 kHz and 2 540 kHz; rms per-channel deviation: 200 kHz; continuity pilot at 8 500 kHz produces 140 kHz rms deviation of main carrier. $D = 200 \times 10^3 \times 3.76 \times 4.36$ $= 3.28 \times 10^6$ Hz $M = 2.54 \times 10^6$ $K = 1$ $f_p = 8.5 \times 10^6$ $(2M + 2DK) < 2 f_p$ Bandwidth: 17×10^6 Hz = 17 MHz	17M0F8EJF
Stereophonic sound broadcasting with multiplexed subsidiary telephony sub-carrier	$B_n = 2M + 2DK$ $K = 1$ (typically)	Pilot tone system; $M = 75\ 000$ $D = 75\ 000$ Hz Bandwidth: 300 000 Hz = 300 kHz	300KF8EHF

III-B. MULTIPLYING FACTORS FOR USE IN COMPUTING *D*, PEAK FREQUENCY DEVIATION, IN FM FREQUENCY DIVISION MULTIPLEX (FM-FDM) MULTI-CHANNEL EMISSSIONS	
For FM-FDM systems the necessary bandwidth is: $$B_n = 2M + 2DK$$ The value of D, or peak frequency deviation, in these formulae for B_n is calculated by multiplying the rms value of per-channel deviation by the appropriate "multiplying factor" shown below. In the case where a continuity pilot of frequency f_p exists above the maximum modulation frequency M, the general formula becomes: $$B_n = 2f_p + 2DK$$ In the case where the modulation index of the main carrier produced by the pilot is less than 0.25, and the rms frequency deviation of the main carrier produced by the pilot is less than or equal to 70% of the rms value of per-channel deviation, the general formula becomes either: $$B_n = 2f_p \quad \text{or} \quad B_n = 2M + 2DK$$ whichever if greater.	
Number of telephone channels N_c	Multiplying factor[1]
	$(\text{Peak factor}) \times \text{antilog}\left[\frac{\text{value in dB above modulation reference level}}{20}\right]$
$3 < N_c < 12$	$4.47 \times \text{antilog}\left[\frac{\text{a value in dB specified by the equipment manufacturer or station licensee, subject to administration approval}}{20}\right]$
$12 \le N_c < 60$	$3.76 \times \text{antilog}\left[\frac{2.6 + 2\log N_c}{20}\right]$
	Multiplying factor[2]
Number of telephone channels N_c	$(\text{Peak factor}) \times \text{antilog}\left[\frac{\text{value in dB above modulation reference level}}{20}\right]$
$60 \le N_c < 240$	$3.76 \times \text{antilog}\left[\frac{-1 + 4\log N_c}{20}\right]$
$N_c \ge 240$	$3.76 \times \text{antilog}\left[\frac{-15 + 10\log N_c}{20}\right]$

(1) In the above chart, the multipliers 3.76 and 4.47 correspond to peak factors of 11.5 and 13.0 dB, respectively.

(2) In the above chart, the multipliers 3.76 correspond to peak factors of 11.5 dB.

Description of emission	Necessary bandwidth		Designation of emission
	Formula	Sample calculation	
IV. PULSE MODULATION			
1. Radar			
Unmodulated pulse emission	$B_n = \frac{2K}{t}$ K depends upon the ratio of pulse duration to pulse rise time. Its value usually falls between 1 and 10 and in many cases it does not need to exceed 6	Primary radar range resolution = 150 m $K = 1.5$ (triangular pulse where $t \simeq t_r$, only components down to 27 dB from the strongest are considered) Then: $t = \left[\frac{2 \times (\text{range resolution})}{\text{velocity of light}}\right]$ $= \frac{2 \times 150}{3 \times 10^8}$ $= 1 \times 10^{-6}$ s Bandwidth: 3×10^6 Hz = 3 MHz	3M00P0NAN
2. Composite emissions			
Radio-relay system	$B_n = \frac{2K}{t}$ $K = 1.6$	Pulse position modulated by 36 voice channel baseband; pulse width at half amplitude = 0.4 µs Bandwidth: 8×10^6 Hz = 8 MHz (Bandwidth independent of the number of voice channels)	8M00M7EJT
3. Standard frequency and time signals 3.1 High frequency (tone bursts)			
Ticks used for epoch measurement	$B_n = 2/t_r$	$t_r = 1$ ms Bandwidth: 2 000 Hz = 2 kHz	2K00K2XAN
3.2 Low frequency (time code)			
Time code leading edge used for epoch measurement	$B_n = 2/t_r$	$t_r = 1$ ms Bandwidth = 2 000 Hz = 2 kHz	2K00K2XAN
V. MISCELLANEOUS			
Orthogonal frequency division multiplexing (OFDM) or coded OFDM (COFDM)	$B_n = N_s \cdot K$	53 active sub-carriers are used, each spaced 312.5 kHz apart ($K = 53$ and $N_s = 312.5$ kHz). Data sub-carriers can be BPSK, QPSK, QAM modulated $B_n = 312.5$ kHz × 53 = 16.6 MHz	16M6W7D

RECOMMENDATION ITU-R SA.1154-0*,**

Provisions to protect the space research (SR), space operations (SO) and Earth exploration-satellite services (EES) and to facilitate sharing with the mobile service in the 2 025-2 110 MHz and 2 200-2 290 MHz bands

(1995)

The ITU Radiocommunication Assembly,

considering

a) that the bands 2 025-2 110 MHz and 2 200-2 290 MHz are allocated on a primary basis to three of the space science services (SR, SO, EES), the fixed service (FS) and the mobile service (MS) subject to the provisions of Nos. 5.391 and 5.392 of the Radio Regulations (RR);

b) that the World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (Malaga-Torremolinos, 1992) (WARC-92), in its Resolution No. 211, invites the ex-CCIR to continue to study appropriate provisions to protect the space science services operating in the bands 2 025-2 110 MHz and 2 200-2 290 MHz from harmful interference from emissions by stations of the mobile service and to report the results of studies to the next competent conference;

c) that there is an increasing use of SR, SO and EES services in these frequency bands by space stations in low-Earth orbit (LEO);

d) that the introduction of future high density or conventional land mobile systems in the 2 025-2 110 MHz and 2 200-2 290 MHz bands would cause unacceptable interference to the SR, SO and EES services; for further information see Annex 1;

e) that studies indicate that specific low density mobile systems, such as those described in Annex 2, could share the 2 025-2 110 MHz and 2 200-2 290 MHz bands with the SR, SO and EES services;

f) that in some countries the space science services have successfully shared for many years with low density mobile electronic news gathering (ENG) systems (see Annex 3) and aeronautical mobile telemetry systems (see Annex 4) without restrictions, however, restrictions may be needed in the future considering the expected growth rate of these systems;

g) that space science service operations in the band 2 200-2 290 MHz are more vulnerable to interference than operations in the band 2 025-2 110 MHz because of high gain antennas of geostationary data relay satellite (DRS) spacecraft pointing towards the Earth when tracking a low-Earth orbiting spacecraft;

h) that the protection criteria required for the SR service are the most stringent of the three space science services and provide adequate protection for the SR, SO and EES services;

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* This Recommendation should be brought to the attention of Radiocommunication Study Groups 4, 8 and 9.

** Radiocommunication Study Group 7 made editorial amendments to this Recommendation in 2003 in accordance with Resolution ITU-R 44.

j) that Recommendation ITU-R SA.609 (§ 1, 1.1, 1.2 and 2) specifies the protection criteria for the SR service;

k) that the protection criteria of Recommendation ITU-R SA.609 have been used repeatedly in sharing studies and are widely recognized;

l) that SR, SO and EES services use the 2 025-2 110 MHz and 2 200-2 290 MHz bands for Earth-to-space, space-to-Earth and space-to-space radiocommunications. The space-to-space links typically include the use of a DRS as described in the hypothetical reference system in Recommendations ITU-R SA.1020 and ITU-R SA.1018. The sharing criteria should consider the protection requirements of DRS radiocommunication links operating in the 2 025-2 110 MHz and 2 200-2 290 MHz bands;

m) that for the protection of SR, SO and EES services, Earth-to-space and space-to-Earth links, a *N*/*I* of 6 dB, resulting in a 1 dB degradation is considered sufficient in most cases;

n) that, taking into account the typically low margins on space-to-space links of 2 dB and less, a *N*/*I* of 10 dB, resulting in a 0.4 dB degradation is considered necessary for DRS space-to-space links;

o) that the bands under consideration are shared with the FS and the MS. Each service is assumed to contribute half of the total interference to the spacecraft. Due to expected coordination only one of the services is assumed to interfere with an earth station;

p) that DRS spacecraft are typically located on the geostationary orbit (GSO);

q) that the 2 025-2 110 MHz band is used for SR, SO and EES Earth-to-space links to both low-Earth orbiting and GSO spacecraft. This band is also used for SR, SO and ESS space-to-space links, typically for radiocommunications from DRS spacecraft to low-Earth orbiting spacecraft;

r) that the 2 200-2 290 MHz band is used for SR, SO and EES space-to-Earth links from both low-Earth orbiting and GSO spacecraft. This band is also used for SR, SO and EES space-to-space links, typically for radiocommunications from low-Earth orbiting spacecraft to DRS spacecraft;

s) that terms concerning the density mobile systems refer to the number of systems and the population distribution of systems,

recognizing

1 that specifying a maximum number of mobile stations worldwide operating in the 2 025-2 110 MHz and 2 200-2 290 MHz bands such that the aggregate interference level does not exceed the sharing criteria may constitute a valid technical solution. However, the implementation of such a solution may not be practical,

further recognizing

1 that it is a unique combination of technical and operational characteristics of specific mobile systems that facilitate sharing, and sharing between such mobile systems and the SR, SO and EES services can be described in both qualitative and quantitative terms,

recommends

1 that the following provisions are suitable to protect the SR, SO and EES services from aggregate interference from emissions of mobile systems in the 2 025-2 110 MHz band:

1.1 that the aggregate interference at the input terminals of the spacecraft receiver, except in the case of a space-to-space link, should not exceed –180 dB(W/kHz) for more than 0.1% of the time;

1.2 that in the case of space-to-space links the aggregate interference at the input terminals of the spacecraft receiver should not exceed –184 dB(W/kHz) for more than 0.1% of the time;

2 that the following provisions are suitable to protect the SR, SO and EES services from aggregate interference from emissions of mobile systems in the 2 200-2 290 MHz band:

2.1 that the aggregate interference at the input terminals of the receiver in the earth station should not exceed –216 dB(W/Hz) for more than 0.1% of the time;

2.2 that the aggregate interference at the input terminals of the DRS spacecraft receiver should not exceed –184 dB(W/kHz) for more than 0.1% of the time;

3 that high density or conventional type mobile systems should not be introduced in the 2 025-2 110 MHz and 2 200-2 290 MHz bands, because they will cause unacceptable interference in the SR, SO and EES services as confirmed in Annex 1;

4 that new mobile systems should be introduced in such a way that their long term, worldwide deployment would not cause aggregate interference levels in excess of the values given in § 1 and 2;

5 that technical and operational parameters such as low power spectral densities, low worldwide population densities and intermittent transmissions (see Annex 2) be preferred for the introduction of new mobile systems;

6 that during the consideration of new low density mobile systems for introduction in the 2 025-2 110 MHz band, technical and operational characteristics, similar to those described in Annex 3, should be used for guidance;

7 that during the consideration of new low density mobile systems for introduction in the 2 200-2 290 MHz band, technical and operational characteristics, similar to those described in Annex 4, should be used for guidance.

Annex 1

Compatibility study of space research/space operations and high density land mobile systems

1 Introduction

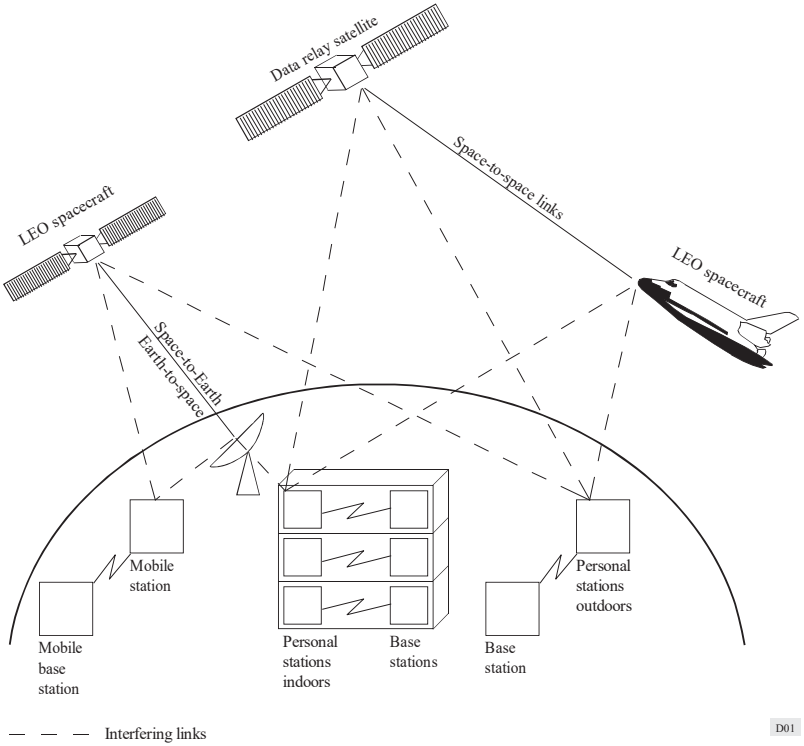
Sharing between high density and conventional land mobile systems on the one hand and space services on the other hand is not feasible. This Annex is based on contributions which lead to this conclusion and provides the underlying analysis. The mobile system considered in this study is the future public land mobile telecommunication system (FPLMTS). The model used is also applicable to conventional type mobile systems.

The bands 2 025-2 110 GHz and 2 200-2 290 MHz are intensively used for space operations, Earth exploration by satellite, and space research on a worldwide basis with numerous agreements for international cross-support among space agencies. Due to the long distances between transmitters and receivers, signal levels at the receivers are very low. Consequently these services are very sensitive to interference requiring high protection levels as specified in the RR and ITU-R Recommendations.

Figure 1 shows the various links considered and the resulting interference configurations. Only voice services are considered for the personal and mobile stations. Additional interference from base stations has not been studied yet.

FIGURE 1

Interference configurations between FPLMTS units and space services



At present it is already a challenge for frequency managers to satisfy new assignment requests for the currently allocated space services in such a way as to minimize interference impacts on existing assignments. Consequently, intra-service sharing with additional users becomes increasingly difficult.

In the case of mobile services antenna patterns are quasi omnidirectional and the envisaged tens of millions of mobile transmitters have a very high cumulative interference level. As FPLMTS units are "mobile" by definition, coordination is not possible for obvious reasons. It can be demonstrated that for practically every configuration considered, sharing with these mobile systems is not feasible.

2 Radio regulatory and band occupation aspects

The 2 025-2 110 MHz and 2 200-2 290 MHz bands are allocated on a co-primary basis to the SR, SO and EES and the mobile service in all ITU regions.

Maximum tolerable interference levels for earth stations are defined in Appendix 7 to the RR, Table 8b and in Recommendations ITU-R SA.363 and ITU-R SA.609. Antenna diagrams for earth stations are based on the radiation patterns specified in Appendix 8 to the RR, Annex III. The minimum elevation angles for earth station antennas are in agreement with RR No. 21.15 and RR No. 21.14. Interference levels for spacecraft receivers are specified in Recommendations ITU-R SA.609 and ITU-R SA.363.

In the band 2 025-2 110 MHz there are currently more than 300 assignments. In the band 2 200-2 290 MHz the number of assignments is above 350. For the space-to-space links there are currently six allocations for the data relay system with a number of additional ones in progress for the international space station programme as well as for the European and the Japanese data relay satellite programmes.

It is apparent that the bands under consideration are heavily used by space services and that a large number of satellites and earth stations would be affected by land mobile services operating in these frequency bands.

3 Land mobile services (FPLMTS) system assumptions

A wide range of services is foreseen for future mobile communication systems. One of the services envisaged for operation in the bands near 2 GHz is the future public land mobile telecommunication system (FPLMTS). The designated bandwidth for these services is 230 MHz.

The FPLMTS is in the planning stage with preliminary figures on subscriber rates, traffic densities, and power levels. Radiocommunication Study Group 8 provided relatively detailed assumptions on power levels, bandwidth requirements, traffic density, etc. A summary of system assumptions provided is listed in Table 1.

TABLE 1

Summary of system assumptions

	Mobile station outdoor	Personal station outdoor	Personal station Indoor
Base station antenna height (m)	50	< 10	< 3
Traffic density urban area (E/km^2)	500 (0.25)	1 500 (1.2)	20 000 (1.2)
Cell area (km^2)	0.94	0.016	0.0006
Duplex bandwidth per channel (kHz)	25	50	50
Traffic per cell (E)	470	24	12
Number of channels per cell	493	34	23
Bandwidth for voice services (MHz)	111	27	24
Station power range (W)	1-5	0.02-0.05	0.003-0.01
Speech coding rate (kbit/s)	8	(16)	(16)
Peak-to-mean ratio for traffic	(3)	3	(3)
Peak traffic density per station (E)	0.1 (0.04)	0.04 (0.1)	0.2 (0.1)
Subscriber rate (penetration) (%)	50 (10)	80 (20)	(20)

In some cases it was found that for an average interference assessment the FPLMTS assumptions were too optimistic, in particular regarding traffic density and subscriber rate. Values quoted between brackets have been used instead. With the original FPLMTS data the interference excess values would be higher. Where no data were available the numbers between brackets have been used for the calculations.

Only the voice services have been taken into account but it is expected that non-voice services will result in very similar values.

The traffic density assumptions for the analyses are based upon figures available for Europe. The population in all common market countries is currently around 323 million living in an area of 2.3 million km^2. This leads to an average of 140 people per km^2 used as a basis for interference calculation to earth stations.

The traffic density assumptions for the interference scenario for spacecraft receivers can be derived in a similar way. A geostationary spacecraft “sees” an area as indicated in Fig. 3 with approximately 4 billion people living in it by the year 2000. The minimum orbit height of a spacecraft is 250 km. Figure 4 shows the area seen by a spacecraft flying at orbit heights of 250 km and 750 km, respectively. The interference reception area for a 250 km orbit is already 9.6 million m^2. The population living in this area is estimated to more than 600 million people. Figure 5 shows interference reception areas for low inclination orbits around 29° which are typical for space shuttle type orbits.

Environmental attenuation for transmission paths through windows, walls, ceilings, buildings and trees have been taken into account for all FPLMTS services. Typical attenuation figures are assumed to be; for windows (6.6 dB), walls and ceilings (27 dB). It was assumed that the signal of most but not all indoor personal units would be attenuated. There will remain a small percentage of

terminals which will radiate through open windows, on balconies, terraces or other "open" locations. For this study it was assumed that the signal from around 5% of the units is hardly attenuated and from 25% of units attenuated by glass. The interference from the remaining 70% of units was considered insignificant. An average attenuation of 10 dB has consequently been taken into account for indoor personal units. The signals from outdoor personal units and mobile units will only be attenuated if the signal is going through buildings and trees. This is often the case for low elevation angles but less significant for higher angles. Considering that the main interference comes from units close to the subsatellite point, which means high elevation angles, an average attenuation of not more than 3 dB is expected.

The interference caused by base stations has not been studied in this paper as sufficient technical information was not available. It is evident that the same order of magnitude must be expected in addition.

4 Protection requirements for space services

4.1 Protection requirements for earth stations

The maximum interference levels at the earth station receivers depend on the service in operation and are in agreement with Appendix 7 to the RR, Table 8b and Recommendation ITU-R SA.363. These values and the corresponding minimum elevation angles Θ_r are as follows:

1. Space operation: –184.0 dB(W/kHz), $\Theta_r = 3°$

2. Space Research: –216.0 dB(W/Hz), $\Theta_r = 5°$

For typical support of SO and Space Research missions, antennas with a diameter between 5.5 and 15 m are in operation for general support up to and beyond the geostationary orbit. Figure 2 shows antenna gain characteristics for the stations considered. The radiation patterns are based on Appendix 8 to the RR, Annex III.

4.2 Protection requirements for spacecraft receivers

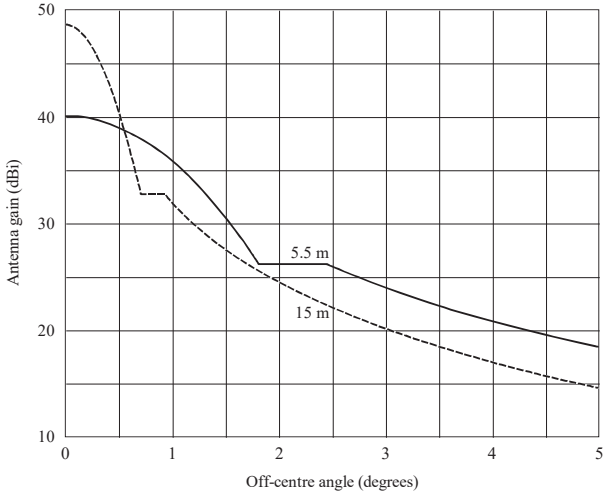
Typical system noise temperatures of spacecraft receivers range around 800 K resulting in a noise spectral density of around –200 dB(W/Hz). Some critical space research missions require noise temperatures down to 600 K.

Recommendation ITU-R SA.609 specifies that interference shall not exceed a value of –177 dB(W/kHz) at the input terminals of the receiver for more than 0.1% of time. With fixed, mobile and space services in this band, each service is assumed to contribute one third of the total interference. This results in –182 dB(W/kHz) equivalent to –212 dB(W/Hz) acceptable interference contribution from mobile services. This number fits well with the protection criteria in *recommends* 1.1, 1.2 and 2.2.

The average gain of a quasi omnidirectional antenna is around 0 dBi with gain minima exceeding occasionally –6 dBi. Such an antenna is required to establish a link to the spacecraft in emergency cases or when other antennas cannot be used for technical or operational reasons, for instance during launch and early orbit phases. This applies also to communication satellites. With a 0 dBi antenna the acceptable interference from mobile units at the antenna input is consequently –212 dB(W/Hz).

FIGURE 2

Typical antenna characteristics for satellite earth stations



Frequency = 2.25 GHz
G_{min} = – 6 and – 10 dBi

D02

The situation is more severe for a space-to-space link where, for example, a data relay satellite points a high gain antenna to a low-Earth orbiting satellite. Applying the same assumptions as above but taking a typical antenna gain of 35 dBi the acceptable interference level is consequently –247 dB(W/Hz) at the input of the antenna.

Recommendation ITU-R SA.363 specifies a C/I protection ratio of 20 dB for space operations. In recent years many space agencies have introduced channel coding techniques in order to conserve transmitter power and consequently also reduce interference to other systems. Two cases, i.e. uncoded and coded transmissions, have to be distinguished:

– Uncoded transmissions require an E_s/N_0 of 9.6 dB for a bit-error rate of 10^{-5}. Adding a typical margin of 3 dB results in a required C/N of 12.6 dB. The total interference-to-noise ratio I/N is consequently –7.4 dB. Allowing one third of the total interference for mobile services leads to an I_m/N of –12.4 dB. For a typical noise power density of –200 dB(W/Hz) the acceptable interference is –212.4 dB(W/Hz).

– Coded transmissions require an E_s/N_0 of 1.5 dB for a bit-error rate of 10^{-5} with standard convolutional channel coding. Adding a typical margin of 3 dB results in a required C/N of 4.5 dB. The I/N is consequently –15.5 dB. Allowing one third of the total interference for mobile services leads to an I_m/N of –20.5 dB. For a noise power density of –200 dB(W/Hz) the acceptable interference is –217.5 dB(W/Hz), that is 5 dB lower than the protection value of Recommendation ITU-R SA.609.

Although coded transmissions require higher protection levels, for this study a protection criterion of –212 dB(W/Hz) has been adopted as it is consistent with values specified in Recommendations ITU-R SA.609 and ITU-R SA.363.

5 Interference analysis

5.1 Earth-to-space link (2 025-2 110 MHz)

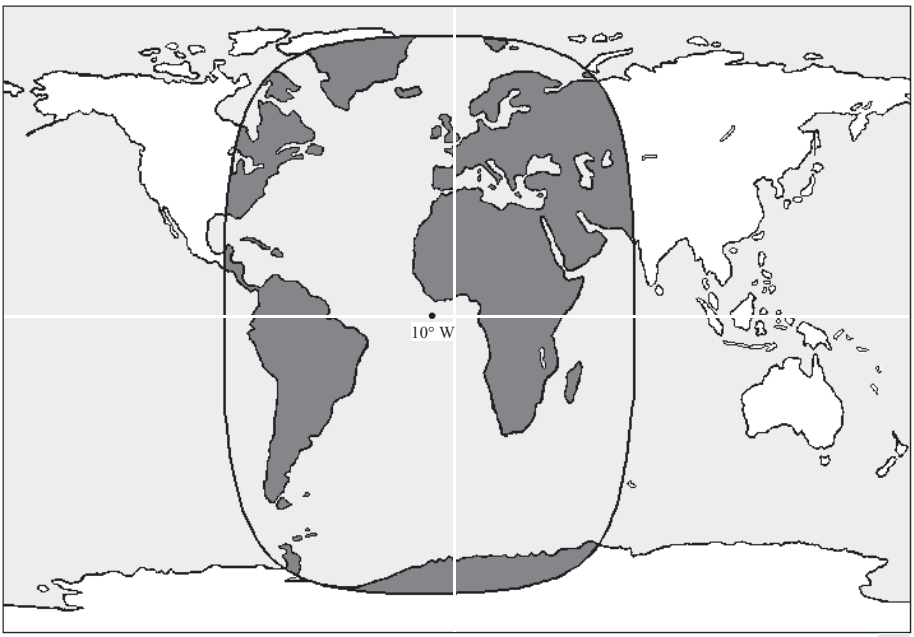
5.1.1 Interference caused to the spacecraft

Earth-to-space links considered in this analysis are based on orbit heights between 250 and 36 000 km as more than 90% of all spacecraft are operated at or below the geostationary orbit.

Figure 3 shows the area from which a geostationary spacecraft will receive signals via a quasi omnidirectional antenna. The arbitrarily selected position of the spacecraft is 10° W. It is estimated that in the worst case the spacecraft can see an area where more than 70% of all mobile terminals on the Earth are located.

FIGURE 3

Interference reception area for geostationary satellites



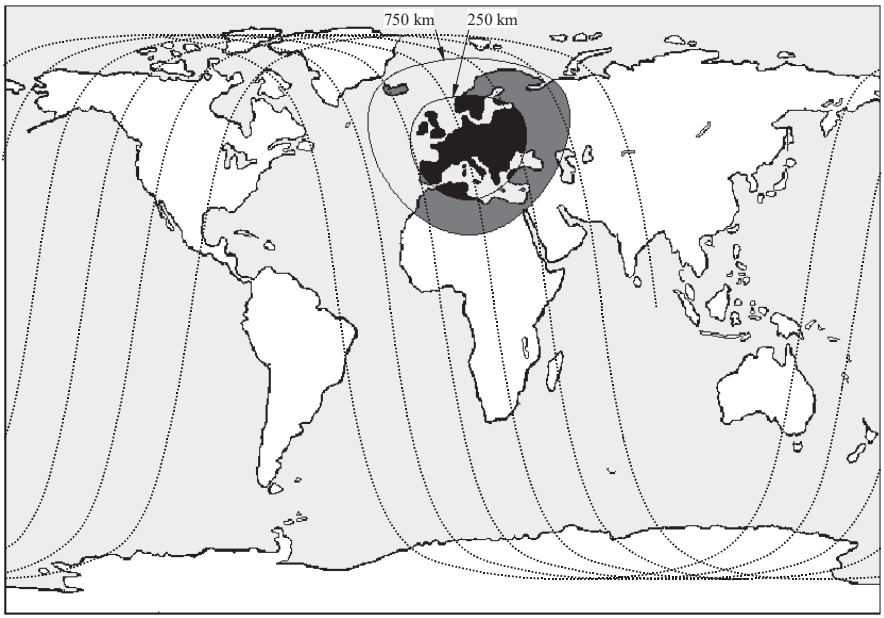
D03

Figure 4 shows the area from which a low-Earth orbiting satellite at orbit heights between 250 and 750 km will receive signals. The position of the spacecraft has in this case been assumed to be above the middle of Europe. The resulting "window" will move along the ground track given in dotted lines. It is apparent that a very large area with potentially millions of transmitting mobiles can be seen by the spacecraft.

Figure 5 shows the total area from which space shuttle type spacecraft with a typical inclination of 29° will receive interference.

FIGURE 4

Interference reception area for low-Earth orbiters (i = 98°)



D04

The area of interference A_i is determined by:

$$A_i = \frac{2\pi R^2 h}{R + h}$$

where:

R: Earth radius (6 378 km)

h: orbit height (250 to 36 000 km).

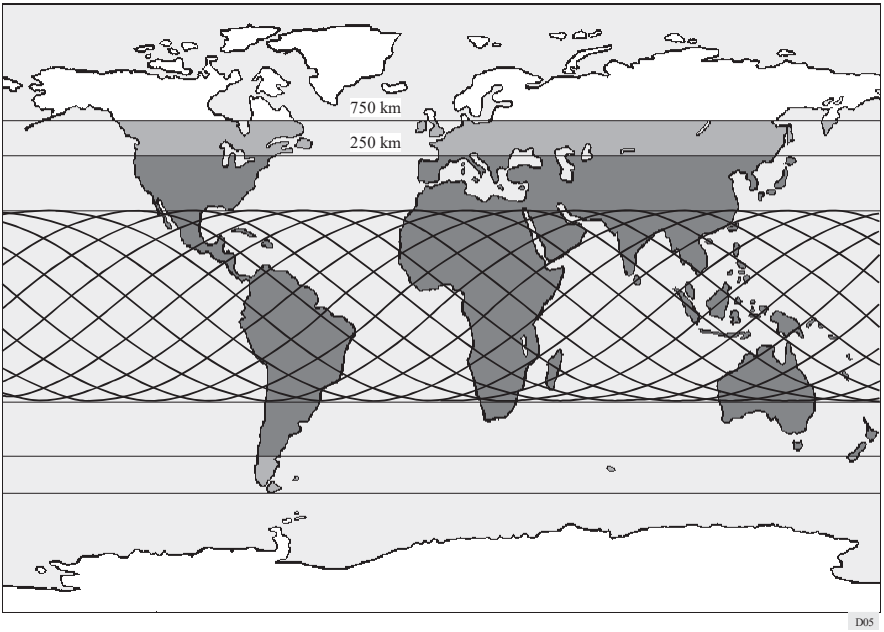
At an altitude of 250 km the spacecraft will receive interference from an area of 9.6 million km^2. This number increases to 27 million km^2 for an orbit height of 750 km. The maximum area seen by a geostationary satellite is 217 million km^2.

The interference spectral density level P_i received by a spacecraft antenna from one single mobile transmitter can be calculated as follows:

$$P_i = \frac{E_i c^2}{B_i (4\pi x f)^2}$$

FIGURE 5

Interference reception area for low-Earth orbiters (i = 29°)



The cumulative interference $P_{\Sigma i}$ from all mobiles in the interference area is given by:

$$P_{\Sigma i} = \int_{x=h}^{d_m} \frac{n_a P_i B_i h^2 \, \mathrm{d}A_{(x)}}{B_m A_i x^2} \, \mathrm{d}x = \frac{n_a E_i c^2}{(4\pi f)^2 B_m A_i} \int_{x=h}^{d_m} \frac{\mathrm{d}A_{(x)}}{x^2} \, \mathrm{d}x$$

$$A_{(x)} = \frac{\pi R (x^2 - h^2)}{R + h}$$

$$\frac{\mathrm{d}A_{(x)}}{\mathrm{d}x} = \frac{2\pi R}{R + h} x$$

$$d_m = \sqrt{(R + h)^2 - R^2}$$

$$P_{\Sigma i} = \frac{n_a E_i c^2}{(4\pi f)^2 B_m R h} [\ln(d_m) - \ln(h)]$$

where:

P_i: power density of interferer

E_i: e.i.r.p. of interferer

x: distance to interferer

f: transmission frequency

n_a: number of active mobiles

c: speed of light

B_i: bandwidth of one mobile

B_m: bandwidth of mobile service

d_m: maximum distance to interferer.

For the sake of simplicity an equal distribution of active terminals over the available bandwidth and over the interference area has been assumed. Table 2 lists the detailed assumptions made and the resulting interference levels. It must be concluded that sharing for these links is impossible as the interference levels are several orders of magnitude above acceptable levels.

5.1.2 Interference caused to mobile units

Mobile units will receive harmful interference from a transmitting earth station if operated within a certain distance of that station. Maximum e.i.r.p. levels for the support of near-Earth satellites range typically from 66 to 78 dBW.

Taking into account the antenna gains in the horizontal direction as shown in Fig. 2 and the fact that an antenna radiates in principle into all directions with a lowest gain specification of –10 dBi for the back of the antenna (–6 dBi for a 5.5 m antenna) the following e.i.r.p. levels around the antenna must be expected in the horizontal direction. E.i.r.p. density levels depend very much on the transmitted data rate. For the SO service the maximum data rate is typically a few kbit/s whereas for the SR service a range from at least 1 kbit/s to 100 kbit/s must be taken into account.

Antenna diameter (m)	e.i.r.p. range (dBW)	e.i.r.p. density range (dB(W/4 kHz))
5.5 (3°)	20-50	14-47
15 (3°)	19-50	13-47

Protection levels of the FPLMTS units are not known, but the system will be self-interference limited and not noise limited. Assuming that interference levels of around –150 dB(W/4 kHz) are acceptable, and assuming some further loss due to signal diffraction, a protection zone of up to 100 km may be required to allow satisfactory operation of the mobile units.

5.2 Space-to-Earth link (2 200-2 290 MHz)

For these links a distinction between the various space services must be made. The most critical one is space research but results for space operation and Earth exploration are in fact very similar.

Assumptions on the distribution of mobile transmitters around a satellite earth station are difficult to make as they depend to a large extent on the location of the station. An average distribution based on the number of inhabitants in the European common market countries has been assumed. The average population density is 140 people per km^2 resulting from 323 million people living in 2.3 million km^2. The resulting average traffic density is 2.8 E/km^2 for personal stations and 0.56 E/km^2 for mobile stations.

TABLE 2

Earth-to-space links (2 025-2 110 MHz)

	Indoor personal station		Outdoor personal station		Mobile station	
Spacecraft orbit height (km)	250	36 000	250	36 000	250	36 000
e.i.r.p. of single FPLMTS unit (W)	0.003	0.003	0.020	0.020	1.00	1.00
Channel bandwidth for voice communications (kHz)	50.0	50.0	50.0	50.0	25.0	25.0
e.i.r.p. density of single FPLMTS unit (dB(W/Hz))	–72.2	–72.2	– 64.0	– 64.0	– 44.0	– 44.0
Space (spreading) loss (dB)	146.7	189.8	146.7	189.8	146.7	189.8
Interference of a single unit (dB(W/Hz))	–218.9	–262.1	–210.7	–253.8	–190.7	–233.8
Acceptable interference density (dB(W/Hz))	–212.0	–212.0	–212.0	–212.0	–212.0	–212.0
Interference excess of one unit (dB)	– 6.9	–50.1	1.3	– 41.8	21.3	–21.8
Area of interference seen by spacecraft (millions/km^2)	9.64	217.13	9.64	217.13	9.64	217.13
Total number of population in area (millions)	600	4 000	600	4 000	600	4 000
Percentage of subscribers to service (%)	20.0	20.0	20.0	20.0	10.0	10.0
Average units in total per km^2	12.4	3.7	12.4	3.7	6.2	1.8
Percentage of active units in area (%)	10.0	10.0	10.0	10.0	4.0	4.0
Simultaneously active units in area (millions)	12.0	80.0	12.0	80.0	2.4	16.0
Average active units per km^2 (E/km^2)	1.24	0.37	1.24	0.37	0.25	0.07
Envisaged service bandwidth (voice channels) (MHz)	24	24	27	27	111	111
Number of active units per channel	25 000	166 667	22 222	148 148	541	3 604
Environmental attenuation (buildings, trees) (dB)	10.0	10.0	3.0	3.0	3.0	3.0
Cumulative interference from all active units (dB(W/Hz))	–196	–221	–181	–206	–177	–202
Average excess of acceptable interference (dB)	16.0	–8.5	30.7	6.2	34.6	10.1
Increased interference during peak activities (dB)	5.0	5.0	5.0	5.0	5.0	5.0
Increased interference with higher power levels (dB)	5.2	5.2	4.0	4.0	7.0	7.0
Increased interference over high density areas (dB)	5.3	0.0	5.3	0.0	5.3	0.0
Worst case excess of acceptable interference (dB)	31.5	1.7	45.0	15.2	51.8	22.1

The interference is integrated over a distance ranging from 1-10 km around the station for which a line-of-sight connection can be assumed. For most station locations it cannot be excluded that mobiles come even closer than 1 km. Additional interference is of course received from further distant mobile terminals but for the sake of simplicity this is not taken into account here. The antenna gain varies with the azimuth angle and has been integrated over 360° in order to come to an average antenna gain value.

The cumulative interference is determined by:

$$P_{\Sigma i} = \int_{x=d_1}^{d_2} \frac{md_a\, P_i\, B_i\, \mathrm{d}A_{(x)}}{B_m}\, \mathrm{d}x = \frac{md_a\, E_i\, c^2}{(4\pi f)^2\, B_m} \int_{x=d_1}^{d_2} \frac{\mathrm{d}A_{(x)}}{x^2}\, \mathrm{d}x$$

$$A_{(x)} = \pi x^2$$

$$\frac{\mathrm{d}A_{(x)}}{\mathrm{d}x} = 2\pi x$$

$$P_{\Sigma i} = \frac{md_a\, E_i\, c^2}{8\pi f^2\, B_m}\, [\ln(d_2) - \ln(d_1)]$$

where:

md_a: average mobile density

d_1: minimum radius around station

d_2: maximum radius around station.

Tables 3a and 3b list the detailed results for the space services considered. The worst-case results from a mobile unit transmitting into the direction of the main beam. A single station transmitting at a distance of 10 km was assumed representative although a much shorter distance is possible. The main conclusion to be drawn is that, even when an average gain specification of a few dBi around the antenna is assumed and a simplified interference calculation unfavourable to the space services is performed, interference levels are produced which are several orders of magnitude above the acceptable levels; hence sharing is impossible.

5.3 Space-to-space link (2 025-2 110 MHz)

The most critical case in this category is the link between a geostationary satellite, for example a data relay satellite, and a low-Earth orbiting satellite. The orbit height of the latter one ranges typically between 250 and 1 000 km.

Such a link is for example representative for a manned space shuttle which will orbit around 400 km. It is imperative that this spacecraft has an omnidirectional antenna in order to enable safe commanding and communications during every flight phase and in particular in emergency situations.

Due to power flux-density limitations on the Earth, a limit is also set on the e.i.r.p. which the data relay satellite may radiate towards the Earth, i.e. towards the low orbiting satellite. This results in very tight link margins. Interference, even at low levels, is extremely critical.

The calculated interference levels are so high that any data or communication links to low orbiting spacecraft are totally blanked out. An e.i.r.p. increase on the transmitting geostationary satellite is not feasible due to power flux-density restrictions. Consequently, sharing with land mobiles is impossible.

Table 4 lists the detailed results.

TABLE 3

Space-to-Earth links (2 200-2 290 MHz)

Table 3a: Space operation service	Indoor personal station		Outdoor personal station		Mobile station	
Average horizontal gain of earth station (5.5 m) (dBi)		7.5		7.5		7.5
Maximum horizontal gain of earth station (3°) (dBi)	24.0		24.0		24.0	
Active units per km^2 (E/km^2)		2.800		2.800		0.560
Active unit density per channel per km^2		0.0058		0.0052		0.0001
e.i.r.p. of single FPLMTS unit (W)	0.003	0.003	0.020	0.020	1.000	1.000
e.i.r.p. density of single FPLMTS unit (dB(W/Hz))	–72.2	–72.2	–64.0	–64.0	–44.0	–44.0
Acceptable interference density at receiver input (dB(W/kHz))	–184.0	–184.0	–184.0	–184.0	–184.0	–184.0
Acceptable interference density at antenna input (dB(W/kHz))	–208.0	–191.5	–208.0	–191.5	–208.0	–191.5
Interference of units between 1 and 10 km (dB(W/kHz))		–152.4		–144.7		–140.9
Interference of 1 unit at 10 km distance (LOS) (dB(W/kHz))	–161.5		–153.3		–133.3	
Excess of acceptable interference (dB)	46.5	39.1	54.7	46.8	74.7	50.6

Table 3b: Space research	Indoor personal station		Outdoor personal station		Mobile station	
Average horizontal gain of earth station (15 m) (dBi)		2.4		2.4		2.4
Maximum horizontal gain of earth station (5°) (dBi)	14.5		14.5		14.5	
Active units per km^2 (E/km^2)		2.800		2.800		0.560
Active unit density per channel per km^2		0.0058		0.0052		0.0001
e.i.r.p. of single FPLMTS unit (W)	0.003	0.003	0.020	0.020	1.000	1.000
e.i.r.p. density of single FPLMTS unit (dB(W/Hz))	–72.2	–72.2	–64.0	–64.0	–44.0	–44.0
Acceptable interference density at receiver input (dB(W/Hz))	–220.0	–220.0	–220.0	–220.0	–220.0	–220.0
Acceptable interference density at antenna input (dB(W/Hz))	–234.5	–222.4	–234.5	–222.4	–234.5	–222.4
Interference of units between 1 and 10 km (dB(W/Hz))		–182.4		–174.7		–170.9
Maximum interference of 1 unit at 10 km distance (dB(W/Hz))	–191.5		–183.3		–163.3	
Excess of acceptable interference (dB)	43.0	40.0	51.2	47.7	71.2	51.5

TABLE 4

Space-to-space links (2 025-2 110 MHz)

	Indoor personal station		Outdoor personal station		Mobile station	
Spacecraft orbit height (km)	250	750	250	750	250	750
e.i.r.p. of single FPLMTS unit (W)	0.003	0.003	0.020	0.020	1.00	1.00
Channel bandwidth for voice communications (kHz)	50.0	50.0	50.0	50.0	25.0	25.0
e.i.r.p. density of single FPLMTS unit (dB(W/Hz))	–72.2	–72.2	– 64.0	– 64.0	– 44.0	– 44.0
Space (spreading) loss (dB)	146.7	156.2	146.7	156.2	146.7	156.2
Interference of a single unit (dB(W/Hz))	–218.9	–228.4	–210.7	–220.2	–190.7	–200.2
Acceptable interference density (dB(W/Hz))	–212.0	–212.0	–212.0	–212.0	–212.0	–212.0
Interference excess of one unit (dB)	– 6.9	–16.4	1.3	–8.2	21.3	11.8
Area of interference seen by spacecraft (million/km^2)	9.64	26.89	9.64	26.89	9.64	26.89
Total number of population in area (millions)	600	800	600	800	600	800
Percentage of subscribers to service (%)	20.0	20.0	20.0	20.0	10.0	10.0
Average units in total per km^2	12.4	5.9	12.4	5.9	6.2	3.0
Percentage of active units in area (%)	10.0	10.0	10.0	10.0	4.0	4.0
Simultaneously active units in area (millions)	12.0	16.0	12.0	16.0	2.4	3.2
Average active units per km^2 (E/km^2)	1.24	0.59	1.24	0.59	0.25	0.12
Envisaged service bandwidth (voice channels) (MHz)	24	24	27	27	111	111
Number of active units per channel	25 000	33 333	22 222	29 630	541	721
Environmental attenuation (buildings, trees) (dB)	10.0	10.0	3.0	3.0	3.0	3.0
Cumulative interference from all active units (dB(W/Hz))	–196.0	–200.9	–181.3	–186.2	–177.4	–182.3
Average excess of acceptable interference (dB)	16.0	11.1	30.7	25.8	34.6	29.7
Increased interference during peak activities (dB)	5.0	5.0	5.0	5.0	5.0	5.0
Increased interference with higher power levels (dB)	5.2	5.2	4.0	4.0	7.0	7.0
Increased interference over high density areas (dB)	5.3	3.0	5.3	3.0	5.3	3.0
Worst case excess of acceptable interference (dB)	31.5	24.3	45.0	37.8	51.8	44.6

5.4 Space-to-space link (2 200-2 290 MHz)

This frequency band is used for data links from low orbiting satellites to geostationary data relay satellites and for short range communications between low orbiting satellites and eventually also between astronauts. Orbit heights between 250 and 36 000 km have consequently to be taken into account.

In principle, the same assumptions as listed above are applicable with the exception that the geostationary satellite uses high gain antennas for the links to the low orbiters. This results in very low acceptable interference levels at the input of the antenna. The beamwidth of the antenna is typically a few degrees so that interference from an area somewhat smaller than for the 250 km orbit can be received. Figure 6 gives a typical example for the area from which interference will be received by a data relay satellite when tracking a low-Earth orbiter.

FIGURE 6

Coverage of a data relay satellite antenna and a 250 km LEO

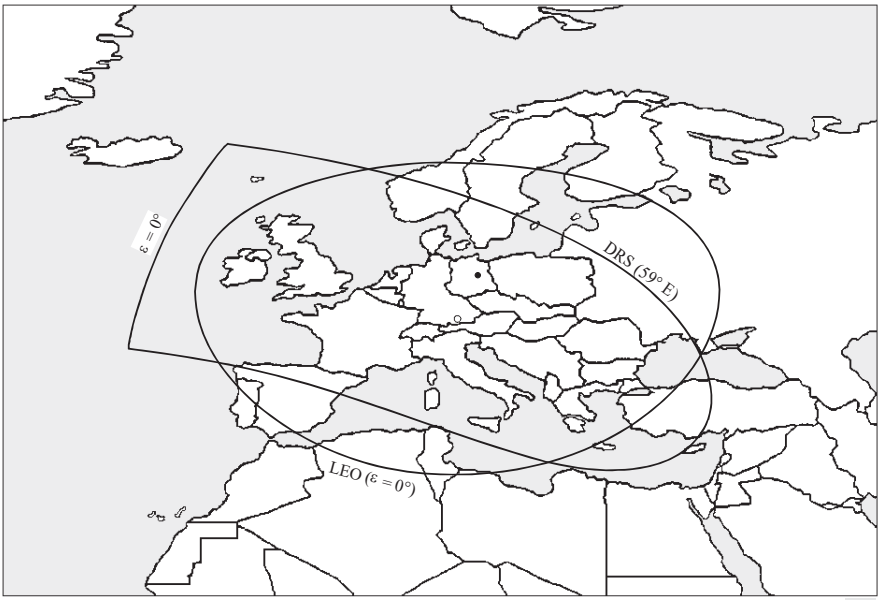


Table 5 lists the detailed results. Also in this case sharing is unfortunately impossible.

5.5 Worst-case scenarios for all links

The assumptions used for the interference studies above are based on an average distribution of mobiles over the interference area, an average activity, minimum power levels for the FPLMTS units and an equal occupation of all available channels. The resulting interference excess values are consequently average numbers on the low end.

TABLE 5

Space-to-space links (2 200-2 290 MHz)

	Indoor personal station		Outdoor personal station		Mobile station	
Spacecraft orbit height (km)	250	36 000	250	36 000	250	36 000
e.i.r.p. of single FPLMTS unit (W)	0.003	0.003	0.020	0.020	1.000	1.000
Channel bandwidth for voice communications (kHz)	50.0	50.0	50.0	50.0	25.0	25.0
e.i.r.p. density of single FPLMTS unit (dB(W/Hz))	–72.2	–72.2	– 64.0	– 64.0	– 44.0	– 44.0
Space (spreading) loss (dB)	146.7	189.8	146.7	189.8	146.7	189.8
Interference of a single unit (dB(W/Hz))	–218.9	–262.1	–210.7	–253.8	–190.7	–233.8
Acceptable interference density (dB(W/Hz))	–212.0	–247.0	–212.0	–247.0	–212.0	–247.0
Interference excess of one unit (dB)	– 6.9	–15.1	1.3	– 6.8	21.3	13.2
Area of interference seen by spacecraft (millions/km^2)	9.64	8.00	9.64	8.00	9.64	8.00
Total number of population in area (millions)	600	500	600	500	600	500
Percentage of subscribers to service (%)	20.0	20.0	20.0	20.0	10.0	10.0
Average units in total per km^2	62.2	62.5	62.2	62.5	62.2	62.5
Percentage of active units in area (%)	10.0	10.0	10.0	10.0	4.0	4.0
Simultaneously active units in area (millions)	12.0	10.0	12.0	10.0	2.4	2.0
Average active units per km^2 (erlangs/km^2)	1.24	1.25	1.24	1.25	0.25	0.25
Envisaged service bandwidth (voice channels) (MHz)	24	24	27	27	111	111
Number of active units per channel	25 000	20 833	22 222	18 519	541	450
Environmental attenuation (buildings, trees) (dB)	10.0	10.0	3.0	3.0	3.0	3.0
Cumulative interference from all active units (dB(W/Hz))	–196.0	–218.9	–181.3	–211.1	–177.4	–207.3
Average excess of acceptable interference (dB)	16.0	27.2	30.7	34.9	34.6	38.8
Increased interference during peak activities (dB)	5.0	5.0	5.0	5.0	5.0	5.0
Increased interference with higher power levels (dB)	5.2	5.2	4.0	4.0	7.0	7.0
Increased interference over high density areas (dB)	5.3	0.0	5.3	0.0	5.3	0.0
Worst case excess of acceptable interference (dB)	31.5	37.4	45.0	43.9	51.8	50.8

If the spacecraft flies over large cities or highly populated areas in Europe the cumulative interference will increase significantly due to the shorter distance from a high number of mobiles to the spacecraft. To take into account large urban and suburban areas it was assumed that 20% of all mobile units seen by the spacecraft are close to the subsatellite point. This is easily possible over large cities like Paris and London with traffic densities up to 20 000 E/km^2 per building floor. This results in increased interference between 3 dB for a 750 km orbit and 5 dB for a 250 dB orbit. For the geostationary orbits no increase was assumed as it is unlikely that a very high mobile concentration can be found near the equator.

An interference increase will also occur at times with peak activities. A traffic density increase up to a factor of 3 can be assumed. This leads to a potential increase of interference between 4 and 7 dB. Another reason for higher interference can be unequal occupation of channels but as this is difficult to estimate it has not been taken into account in this study.

For the Earth-to-space and the two space-to-space links it can be concluded that the worst-case interference can be between 9 and 16 dB higher than the average value.

The situation for the space-to-Earth link is slightly different. The worst case would be a mobile transmitting in the vicinity of the station near the direction of the main beam. Assuming a distance of 10 km between the mobile and the earth station the corresponding interference level would be 43-75 dB above specified protection levels.

6 Conclusions

A short summary of interference excess is listed in Table 6 for all links analysed. The lower value is based on average interference excess. The higher value takes into account worst cases with respect to increased mobile densities in highly populated areas, upper limits of specified operating power, and times with high communication activity. Unequal channel occupation, yet another source of increased interference, has not been considered.

TABLE 6

Interference summary for all links and all mobile units considered

Interference excess (dB)	Indoor personal station	Outdoor personal station	Mobile station
Earth-to-space (2 025-2 110 MHz)	16-32	31-45	35-52
Space-to-Earth (2 200-2 290 MHz)	39-47	47-55	51-75
Space-to-space (2 025-2 110 MHz)	16-32	31-45	35-52
Space-to-space (2 200-2 290 MHz)	27-37	35-45	39-52

An interference analysis between FPLMTS type land mobile systems and the space operations, space research and Earth-exploration service has been presented. On all types of links considered in this Recommendation sharing with this and similar high density mobile systems is not feasible. The resulting interference levels are orders of magnitude higher than acceptable levels specified in the RR and in ITU-R Recommendations.

Annex 2

Summary of studies of the characteristics of mobile systems that facilitate radio-frequency compatibility with the space science services

1 Introduction

This Annex summarizes the results of studies concerning the technical and operational characteristics of mobile systems that might be compatible with the SR, SO and EES systems operating in the 2 025-2 110 MHz and 2 200-2 290 MHz bands.

The characteristics of mobile systems that facilitate sharing are:

– emissions of low power spectral density,

– transmissions of an intermittent nature,

– use of directional transmitting antennas,

– number of mobile stations is self-limiting as a result of the nature of the application.

Studies concerning different sets of assumptions and ranges of values for these general characteristics are presented in the following sections. Further studies regarding the compatibility between mobile systems and space science systems in the 2 025-2 110 MHz and 2 200-2 290 MHz bands would be required to better define the interference environment.

2 Summary of studies of e.i.r.p. and antenna gain

The introduction of technical requirements for the mobile service in the bands 2 025-2 110 MHz and 2 200-2 290 MHz led to the proposal of an e.i.r.p. limit of 28 dBW together with a minimum antenna gain of 24 dBi in order to facilitate sharing with the space science services. Studies were conducted as to the interference effect of such systems on the space research service.

The model used in the study assumed a global and uniform distribution of directional mobile terminals with antenna gains ranging between 22 and 26.5 dBi and e.i.r.p. ranging between 28 and 37 dBW. Orbital heights for spacecraft between 250 km and 36 000 m were taken into account.

The study results show that space science operations in the 2 200-2 290 MHz band are significantly more susceptible to interference than in the 2 025-2 110 MHz band. An antenna gain sensitivity analysis was performed. For the case of constant e.i.r.p. levels, the probability of interference decreases with increasing antenna gain as shown in Fig. 7. The Figure also shows a non-linear increase in interference probability with linearly increasing e.i.r.p.

The study finally concluded that the proposed e.i.r.p. limit of 28 dBW, together with an antenna gain in excess of 24 dBi, are adequate provisions to enable sharing with around 1 000 mobile systems of such kind worldwide.

3 A summary of a study of interference from certain mobile systems

A study was conducted that considered four possible scenarios concerning interference to space science services systems as shown in Table 7.

The characteristics of the systems used in the study are discussed in the following.

3.1 System characteristics

3.1.1 Receive characteristics

3.1.1.1 Data relay satellite

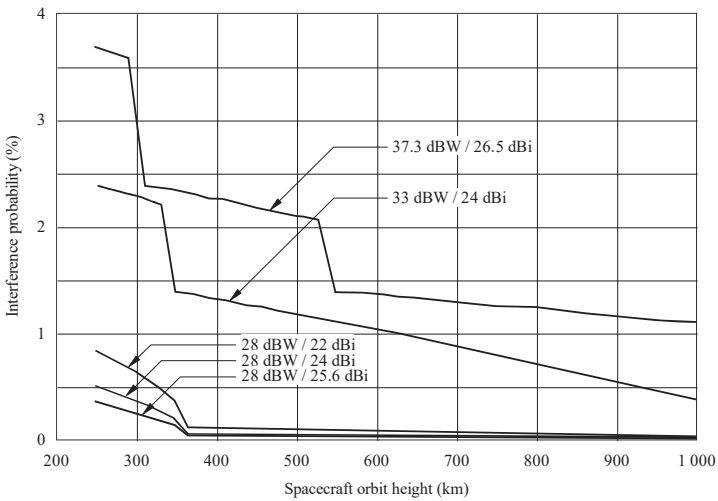
Receive antenna (assumed to track the LEO spacecraft when visible):

– boresight gain = 34 dBi;

– off-beam characteristics in accordance with the reference radiation pattern for single feed circular beams (near in side-lobe level of –20 dB) as defined in Recommendation ITU-R S.672.

FIGURE 7

Interference probability for various ENG system characteristics



1 000 ENG systems
10 % activity

D07

TABLE 7

	2 025-2 110 MHz	2 200-2 290 MHz
Space services Data relay	Space-to-space (Forward) (1)	Space-to-space (Return) (3)
Space services Direct-to-ground	Earth-to-space (2)	Space-to-Earth (4)
Mobile	Directional (ENG)	Omnidirectional

3.1.1.2 LEO spacecraft (DRS pointing)

Receive antenna (assumed to track the geostationary relay satellite when visible):

– boresight gain = 25 dBi;

– off-beam characteristics in accordance with the reference radiation pattern for single feed circular beams (near in side-lobe level of –20 dB) as defined in Recommendation ITU-R S.672;

– orbit altitude = 300 km;

– inclination = 29°.

3.1.1.3 LEO spacecraft (Earth pointing)

Receive antenna omnidirectional (gain = 0 dBi):

– orbit altitude = 300 km;

– inclination = 29°.

3.1.1.4 Earth station

Receive antenna (assumed to track the LEO spacecraft when visible):

– boresight gain = 45 dBi;

– off-beam characteristics in accordance with those defined in RR Appendices 28 and 29.

3.1.2 Transmit characteristics

3.1.2.1 Mobile terminal (directional) – ENG

– antenna boresight gain = 25 dBi;

– power spectral density into the antenna = –38 dB(W/kHz);

– off-beam characteristics in accordance with those defined in RR Appendices 28 and 29.

3.1.2.2 Mobile terminal (omnidirectional)

– antenna gain = 0 dBi;

– power spectral density into the antenna = –42 dB(W/kHz).

3.2 Summary and conclusions

Four geometric configurations (A-D) were evaluated for the scenarios shown in Table 7 using the technical characteristics shown above. The results of a probabilistic analysis are summarized in Table 8.

TABLE 8

Reference	Entry	Maximum level of interference relative to criterion (dB)	Probability criterion exceeded (%)
1 A	ENG into LEO (DRS pointing)	+ 31.0	0.65
1 B		+ 7.5	0.20
1 C		+ 6.5	0.15
1 D		+ 6.5	0.15
2 A	ENG into LEO (Earth pointing)	+ 2.5	0.20
2 B		+ 2.5	0.04
2 C		+ 2.5	0.045
2 D		+ 2.5	0.035
3 A	Omni into DRS	– 16.5	2.50(1)
3 B		– 16.5	1.50(1)
3 C		– 15.0	0.15(1)
3 D		– 15.0	0.50(1)
4 A	Omni into ES	+ 48.5	1.00
4 B		+ 48.0	0.55

(1) Probability of maximum level of interference.

3.2.1 Interference from directional mobiles to a LEO spacecraft (DRS pointing) in the band 2 025-2 110 MHz

The values in Table 8 suggest that a single ENG terminal in various geometric configurations can exceed the applicable protection criteria. However, considering the majority of configurations, if the ENG transmit power were decreased by 1 dB then the probability that the protection criterion would be exceeded would be decreased to 0.1%. This would not, of course, be true for the more critical geometric configurations and, therefore, some constraints may need to be placed on the siting of terrestrial ENG terminals.

3.2.2 Interference from directional mobiles to a LEO spacecraft (Earth pointing) in the band 2 025-2 110 MHz

The results suggest that two or three spatially separated co-channel terminals would be acceptable. This translates into an acceptable community of between 100 and 150 ENG terminals not considering the worst case geometry.

3.2.3 Interference from omnidirectional mobiles to a geostationary data relay satellite (tracking a LEO spacecraft) in the band 2 200-2 290 MHz

The values presented in Table 8 show that the interfering power levels from a single omnidirectional terminal are well within the permissible criteria. However, the probabilities of these

levels occurring are high and hence multiple terminals could give rise to aggregate levels of interference which whilst just exceeding the permissible power levels would exceed the permissible levels many times in terms of probability of occupance.

3.2.4 Interference from omnidirectional mobiles to an earth station (tracking a LEO spacecraft) in the band 2 200-2 290 MHz

Assuming no line-of-sight paths such that the basic transmission loss follows an inverse third power law, a single omnidirectional terminal may operate within 0.5 km of an earth station (with an elevation greater than 5°).

Annex 3

Description of certain electronic news gathering (ENG) systems operating in the 2 025-2 110 MHz band

1 Introduction

This Annex presents information about the unique technical and operational characteristics used by specific ENG systems operated by one administration that may facilitate sharing with the SR, SO, and EES services.

2 Characteristics/description of ENG systems

ENG systems include both mobile point-of-view and transportable ENG systems that provide video from a variety of locations and activities. ENG systems are used for on-location coverage of news events or interviews and live-action video during sports or entertainment events. Because of the value of on-location video, most local television stations in urban areas of the United States of America operate ENG systems. The transportable ENG systems, used for on-location coverage, are generally mounted in vans and operate in a stationary mode transmitting video to a fixed receive site. These systems provide mobility for news coverage throughout a geographic region.

3 ENG systems and environments

This section describes two common operational modes.

3.1 Transportable

The transportable ENG systems described in the previous section are used for live or taped on-location video for news, sports, and entertainment broadcasts. The transportable ENG systems are generally mounted in vans and use transmitters operating around 10.8 dBW of power. These systems utilize directional antennas with gains between 20-22 dBi mounted on top of a pneumatic

mast of up to 15 m in height. ENG systems may employ linear or circular polarization to provide additional interference protection from each other. Many ENG systems (probably 30-50%) transmit with up to 5 dB of transmission line loss.

3.2 Point-of-view

Small light-weight microwave transmitters are used for mobile and close-up video situations since live pictures are desired and because video recorders are impractical due to size and ruggedness requirements. These transmitters usually operate with up to 5 dBW of power. These systems utilize essentially omnidirectional antennas with 0-3 dBi of gain and may also use linear or circular polarization.

A small point-of-view system usually operates instead of, rather than in addition to, a transportable ENG operation on the same channel. Point-of-view systems cannot usually operate simultaneously with transportable systems because the transportable systems cause excessive interference to the point-of-view receiver.

Table 9 presents characteristics of typical ENG systems that operate in the 2 025-2 110 MHz band.

TABLE 9

Typical 2 GHz ENG systems in use in the United States of America

Type of use	Transmitter location	Transmit power	Antenna gain (dBi)	Receiver location
ENG transportable (van)	Van mast	12 W	22	Tower
Temporary fixed link	Roof	12 W	25	Roof
Convention	Floor of convention hall	100 mW	0-5	Hall rafters
Point-of-view (e.g., skier)	On body/helmet	100 mW	0	Hillside or helicopter
Sports venues				
Playing field	Field	1 W	12	Pressbox
Golf course (system 1)	On golf course	3 W	16	Tethered blimp
Golf course (system 2)	On golf course	12 W	12	Crane
Racecam	In car	3 W	7	Helicopter
Helicopter	Relay helicopter	12 W	7	Ground receive
Marathon				
Motorcycle	Motorcycle	3 W	7	Helicopter
Relay vehicle	Pick-up truck	12 W	12	Helicopter
Helicopter	Relay helicopter	12 W	7	Roof

4 Operational characteristics

All ENG systems, cannot operate simultaneously. Since ENG systems are sensitive to interference, only one transmission per channel per receive site at a time is usually possible. Most television markets in the United States of America contain multiple receive sites that allow for simultaneous transmissions on a channel. In most large markets, however, only six simultaneous transmissions are possible on the busiest channel, and in most markets the number does not exceed two. More than two simultaneous transmissions on a single channel rarely occur. In fact, multiple ENG receive sites and systems exist only in the largest television markets, so most regions have little or no simultaneous ENG activity per channel.

Although used throughout the day, transportable ENG systems operate primarily during weekday local news broadcasts, which usually occur around 1200-1230, 1700-1900, and 2300-2330 local time. In most markets before the afternoon news hours around 1500-1700, ENG use is also significant. The popularity of local morning shows from 0600-0900 is increasing in various markets, and these shows also use ENG systems. Transportable ENG transmitters are operated approximately twice per day. Broadcast engineers estimate that each ENG operation transmits an average of 15 min per operation but can vary from about 5 min to perhaps as long as 5 h.

5 Spectrum use and characteristics

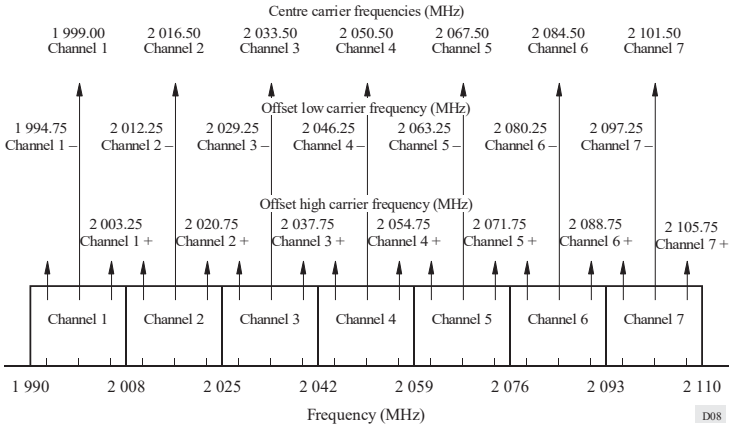
The 1 990-2 110 MHz band is used as the primary ENG band because of favourable propagation characteristics. These include the lower levels of foliage attenuation that apply at higher frequencies and the ability to “building bounce” a signal to achieve a temporary link to a fixed receive site despite unavoidable path blockage.

In the United States of America, the ENG frequency band is divided into 7 channels each with 17 MHz except the first channel which is 18 MHz as shown in Fig. 8. ENG systems are usually operated at the centre of each channel, but the lower offset and upper offset channels are also used. Consequently, 21 carrier frequencies are possible, but all carrier frequencies cannot be used simultaneously. ENG systems may operate at the centre channel, the lower offset channel, the higher offset channel, or the lower and higher offset channels simultaneously, depending on the need and adjacent channel use at any time. Since ENG systems are sensitive to interference, only one transmission per channel per receive site at a time is usually possible.

ENG systems use frequency modulation (FM) for transmitting video. The carrier is virtually never transmitted unmodulated by video raster.

FIGURE 8

ENG channel plan in use in the United States of America



Annex 4

Description of certain aeronautical mobile telemetry systems operating in the 2 200-2 290 MHz band

1 Introduction

The aeronautical mobile telemetry systems operated by one administration consist of a small number of controlled, short duration transmitters operating in a few specific areas.

The number of simultaneously operating transmitting systems within any 1 000 km radius will rarely exceed 15. The maximum e.i.r.p. in the direction of a satellite in any 3 MHz bandwidth within any 1 000 km radius will rarely exceed 10 W.

2 Technical characteristics of aeronautical mobile telemetry systems

Aeronautical telemetry has been using the 2 200-2 290 MHz band for testing of missiles, space launch vehicles, air vehicles, and subsystems thereof since the late 1960s. The duration of the majority of these tests is less than 10 min, however some tests last for several hours. Telemetry operations can occur at any hour of the day with the peak usage during daylight hours. The majority of the flight tests occur at one (or more) of the test ranges operated by the United States of America government.

The characteristics of the telemetry transmitting systems are optimized for the vehicle being tested. Therefore, these characteristics vary considerably from vehicle to vehicle. There is no "typical" transmitting system. The effective radiated power of the telemetry systems is usually between 1 and 5 W. The required power level is determined by the amount of information to be transmitted, the maximum range between transmitting and receiving systems, the required data quality, and the sensitivity of the receiving system. The telemetry transmitting antennas are usually linearly polarized and are typically designed to have nearly isotropic coverage because the orientation of the vehicle under test with respect to the telemetry receiving antenna can change very rapidly. As the receiving antenna tracks a vehicle in flight, large variations occur in the signal levels at the receiver. These "fades" are caused by nulls in the vehicle antenna pattern and propagation anomalies such as multipath and ducting. The decrease in signal level during fades can exceed 30 dB. Therefore, a received signal considerably above threshold is required during optimum flight conditions to avoid data loss during signal fades.

The telemetry data formats and rates vary considerably from vehicle to vehicle. Most telemetry transmitting systems use frequency or phase modulation. The input to the transmitter may be digital, analogue, or a combination of digital and analogue. The 99% power bandwidths of the telemetry transmitting systems vary from less than 1 MHz to more than 10 MHz.

The required pre-detection signal-to-noise ratio (SNR) for acceptable data quality varies from 9 to 15 dB. The maximum distance between the vehicle under test and the telemetry receiving station is usually between 20 and 400 km (the maximum range for some tests is greater than 3 000 km). Typical receiver bandwidths vary from 0.5 to 10 MHz (these values are increasing). Receiving system noise temperatures vary between 200 K and 500 K. Main lobe gains of the receiving antennas vary from 6 dBi for some short-range mobile systems to greater than 50 dBi for large antennas. The larger antennas automatically track the test vehicle while the smaller antennas (gain less than 20 dBi) typically are pointed in the direction of the transmitter. The receiving antenna side lobes depend on the size and design of the receiving antenna. The majority of telemetry receiving antennas have diameters between 2.44 m (8 feet) and 10 m (32.8 feet).

3 Spectrum considerations

Aeronautical mobile telemetry system providers in the United States of America have divided this band into 90 channels each with a 1 MHz bandwidth. Multiple channels are assigned together when a wider bandwidth is needed.

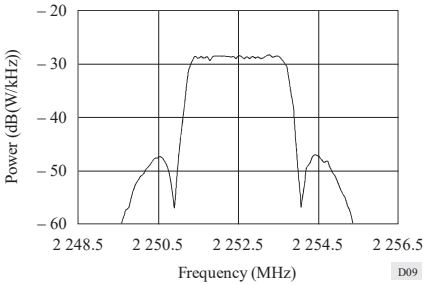
Aeronautical telemetry operations are currently protected by coordination between the various users. The territory of the United States of America is divided into coordination areas. Area frequency coordinators assign and schedule frequency use within these areas.

The potential exists for significant interference between satellite earth stations co-located with aeronautical telemetry transmitting sites in the 2 200-2 290 MHz band. This problem is mitigated by controlling the time, frequency and location of the transmissions by each service in this band. Frequency interference control centres accommodate real-time changes and locate and identify any unauthorized transmissions.

A sample radiated power spectral density is shown in Fig. 9. This Figure shows the nominal power spectral density for one telemetry system. The data in this Figure is not typical, best case or worst case but is included only as an example of the spectral characteristics of the most common type of system currently used for aeronautical mobile telemetry systems. Some aeronautical mobile telemetry systems may have discrete spectral components during portions of a test flight, therefore the maximum spectral densities (dB(W/kHz)) may be significantly larger than the values shown in Fig. 9.

FIGURE 9

Sample spectrum



The maximum aggregate radiated power in any direction from all aeronautical mobile telemetry systems within a radius of 1 000 km will be less than 100 W in the band from 2 200-2 290 MHz. The maximum aggregate radiated power in any 3 MHz bandwidth will rarely exceed 10 W in any direction in any 1 000 km radius.

RECOMMENDATION ITU-R M.1171-1*

Radiotelephony procedures for routine calls in the maritime mobile service

(1995-2023)

Scope

This Recommendation describes the radiotelephony procedures for routine calls within the maritime mobile service.

Keywords

Routine, calling, GMDSS, radiotelephony, maritime mobile service

Abbreviations/Glossary

RR: Radio Regulations

VHF: Very high frequency

Related ITU Recommendations

ITU-R M.493 – Digital selective-calling system for use in the maritime mobile service

ITU-R M.541 – Operational procedures for the use of digital selective-calling equipment in the maritime mobile service

The ITU Radiocommunication Assembly,

considering

a) that there is a need to describe standard procedures for radiotelephony communication in the maritime mobile service,

recommends

that radiotelephony procedures of routine calls in the maritime mobile service should be performed in accordance with the Annex.

Annex

Section I. Calls by radiotelephony

1. The provisions of this Section relating to the intervals between calls are not applicable to a station operating under conditions involving distress, urgency or safety.

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* This Recommendation should be brought to the attention of the International Maritime Organization (IMO), and the Telecommunication Standardization Sector (ITU-T).

Note by the Secretariat: The references made to the Radio Regulations (RR) in this Recommendation refer to the RR as revised by the World Radiocommunication Conference 1995. These elements of the RR will come into force on 1 June 1998. Where applicable, the equivalent references in the current RR are also provided in square brackets.

2. (1) As a general rule, it rests with the ship station's discretion to establish communication with the coast station. For this purpose the ship station may call the coast station only when it comes within the service area of the latter, that is to say, that area within which, by using an appropriate frequency, the ship station can be heard by the coast station.

(2) However, a coast station having traffic for a ship station may call this station if it has reason to believe that the ship station is keeping watch and is within the service area of the coast station.

3. (1) In addition, each coast station should, so far as practicable, transmit its calls in the form of "traffic lists" consisting of the call signs or other identification in alphabetical order of all ship stations for which it has traffic on hand. These calls should be made at specified times fixed in the coast station transmitting schedule shown in the List of Coast Stations and Special Service Stations and at intervals of not less than two hours and not more than four hours during the working hours of the coast station.

(2) Coast stations should transmit their traffic lists on their normal working frequencies in the appropriate bands. The transmission should be preceded by a general call to all stations.

(3) The general call to all stations announcing the traffic lists may be sent on a calling frequency in the following form:

– "ALL STATIONS" not more than three times;
– the words "THIS IS";
– " . . . RADIO" not more than three times;
– "LISTEN TO MY TRAFFIC LIST ON . . . kHz".

In no case may this preamble be repeated.

(4) However, in the bands between 156 MHz and 174 MHz when the conditions for establishing contact are good, the call described in § 3.(3) above may be replaced by:

– "ALL SHIPS";
– the words "THIS IS";
– a call sign or the geographical name of the place as it appears in the List of Coast Stations and Special Service Stations, followed preferably by the word RADIO or by any other appropriate indication (see RR Nos. **19.73** and **19.74**) twice;
– "LISTEN TO MY TRAFFIC ON . . . kHz".

In no case may this preamble be repeated.

(5) The provisions of § 3.(3) are obligatory when 2 182 kHz or 156.8 MHz is used.

(6) The hours at which coast stations transmit their traffic lists and the frequencies and classes of emission which they use for this purpose should be stated in the List of Coast Stations and Special Service Stations, subject to notification to ITU by the administration having jurisdiction over the coast station.

(7) Ship stations should as far as possible listen to the traffic lists transmitted by coast stations. On hearing their call sign or other identification in such a list ship stations must establish communication with appropriate coast stations as soon as they can do so.

(8) When the traffic cannot be sent immediately, the coast station should inform each ship station concerned of the probable time at which working can begin, and also, if necessary, the frequency and class of emission which will be used.

4. When a coast station receives calls from several ship stations at practically the same time, it decides the order in which these stations may transmit their traffic. Its decision should be based on

the order of priority (see RR No. **53.1**) of communication that the ship stations have on hand and on the need for allowing each calling station to clear the greatest possible number of communications.

5. (1) When a station called does not reply to a call sent three times at intervals of two minutes, the calling should cease.

(2) However, when a station called does not reply, the call may be repeated at three-minute intervals.

(3) In areas where reliable VHF communication with a called coast station is practicable, the calling ship station may repeat the call as soon as it is ascertained that traffic has been terminated at the coast station.

(4) In the case of a communication between a station of the maritime mobile service and an aircraft station, calling may be renewed after an interval of five minutes.

(5) Before renewing the call, the calling station should ascertain that the station called is not in communication with another station.

(6) If there is no reason to believe that harmful interference will be caused to other communications in progress, the provisions of § 5.(4) above are not applicable. In such cases the call, sent three times at intervals of two minutes, may be repeated after an interval of not less than three minutes.

(7) However, before renewing the call, the calling station should ascertain that further calling is unlikely to cause interference to other communications in progress and that the station called is not in communication with another station.

(8) Ship stations should not radiate a carrier wave between calls.

6. When the name of the operating agency controlling a ship station is not given in the List of Ship Stations and Maritime Mobile Service Identity Assignments or are no longer in agreement with the particulars given therein, it is the duty of the ship station to provide as a matter of regular procedure, to the coast station to which it transmits traffic, all the necessary information in this respect.

7. (1) The coast station may ask the ship station to provide it with the following information:

a) position and, whenever possible, course and speed;

b) next port of call.

(2) The information referred to in § 7.(1) above should be provided by ship stations, whenever this seems appropriate, without prior request from the coast station. The provision of this information is authorized only by the master or the person responsible for the ship.

Section II. Method of calling, reply to calls and signals preparatory to traffic when using calling methods other than digital selective calling

A. Method of calling

8. (1) The call consists of:

– the call sign or other identification of the station called, not more than three times;

– the words “THIS IS”;

– the call sign or other identification of the calling station, not more than three times (see RR Nos. **19.73** and **19.74**).

(2) However, in the bands between 156 MHz and 174 MHz when the conditions for establishing communication are good, the call described in § 8.(1) above may be replaced by:

– the call sign of the station called, once;

– the words "THIS IS";

– the call sign or other identification of the calling station, twice.

(3) When calling a VHF coast station operating on more than one channel, a ship station calling on a working channel should include the number of that designator in the call.

(4) When communication is established, the call sign or other identification may thereafter be transmitted once only.

(5) When the coast station and ship station are fitted with equipment for digital selective calling they should follow procedure for routine calls. The ship station should call the coast station by speech in the manner given in § 8.(1).

9. Calls for internal communications on board ship should consist of:

a) From the master station:

– the name of the ship followed by a single letter (ALFA, BRAVO, CHARLIE, etc.) indicating the sub-station not more than three times;

– the words "THIS IS";

– the name of the ship followed by the word "CONTROL";

b) From the sub-station:

– the name of the ship followed by the word "CONTROL" not more than three times;

– the words "THIS IS";

– the name of the ship followed by a single letter (ALFA, BRAVO, CHARLIE, etc.) indicating the sub-station.

B. Frequency to be used for calling and for preparatory signals

B1. Bands between 1 605 kHz and 4 000 kHz

10. (1) A radiotelephone ship station calling a coast station should use for the call, in order of preference:

a) a working frequency on which the coast station is keeping watch;

b) the carrier frequency 2 182 kHz;

c) in Regions 1 and 3 and in Greenland, the carrier frequency 2 191 kHz (assigned frequency 2 192.4 kHz) when a carrier frequency of 2 182 kHz is being used for distress;

d) in Region 2 except for Greenland, the carrier frequency 2 191 kHz as a supplementary calling frequency in those areas of heavy usage of 2 182 kHz.

(2) A ship station calling another ship station should use for the call:

a) the carrier frequency 2 182 kHz;

b) an intership frequency, whenever and wherever traffic density is high and prior arrangements can be made.

(3) Subject to the provisions of § 10.(6), coast stations should, in accordance with the requirements of their own country, call ship stations of their own nationality either on a working frequency or, when calls to individual ships are made, on the carrier frequency 2 182 kHz.

(4) However, a ship station which keeps watch simultaneously on the carrier frequency 2 182 kHz and a working frequency should be called on the working frequency.

(5) As a general rule, coast stations should call radiotelephone ship stations of another nationality on the carrier frequency 2 182 kHz.

(6) Coast stations may call ship stations by digital selective calling in accordance with Recommendation ITU-R M.541.

B2. Bands between 4 000 kHz and 27 500 kHz

11. (1) A ship station calling a coast station by radiotelephony should use either one of the calling frequencies mentioned in RR No. **52.221** or the working frequency associated with that of the coast station, in accordance with RR Appendix **17**, Part B Section I.

(2) A coast station calling a ship station by radiotelephony should use one of the calling frequencies mentioned in RR No. **52.222**, one of its working frequencies shown in the List of Coast Stations and Special Service Stations, or the carrier frequency 4 125 kHz or 6 215 kHz, in accordance with the provisions of RR Nos. **52.221.2** and **52.221.3**.

(3) The provisions of § 11.(1) and § 11.(2) do not apply to communications between ship stations and coast stations using the simplex frequencies specified in RR Appendix **17**, Part B, Section I.

B3. Bands between 156 MHz and 174 MHz

12. (1) In the bands between 156 MHz and 174 MHz, intership and coast station to ship calling should, as a general rule, be made on 156.8 MHz. However, coast station to ship calling may be conducted on a working channel or on a two-frequency calling channel which has been implemented in accordance with RR No. **52.236**. Except for distress, urgency or safety communications, when 156.8 MHz should be used, ship to coast station calling should, whenever possible, be made on a working channel or on a two-frequency calling channel which has been implemented in accordance with RR No. **52.236**. Ships wishing to participate in a port operations service or ship movement service should call on a port operations or ship movement working frequency, indicated in the List of Coast Stations and Special Service Stations.

(2) When 156.8 MHz is being used for distress, urgency or safety communications, a ship station desiring to participate in the port operations service may establish contact on 156.6 MHz, or another port operations frequency indicated in the List of Coast Stations and Special Service Stations.

B4. Procedure for calling a station providing pilot service

13. A radiotelephone ship station calling a pilot station providing pilot service should use the frequencies or channels assigned for the pilot station, in order of preference:

a) an appropriate channel in the bands between 156 MHz and 174 MHz;

b) a working frequency in the bands between 1 605 kHz and 4 000 kHz;

c) the carrier frequency 2 182 kHz, and then only to determine the working frequency to be used.

C. Form of reply to calls

14. The reply to calls consists of:

– the call sign or other identification of the calling station, not more than three times;

– the words "THIS IS";

– the call sign or other identification of the station called (see RR Nos. **19.73** and **19.74**), not more than three times.

D. Frequency for reply

D1. Bands between 1 605 kHz and 4 000 kHz

15. (1) When a ship station is called on the carrier frequency 2 182 kHz, it should reply on the same carrier frequency unless another frequency is indicated by the calling station.

(2) When a ship station is called by digital selective calling it should reply on a frequency on which the coast station keeps watch.

(3) When a ship station is called on a working frequency by a coast station of the same nationality, it should reply on the working frequency normally associated with the frequency used by the coast station for the call.

(4) When calling a coast station or another ship station, a ship station should indicate the frequency on which a reply is required if this frequency is not the normal one associated with the frequency used for the call.

(5) A ship station which frequently exchanges traffic with a coast station of another nationality may use the same procedure for reply as ships of the nationality of the coast station.

(6) As a general rule a coast station should reply:

a) on the carrier frequency 2 182 kHz to calls made on the carrier frequency 2 182 kHz, unless another frequency is indicated by the calling station;

b) on a working frequency to calls made on a working frequency;

c) on a working frequency to calls made in Regions 1 and 3 and in Greenland on the carrier frequency 2 191 kHz (assigned frequency 2 192.4 kHz).

D2. Bands between 4 000 kHz and 27 500 kHz

16. (1) A ship station called by a coast station should reply either on one of the calling frequencies mentioned in RR No. **52.221** or on the working frequency associated with that of the coast station, in accordance with RR Appendix **17**, Part B, Section I.

(2) A coast station called by a ship station should reply on one of the calling frequencies mentioned in RR No. **52.222**, or on one of its working frequencies shown in the List of Coast Stations and Special Service Stations.

(3) When a station is called on the carrier frequency 4 125 kHz it should reply on the same frequency unless another frequency is indicated for that purpose by the calling station.

(4) When a station is called on the carrier frequency 6 215 kHz it should reply on the same frequency unless another frequency is indicated for that purpose by the calling station.

(5) The provisions of § 16.(1) and § 16.(2) do not apply to communication between ship stations and coast stations using the simplex frequencies specified in RR Appendix **17**, Part B, Section I.

D3. Bands between 156 MHz and 174 MHz

17. When a station is called on 156.8 MHz it should reply on the same frequency unless another frequency is indicated by the calling station.

E. Indication of the frequency to be used for traffic

E1. Bands between 1 605 kHz and 4 000 kHz

18. If communication is established on the carrier frequency 2 182 kHz, coast and ship stations should transfer to working frequencies for the exchange of traffic.

E2. Bands between 4 000 kHz and 27 500 kHz

19. After a ship station has established communication with a coast station, or another ship station, on the calling frequency of the band chosen, traffic should be exchanged on their respective working frequencies.

E3. Bands between 156 MHz and 174 MHz

20. (1) Whenever communication has been established between a coast station in the public correspondence service and a ship station either on 156.8 MHz or on a two-frequency calling channel (see RR No. **52.237**), the stations should transfer to one of their normal pairs of working frequencies for the exchange of traffic. The calling station should indicate the channel to which it is proposed to transfer by reference to the frequency in MHz or, preferably, to its channel designator.

(2) When communication on 156.8 MHz has been established between a port station and a ship station, the ship station should indicate the particular service required (such as navigational information, docking instructions, etc.) and the port station should then indicate the channel to be used for the exchange of traffic by reference to the frequency in MHz, or, preferably, to its channel designator.

(3) When communication on 156.8 MHz has been established between a coast station in the ship movement service and a ship station, the coast station should then indicate the channel to be used for the exchange of traffic by reference to the frequency in MHz or, preferably, to its channel designator.

(4) A ship station, when it has established communication with another ship station on 156.8 MHz, should indicate the intership channel to which it is proposed to transfer for the exchange of traffic by reference to the frequency in MHz or, preferably, to its channel designator.

(5) However, a brief exchange of traffic not to exceed one minute concerning the safety of navigation need not be transmitted on a working frequency when it is important that all ships within range receive the transmission.

(6) Stations hearing a transmission concerning the safety of navigation should listen to the message until they are satisfied that the message is of no concern to them. They should not make any transmission likely to interfere with the message.

F. Agreement on the frequency to be used for traffic

21. (1) If the station called is in agreement with the calling station, it should transmit:

a) an indication that from that moment onwards it will listen on the working frequency or channel announced by the calling station;

b) an indication that it is ready to receive the traffic of the calling station.

(2) If the station called is not in agreement with the calling station on the working frequency or channel to be used, it should transmit an indication of the working frequency or channel proposed.

(3) For communications between a coast station and a ship station, the coast station should finally decide the frequency or channel to be used.

(4) When agreement is reached regarding the working frequency or channel which the calling station should use for its traffic, the station called should indicate that it is ready to receive the traffic.

G. Difficulties in reception

22. (1) If the station called is unable to accept traffic immediately, it should reply to the call as indicated in § 14 followed by "WAIT . . . MINUTES", indicating the probable duration of waiting time in minutes. If the probable duration exceeds ten minutes the reason for the delay should be given. Alternatively the station called may indicate, by any appropriate means, that it is not ready to receive traffic immediately.

(2) When a station receives a call without being certain that such a call is intended for it, it should not reply until the call has been repeated and understood.

(3) When a station receives a call which is intended for it, but identification of the calling station is uncertain, it should reply immediately asking for a repetition of the call sign or other identification of the calling station.

Section III. Forwarding (routing) of traffic

A. Traffic frequency

23. (1) Every station should transmit its radiotelephone calls on one of its working frequencies in the band in which the call has been made.

(2) In addition to its normal working frequency, specified in the List of Coast Stations and Special Service Stations, a coast station may use one or more supplementary frequencies in the same band, in accordance with the provisions of RR Article **52**.

(3) Before transmitting for other than distress purposes on any of the frequencies identified in RR Appendix **15** for distress and safety, a station should, where practicable, listen on the frequency concerned to make sure that no distress transmission is being sent. The use of frequencies reserved for calling should be forbidden for traffic, except distress traffic (see RR No. **31.4**).

(4) After communication has been established on the frequency to be used for traffic, the transmission of a radiotelegram or radiotelephone call should be preceded by:

– the call sign or other identification of the station called;

– the words "THIS IS";

– the call sign or other identification of the calling station (see RR Nos. **19.73** and **19.74**) once.

Section IV. Duration and control of working

24. (1) In communications between coast stations and ship stations, the ship station should comply with the instructions given by the coast station in all questions relating to the order and time of transmission, to the choice of frequency, and to the duration and suspension of work.

(2) In communications between ship stations, the station called controls the working in the manner indicated in § 24.(1) above. However, if a coast station finds it necessary to intervene, the ship stations should comply with the instructions given by the coast station.

RECOMMENDATION ITU-R M.1172-0*

MISCELLANEOUS ABBREVIATIONS AND SIGNALS TO BE USED FOR RADIOCOMMUNICATIONS IN THE MARITIME MOBILE SERVICE

(1995)

The ITU Radiocommunication Assembly,

considering

a) that there is a need to describe miscellaneous abbreviations and signals to be used in the maritime mobile service,

recommends

1 that the use of miscellaneous abbreviations and signals for radiocommunications in the maritime mobile service be in accordance with Annex 1.

ANNEX 1

Miscellaneous abbreviations and signals to be used for radiocommunications in the maritime mobile service

Section I. Q Code

Introduction

1 The series of groups listed in this Annex range from QOA to QUZ.

2 The QOA to QQZ series are reserved for the maritime mobile service.

3 Certain Q code abbreviations may be given an affirmative or negative sense by sending, immediately following the abbreviation, the letter C or the letters NO (in radiotelephony spoken as: CHARLIE or NO).

4 The meanings assigned to Q code abbreviations may be amplified or completed by the appropriate addition of other groups, call signs, place names, figures, numbers, etc. It is optional to fill in the blanks shown in parentheses. Any data which are filled in where blanks appear shall be sent in the same order as shown in the text of the following tables.

5 Q code abbreviations are given the form of a question when followed by a question mark in radiotelegraphy and RQ (ROMEO QUEBEC) in radiotelephony. When an abbreviation is used as a question and is followed by additional or complementary information, the question mark (or RQ) should follow this information.

6 Q code abbreviations with numbered alternative significations shall be followed by the appropriate figure to indicate the exact meaning intended. This figure shall be sent immediately following the abbreviation.

7 All times shall be given in Coordinated Universal Time (UTC) unless otherwise indicated in the question or reply.

8 An asterisk * following a Q code abbreviation means that this signal has a meaning similar to a signal appearing in the International Code of Signals.

* This Recommendation should be brought to the attention of the International Maritime Organization (IMO).

Abbreviations Available for the Maritime Mobile Service

A. List of Abbreviations in Alphabetical Order

Abbre-viation	Question	Answer or Advice
QOA	Can you communicate by radio-telegraphy (500 kHz)?	I can communicate by radiotele-graphy (500 kHz).
QOB	Can you communicate by radio-telephony (2 182 kHz)?	I can communicate by radio-telephony (2 182 kHz).
QOC	Can you communicate by radiote-lephony (channel 16 – frequency 156.80 MHz)?	I can communicate by radiotele-phony (channel 16 – frequency 156.80 MHz).
QOD	Can you communicate with me in … 0. Dutch 5. Italian 1. English 6. Japanese 2. French 7. Norwegian 3. German 8. Russian 4. Greek 9. Spanish?	I can communicate with you in … 0. Dutch 5. Italian 1. English 6. Japanese 2. French 7. Norwegian 3. German 8. Russian 4. Greek 9. Spanish.
QOE	Have you received the safety signal sent by … *(name and/or call sign)*?	I have received the safety signal sent by … *(name and/or call sign)*.
QOF	What is the commercial quality of my signals?	The quality of your signals is … 1. not commercial 2. marginally commercial 3. commercial.
QOG	How many tapes have you to send?	I have … tapes to send.
QOH	Shall I send a phasing signal for … seconds?	Send a phasing signal for … sec-onds.
QOI	Shall I send my tape?	Send your tape.
QOJ	Will you listen on … kHz (*or* MHz) for signals of emergency position-indicating radiobea-cons?	I am listening on … kHz (*or* MHz) for signals of emergency posi-tion-indicating radiobeacons.

Abbre-viation	Question	Answer or Advice
QOK	Have you received the signals of an emergency position-indicating radiobeacon on … kHz (*or* MHz)?	I have received the signals of an emergency position-indicating radiobeacon on … kHz (*or* MHz).
QOL	Is your vessel fitted for reception of selective calls? If so, what is your selective call number or signal?	My vessel is fitted for the reception of selective calls. My selective call number or signal is …
QOM	On what frequencies can your vessel be reached by a selective call?	My vessel can be reached by a selective call on the following frequency/ies … (periods of time to be added if necessary).
QOO	Can you send on any working frequency?	I can send on any working frequency.
QOT	Do you hear my call; what is the approximate delay in minutes before we may exchange traffic?	I hear your call; the approximate delay is … minutes.
QRA	What is the name of your vessel (*or* station)?	The name of my vessel (*or* station) is …
QRB	How far approximately are you from my station?	The approximate distance between our stations is … nautical miles (*or* kilometres).
QRC	By what private enterprise (*or* state administration) are the accounts for charges for your station settled?	The accounts for charges of my station are settled by the private enterprise … (*or* state administration).
QRD	Where are you bound for and where are you from?	I am bound for … from …
QRE	What is your estimated time of arrival at … (*or* over …) *(place)*?	My estimated time of arrival at … (*or* over …) *(place)* is … hours.
QRF	Are you returning to … *(place)*?	I am returning to … *(place)*. *or* Return to ... (*place*).

Abbre-viation	Question	Answer or Advice
QRG	Will you tell me my exact frequency (*or* that of …)?	Your exact frequency (*or* that of …) is ... kHz (*or* MHz).
QRH	Does my frequency vary?	Your frequency varies.
QRI	How is the tone of my transmission?	The tone of your transmission is … 1. good 2. variable 3. bad.
QRJ	How many radiotelephone calls have you to book?	I have … radiotelephone calls to book.
QRK	What is the intelligibility of my signals (*or* those of … *(name and/or call sign)*)?	The intelligibility of your signals (*or* those of … *(name and/or call sign)*) is … 1. bad 2. poor 3. fair 4. good 5. excellent.
QRL	Are you busy?	I am busy (*or* I am busy with … *(name and/or call sign)*). Please do not interfere.
QRM	Is my transmission being interfered with?	Your transmission is being interfered with … 1. nil 2. slightly 3. moderately 4. severely 5. extremely.
QRN	Are you troubled by static?	I am troubled by static … 1. nil 2. slightly 3. moderately 4. severely 5. extremely.

Abbre-viation	Question	Answer or Advice
QRO	Shall I increase transmitter power?	Increase transmitter power.
QRP	Shall I decrease transmitter power?	Decrease transmitter power.
QRQ	Shall I send faster?	Send faster (… words per minute).
QRR	Are you ready for automatic operation?	I am ready for automatic operation. Send at … words per minute.
QRS	Shall I send more slowly?	Send more slowly (… words per minute).
QRT	Shall I stop sending?	Stop sending.
QRU	Have you anything for me?	I have nothing for you.
QRV	Are you ready?	I am ready.
QRW	Shall I inform … that you are calling him on … kHz (*or* MHz)?	Please inform … that I am calling him on … kHz (*or* MHz).
QRX	When will you call me again?	I will call you again at … hours on … kHz (*or* MHz).
QRY	What is my turn? *(Relates to communication.)*	Your turn is Number … *(or according to any other indication). (Relates to communication.)*
QRZ	Who is calling me?	You are being called by … (on … kHz(*or* MHz)).
QSA	What is the strength of my signals (*or* those of … *(name and/or call sign)*)?	The strength of your signals (*or* those of … *(name and/or call sign)*) is … 1. scarcely perceptible 2. weak 3. fairly good 4. good 5. very good.

Abbre-viation	Question	Answer or Advice
QSB	Are my signals fading?	Your signals are fading.
QSC	Are you a low traffic ship station?	I am a low traffic ship station.
QSD	Are my signals mutilated?	Your signals are mutilated.
QSE*	What is the estimated drift of the survival craft?	The estimated drift of the survival craft is … *(figures and units)*.
QSF*	Have you effected rescue?	I have effected rescue and am proceeding to … base (with … persons injured requiring ambulance).
QSG	Shall I send … telegrams at a time?	Send … telegrams at a time.
QSH	Are you able to home with your direction-finding equipment?	I am able to home with my direction-finding equipment (on … *(name and/or call sign)*).
QSI		I have been unable to break in on your transmission. *or* Will you inform … *(name and/or call sign)* that I have been unable to break in on his transmission (on … kHz (*or* MHz)).
QSJ	What is the charge to be collected to … including your internal charge?	The charge to be collected to … including my internal charge is … francs.
QSK	Can you hear me between your signals and if so may I break in on your transmission?	I can hear you between my signals; break in on my transmission.
QSL	Can you acknowledge receipt?	I am acknowledging receipt.

Abbre-viation	Question	Answer or Advice
QSM	Shall I repeat the last telegram which I sent you (*or* some previous telegram)?	Repeat the last telegram which you sent me (*or* telegram(s) number(s) …).
QSN	Did you hear me (*or* … *(name and/or call sign)*) on … kHz (*or* MHz)?	I did hear you (*or* … *(name and/or call sign)*) on … kHz (*or* MHz).
QSO	Can you communicate with … *(name and/or call sign)* direct (*or* by relay)?	I can communicate with … *(name and/or call sign)* direct (*or* by relay through …).
QSP	Will you relay to … *(name and/or call sign)* free of charge?	I will relay to … *(name and/or call sign)* free of charge.
QSQ	Have you a doctor on board (*or* is … *(name of person)* on board)?	I have a doctor on board (*or* … *(name of person)* is on board).
QSR	Shall I repeat the call on the calling frequency?	Repeat your call on the calling frequency; did not hear you (*or* have interference).
QSS	What working frequency will you use?	I will use the working frequency … kHz (*or* MHz) *(in the high frequency bands normally only the last three figures of the frequency need be given)*.
QSU	Shall I send or reply on this frequency (*or* on … kHz (*or* MHz)) (with emissions of class …)?	Send or reply on this frequency (*or* on … kHz (*or* MHz)) (with emissions of class …).
QSV	Shall I send a series of Vs (*or* signs) for adjustment on this frequency (*or* on … kHz (*or* MHz))?	Send a series of Vs (*or* signs) for adjustment on this frequency (*or* on … kHz (*or* MHz)).

Abbre-viation	Question	Answer or Advice
QSW	Will you send on this frequency (*or* on … kHz (*or* MHz)) (with emissions of class …)?	I am going to send on this frequency (*or* on … kHz (*or* MHz)) (with emissions of class …).
QSX	Will you listen to … *(name and/or call sign(s))* on … kHz (*or* MHz), or in the bands …/ channels …?	I am listening to … *(name and/or call sign(s))* on … kHz (*or* MHz), or in the bands …/ channels …
QSY	Shall I change to transmission on another frequency?	Change to transmission on another frequency (*or* on … kHz (*or* MHz)).
QSZ	Shall I send each word or group more than once?	Send each word or group twice (*or* … times).
QTA	Shall I cancel telegram (*or* message) number …?	Cancel telegram (*or* message) number …
QTB	Do you agree with my counting of words?	I do not agree with your counting of words; I will repeat the first letter or digit of each word or group.
QTC	How many telegrams have you to send?	I have … telegrams for you (*or* for … *(name and/or call sign)*).
QTD*	What has the rescue vessel or rescue aircraft recovered?	… *(identification)* has recovered… 1. … *(number)* survivors 2. wreckage 3. … *(number)* bodies.
QTE	What is my TRUE bearing from you? *or* What is my TRUE bearing from … *(name and/or call sign)*? *or*	Your TRUE bearing from me is … degrees at … hours. *or* Your TRUE bearing from … *(name and/or call sign)* was … degrees at … hours. *or*

Abbre-viation	Question	Answer or Advice
QTE (cont.)	What is the TRUE bearing of … *(name and/or call sign)* from … *(name and/or call sign)*?	The TRUE bearing of … *(name and/or call sign)* from … *(name and/or call sign)* was … degrees at … hours.
QTF	Will you give me my position according to the bearings taken by the direction-finding stations which you control?	Your position according to the bearings taken by the direction-finding stations which I control was … latitude, … longitude *(or other indication of position)*, class … at … hours.
QTG	Will you send two dashes of ten seconds each (*or* carrier) followed by your call sign (*or* name) (repeated … times) on … kHz (or MHz)?	I am going to send two dashes of ten seconds each (*or* carrier) followed by my call sign (*or* name) (repeated … times) on … kHz (*or* MHz).
	or	*or*
	Will you request … *(name and/or call sign)* to send two dashes of ten seconds each (*or* carrier) followed by his call sign *(and/or name)* (repeated … times) on … kHz (*or* MHz)?	I have requested … *(name and/or call sign)* to send two dashes of ten seconds each (*or* carrier) followed by his call sign *(and/or name)* (repeated … times) on ... kHz (*or* MHz).
QTH	What is your position in latitude and longitude *(or according to any other indication)*?	My position is … latitude, … longitude *(or according to any other indication).*
QTI*	What is your TRUE course?	My TRUE course is … degrees.

Abbre-viation	Question	Answer or Advice
QTJ*	What is your speed? *(Requests the speed of a ship or aircraft through the water or air respectively.)*	My speed is … knots (*or* kilometres per hour *or* … statute miles per hour). *(Indicates the speed of a ship or aircraft through the water or air respectively.)*
QTK*	What is the speed of your aircraft in relation to the surface of the Earth?	The speed of my aircraft in relation to the surface of the Earth is … knots (*or* … kilometres per hour *or* … statute miles per hour).
QTL*	What is your TRUE heading?	My TRUE heading is … degrees.
QTM*	What is your MAGNETIC heading?	My MAGNETIC heading is … degrees.
QTN	At what time did you depart from … *(place)*?	I departed from … *(place)* at … hours.
QTO	Have you left dock (*or* port)? *or* Are you airborne?	I have left dock (*or* port). *or* I am airborne.
QTP	Are you going to enter dock (*or* port)? *or* Are you going to alight (*or* land)?	I am going to enter dock (*or* port). *or* I am going to alight (*or* land).
QTQ	Can you communicate with my station by means of the International Code of Signals (INTERCO)?	I am going to communicate with your station by means of the International Code of Signals (INTERCO).
QTR	What is the correct time?	The correct time is … hours.
QTS	Will you send your call sign (*and/or* name) for … seconds?	I will send my call sign (*and/or* name) for … seconds.
QTT		The identification signal which follows is superimposed on another transmission.

Abbre-viation	Question	Answer or Advice
QTU	What are the hours during which your station is open?	My station is open from … to … hours.
QTV	Shall I stand guard for you on the frequency of … kHz (*or* MHz) (from … to … hours)?	Stand guard for me on the frequency of … kHz (*or* MHz) (from … to … hours).
QTW*	What is the condition of survivors?	Survivors are in … condition and urgently need …
QTX	Will you keep your station open for further communication with me until further notice (*or* until … hours)?	I will keep my station open for further communication with you until further notice (*or* until … hours).
QTY*	Are you proceeding to the position of incident and if so when do you expect to arrive?	I am proceeding to the position of incident and expect to arrive at … hours (on ... *(date)*).
QTZ*	Are you continuing the search?	I am continuing the search for … (aircraft, ship, survival craft, survivors or wreckage).
QUA	Have you news of … *(name and/or call sign)*?	Here is news of … *(name and/or call sign)*.
QUB*	Can you give me in the following order information concerning: the direction in degrees TRUE and speed of the surface wind; visibility; present weather; and amount, type and height of base of cloud above surface elevation at … *(place of observation)*?	Here is the information requested: … *(The units used for speed and distances should be indicated.)*

Abbre-viation	Question	Answer or Advice
QUC	What is the number *(or other indication)* of the last message you received from me (*or* from … *(name and/or call sign)*)?	The number *(or other indication)* of the last message I received from you (*or* from … *(name and/or call sign)*) is …
QUD	Have you received the urgency signal sent by … *(name and/or call sign)*?	I have received the urgency signal sent by … *(name and/or call sign)* at … hours.
QUE	Can you speak in … *(language)*, with interpreter if necessary; if so, on what frequencies?	I can speak in … *(language)* on … kHz (*or* MHz).
QUF	Have you received the distress signal sent by … *(name and/or call sign)*?	I have received the distress signal sent by … *(name and/or call sign)* at … hours.
QUH*	Will you give me the present barometric pressure at sea level?	The present barometric pressure at sea level is … *(units)*.
QUM	May I resume normal working?	Normal working may be resumed.
QUN	1. *When directed to all stations:* Will vessels in my immediate vicinity … *or* (in the vicinity of … latitude, … longitude) *or* (in the vicinity of …) please indicate their position, TRUE course and speed? 2. *When directed to a single station:* Please indicate your position, TRUE course and speed.	My position, TRUE course and speed are …

Abbre-viation	Question	Answer or Advice
QUO*	Shall I search for…. 1. aircraft 2. ship 3. survival craft in the vicinity of … latitude, … longitude *(or according to any other indication)*?	Please search for … 1. aircraft 2. ship 3. survival craft in the vicinity of … latitude, … longitude *(or according to any other indication)*.
QUP*	Will you indicate your position by … 1. searchlight 2. black smoke trail 3. pyrotechnic lights?	My position is indicated by … 1. searchlight 2. black smoke trail 3. pyrotechnic lights.
QUR*	Have survivors … 1. received survival equipment 2. been picked up by rescue vessel 3. been reached by ground rescue party?	Survivors ... 1. are in possession of survival equipment dropped by … 2. have been picked up by rescue vessel 3. have been reached by ground rescue party.
QUS*	Have you sighted survivors or wreckage? If so, in what position?	Have sighted … 1. survivors in water 2. survivors on rafts 3. wreckage in position … latitude, … longitude *(or according to any other indication)*.
QUT*	Is position of incident marked?	Position of incident is marked by … 1. flame or smoke float 2. sea marker 3. sea marker dye 4. … *(specify other marking)*.

Abbre-viation	Question	Answer or Advice
QUU*	Shall I home ship or aircraft to my position?	Home ship or aircraft … *(name and/or call sign)* … 1. to your position by sending your call sign and long dashes on … kHz (*or* MHz) 2. by sending on … kHz (*or* MHz) TRUE track to reach you.
QUW*	Are you in the search area designated as … *(designator or latitude and longitude)*?	I am in the … *(designation)* search area.
QUX	Do you have any navigational warnings or gale warnings in force?	I have the following navigational warning(s) or gale warning(s) in force: …
QUY*	Is position of survival craft marked?	Position of survival craft was marked at … hours by … 1. flame or smoke float 2. sea marker 3. sea marker dye 4. … *(specify other marking)*.
QUZ	May I resume restricted working?	Distress phase still in force; restricted working may be resumed.

B. List of Signals According to the Nature of Questions, Answer or Advice

Abbre-viation	Question	Answer or Advice
	Name	
QRA	What is the name of your vessel (*or* station)?	The name of my vessel (*or* station) is …
	Route	
QRD	Where are you bound for and where are you from?	I am bound for … from …
	Position	
QRB	How far approximately are you from my station?	The approximate distance between our stations is … nautical miles (*or* kilometres).
QTH	What is your position in latitude and longitude *(or according to any other indication)*?	My position is … latitude, … longitude *(or according to any other indication)*.
QTN	At what time did you depart from … *(place)*?	I departed from … *(place)* at … hours.
	Quality of Signals	
QOF	What is the commercial quality of my signals?	The quality of your signals is … 1. not commercial 2. marginally commercial 3. commercial.
QRI	How is the tone of my transmission?	The tone of your transmission is… 1. good 2. variable 3. bad.

Abbre-viation	Question	Answer or Advice
	Quality of Signals (cont.)	
QRK	What is the intelligibility of my signals (*or* those of … *(name and/or call sign)*)?	The intelligibility of your signals (*or* those of … *(name and/or call sign)*) is … 1. bad 2. poor 3. fair 4. good 5. excellent.
	Strength of Signals	
QRO	Shall I increase transmitter power?	Increase transmitter power.
QRP	Shall I decrease transmitter power?	Decrease transmitter power.
QSA	What is the strength of my signals (*or* those of … *(name and/or call sign)*)?	The strength of your signals (*or* those of … *(name and/or call sign)*) is … 1. scarcely perceptible 2. weak 3. fairly good 4. good 5. very good.
QSB	Are my signals fading?	Your signals are fading.
	Keying	
QRQ	Shall I send faster?	Send faster (… words per minute).
QRR	Are you ready for automatic operation?	I am ready for automatic operation. Send at … words per minute.

Abbre-viation	Question	Answer or Advice
	Keying (cont.)	
QRS	Shall I send more slowly?	Send more slowly (… words per minute).
QSD	Are my signals mutilated?	Your signals are mutilated.
	Interference	
QRM	Is my transmission being interfered with?	Your transmission is being interfered with … 1. nil 2. slightly 3. moderately 4. severely 5. extremely.
QRN	Are you troubled by static?	I am troubled by static … 1. nil 2. slightly 3. moderately 4. severely 5. extremely.
	Adjustment of Frequency	
QRG	Will you tell me my exact frequency (*or* that of …)?	Your exact frequency (*or* that of …) is … kHz (*or* MHz).
QRH	Does my frequency vary?	Your frequency varies.
QTS	Will you send your call sign *(and/or name)* for … seconds?	I will send my call sign *(and/or name)* for … seconds.
	Choice of Frequency and/or Class of Emission	
QOO	Can you send on any working frequency?	I can send on any working frequency.

Abbre-viation	Question	Answer or Advice
	Choice of Frequency and/or Class of Emission (cont.)	
QSN	Did you hear me (*or* … *(name and/or call sign)*) on … kHz (*or* MHz)?	I did hear you (*or* … *(name and/or call sign)*) on … kHz (*or* MHz).
QSS	What working frequency will you use?	I will use the working frequency … kHz (*or* MHz) *(in the high frequency bands normally only the last three figures of the frequency need be given)*.
QSU	Shall I send or reply on this frequency (*or* on … kHz (*or* MHz)) (with emissions of class …)?	Send or reply on this frequency (*or* on … kHz (*or* MHz)) (with emissions of class …).
QSV	Shall I send a series of Vs (*or* signs) for adjustment on this frequency (*or* on … kHz (*or* MHz))?	Send a series of Vs (*or* signs) for adjustment on this frequency (*or* on … kHz (*or* MHz)).
QSW	Will you send on this frequency (*or* on … kHz (*or* MHz)) (with emissions of class …)?	I am going to send on this frequency (*or* on … kHz (*or* MHz)) (with emissions of class …).
QSX	Will you listen to … *(name and/or call sign(s))* on … kHz (*or* MHz), or in the bands …/ channels …?	I am listening to … *(name and/or call sign(s))* on … kHz (*or* MHz), or in the bands …/ channels …
	Change of Frequency	
QSY	Shall I change to transmission on another frequency?	Change to transmission on another frequency (*or* on … kHz (*or* MHz)).
	Establishing Communication	
QOA	Can you communicate by radiotelegraphy (500 kHz)?	I can communicate by radiotelegraphy (500 kHz).

Abbre-viation	Question	Answer or Advice
	Establishing Communication (cont.)	
QOB	Can you communicate by radio-telephony (2 182 kHz)?	I can communicate by radiotele-phony (2 182 kHz).
QOC	Can you communicate by radio-telephony (channel 16 – fre-quency 156.80 MHz)?	I can communicate by radio-telephony (channel 16 – fre-quency 156.80 MHz).
QOD	Can you communicate with me in … 0. Dutch 5. Italian 1. English 6. Japanese 2. French 7. Norwegian 3. German 8. Russian 4. Greek 9. Spanish?	I can communicate with you in … 0. Dutch 5. Italian 1. English 6. Japanese 2. French 7. Norwegian 3. German 8. Russian 4. Greek 9. Spanish.
QOT	Do you hear my call; what is the approximate delay in minutes before we may exchange traffic?	I hear your call; the approximate delay is … minutes.
QRL	Are you busy?	I am busy (*or* I am busy with … *(name and/or call sign)*). Please do not interfere.
QRV	Are you ready?	I am ready.
QRX	When will you call me again?	I will call you again at … hours on … kHz (*or* MHz).
QRY	What is my turn? *(Relates to communication.)*	Your turn is Number … *(or ac-cording to any other indication). (Relates to communication.)*
QRZ	Who is calling me?	You are being called by … (on … kHz (*or* MHz)).
QSC	Are you a low traffic ship station?	I am a low traffic ship station.

Abbre-viation	Question	Answer or Advice
	Establishing Communication (cont.)	
QSR	Shall I repeat the call on the calling frequency?	Repeat your call on the calling frequency; did not hear you (*or* have interference).
QTQ	Can you communicate with my station by means of the International Code of Signals (INTERCO)?	I am going to communicate with your station by means of the International Code of Signals (INTERCO).
QUE	Can you speak in … *(language)*, with interpreter if necessary; if so, on what frequencies?	I can speak in … *(language)* on … kHz (*or* MHz).
	Selective Calls	
QOL	Is your vessel fitted for reception of selective calls? If so, what is your selective call number or signal?	My vessel is fitted for the reception of selective calls. My selective call number or signal is …
QOM	On what frequencies can your vessel be reached by a selective call?	My vessel can be reached by a selective call on the following frequency/ies … (periods of time to be added if necessary).
	Time	
QTR	What is the correct time?	The correct time is ... hours.
QTU	What are the hours during which your station is open?	My station is open from … to … hours.
	Charges	
QRC	By what private enterprise (*or* state administration) are the accounts for charges for your station settled?	The accounts for charges of my station are settled by the private enterprise … (*or* state administration).

Abbre-viation	Question	Answer or Advice
	Charges (cont.)	
QSJ	What is the charge to be collected to … including your internal charge?	The charge to be collected to … including my internal charge is … francs.
	Transit	
QRW	Shall I inform … that you are calling him on … kHz (*or* MHz)?	Please inform … that I am calling him on … kHz (*or* MHz).
QSO	Can you communicate with … *(name and/or call sign)* direct (*or* by relay)?	I can communicate with … *(name and/or call sign)* direct (*or* by relay through …).
QSP	Will you relay to … *(name and/or call sign)* free of charge?	I will relay to … *(name and/or call sign)* free of charge.
QSQ	Have you a doctor on board (*or* is … *(name of person)* on board)?	I have a doctor on board (*or* … *(name of person)* is on board).
QUA	Have you news of … *(name and/or call sign)*?	Here is news of … *(name and/or call sign)*.
QUC	What is the number *(or other indication)* of the last message you received from me (*or* from … *(name and/or call sign)*)?	The number *(or other indication)* of the last message I received from you (*or* from … *(name and/or call sign)*) is ...
	Exchange of Correspondence	
QOG	How many tapes have you to send?	I have … tapes to send.
QOH	Shall I send a phasing signal for … seconds?	Send a phasing signal for … seconds.

Abbre-viation	Question	Answer or Advice
	Exchange of Correspondence (cont.)	
QOI	Shall I send my tape?	Send your tape.
QRJ	How many radiotelephone calls have you to book?	I have … radiotelephone calls to book.
QRU	Have you anything for me?	I have nothing for you.
QSG	Shall I send … telegrams at a time?	Send … telegrams at a time.
QSI		I have been unable to break in on your transmission. *or* Will you inform … *(name and/or call sign)* that I have been unable to break in on his transmission (on … kHz (*or* MHz)).
QSK	Can you hear me between your signals and if so may I break in on your transmission?	I can hear you between my signals; break in on my transmission.
QSL	Can you acknowledge receipt?	I am acknowledging receipt.
QSM	Shall I repeat the last telegram which I sent you (*or* some previous telegram)?	Repeat the last telegram which you sent me (*or* telegram(s) number(s) …).
QSZ	Shall I send each word or group more than once?	Send each word or group twice (*or* … times).
QTA	Shall I cancel telegram (*or* message) number …?	Cancel telegram (*or* message) number …
QTB	Do you agree with my counting of words?	I do not agree with your counting of words; I will repeat the first letter or digit of each word or group.

Abbre-viation	Question	Answer or Advice
	Exchange of Correspondence (cont.)	
QTC	How many telegrams have you to send?	I have … telegrams for you (*or* for … *(name and/or call sign)*).
QTV	Shall I stand guard for you on the frequency of … kHz (*or* MHz) (from … to … hours)?	Stand guard for me on the frequency of … kHz (*or* MHz) (from … to … hours).
QTX	Will you keep your station open for further communication with me until further notice (*or* until … hours)?	I will keep my station open for further communication with you until further notice (*or* until … hours).
	Movement	
QRE	What is your estimated time of arrival at … (*or* over …) *(place)*?	My estimated time of arrival at … (*or* over …) *(place)* is … hours.
QRF	Are you returning to … *(place)*?	I am returning to … *(place)*. *or* Return to … *(place)*.
QSH	Are you able to home with your direction-finding equipment?	I am able to home with my direction-finding equipment (on … *(name and/or call sign)*).
QTI*	What is your TRUE course?	My TRUE course is … degrees.
QTJ*	What is your speed? *(Requests the speed of a ship or aircraft through the water or air respectively.)*	My speed is … knots (*or* kilometres per hour *or* … statute miles per hour). *(Indicates the speed of a ship or aircraft through the water or air respectively.)*

Abbre-viation	Question	Answer or Advice
	Movement (cont.)	
QTK*	What is the speed of your aircraft in relation to the surface of the Earth?	The speed of my aircraft in relation to the surface of the Earth is … knots (*or* … kilometres per hour *or* … statute miles per hour).
QTL*	What is your TRUE heading?	My TRUE heading is … degrees.
QTM*	What is your MAGNETIC heading?	My MAGNETIC heading is … degrees.
QTN	At what time did you depart from … *(place)*?	I departed from … *(place)* at … hours.
QTO	Have you left dock (*or* port)? *or* Are you airborne?	I have left dock (*or* port). *or* I am airborne.
QTP	Are you going to enter dock (*or* port)? *or* Are you going to alight (*or* land)?	I am going to enter dock (*or* port). *or* I am going to alight (*or* land).
QUN	1. *When directed to all stations:* Will vessels in my immediate vicinity … *or* (in the vicinity of … latitude, … longitude) *or* (in the vicinity of …) please indicate their position, TRUE course and speed? 2. *When directed to a single station:* Please indicate your position, TRUE course and speed.	My position, TRUE course and speed are …

Abbre-viation	Question	Answer or Advice
	Meteorology	
QUB*	Can you give me in the following order information concerning: the direction in degrees TRUE and speed of the surface wind; visibility; present weather; and amount, type and height of base of cloud above surface elevation at … *(place of observation)*?	Here is the information requested: … *(The units used for speed and distances should be indicated.)*
QUH*	Will you give me the present barometric pressure at sea level?	The present barometric pressure at sea level is … *(units)*.
QUX	Do you have any navigational warnings or gale warnings in force?	I have the following navigational warning(s) or gale warning(s) in force: …
	Radio Direction-Finding	
QTE	What is my TRUE bearing from you?	Your TRUE bearing from me is … degrees at … hours.
	or	*or*
	What is my TRUE bearing from … *(name and/or call sign)*?	Your TRUE bearing from … *(name and/or call sign)* was … degrees at … hours.
	or	*or*
	What is the TRUE bearing of … *(name and/or call sign)* from … *(name and/or call sign)*?	The TRUE bearing of … *(name and/or call sign)* from … *(name and/or call sign)* was … degrees at … hours.

Abbre-viation	Question	Answer or Advice
	Radio Direction-Finding (cont.)	
QTF	Will you give me my position according to the bearings taken by the direction-finding stations which you control?	Your position according to the bearings taken by the direction-finding stations which I control was … latitude, … longitude *(or other indication of position)*, class … at … hours.
QTG	Will you send two dashes of ten seconds each (*or* carrier) followed by your call sign (*or* name) (repeated … times) on … kHz (*or* MHz)?	I am going to send two dashes of ten seconds each (*or* carrier) followed by my call sign (*or* name) (repeated … times) on … kHz (*or* MHz).
	or	*or*
	Will you request … *(name and/or call sign)* to send two dashes of ten seconds each (*or* carrier) followed by his call sign (*and/or* name) (repeated … times) on … kHz (*or* MHz)?	I have requested … *(name and/or call sign)* to send two dashes of ten seconds each (*or* carrier) followed by his call sign (*and/or* name) (repeated … times) on … kHz (*or* MHz).
	Suspension of Work	
QRT	Shall I stop sending?	Stop sending.
QUM	May I resume normal working?	Normal working may be resumed.
QUZ	May I resume restricted working?	Distress phase still in force; restricted working may be resumed.
	Safety	
QOE	Have you received the safety signal sent by … *(name and/or call sign)*?	I have received the safety signal sent by … *(name and/or call sign)*.

Abbre-viation	Question	Answer or Advice
	Safety (cont.)	
QUX	Do you have any navigational warnings or gale warnings in force?	I have the following navigational warning(s) or gale warning(s) in force: …
	Urgency	
QUD	Have you received the urgency signal sent by … *(name and/or call sign)*?	I have received the urgency signal sent by … *(name and/or call sign)* at … hours.
	Distress	
QOJ	Will you listen on … kHz (*or* MHz) for signals of emergency position-indicating radiobeacons?	I am listening on … kHz (*or* MHz) for signals of emergency position-indicating radiobeacons.
QOK	Have you received the signals of an emergency position-indicating radiobeacon on … kHz (*or* MHz)?	I have received the signals of an emergency position-indicating radiobeacon on … kHz (*or* MHz).
QUF	Have you received the distress signal sent by … *(name and/or call sign)*?	I have received the distress signal sent by … *(name and/or call sign)* at … hours.
QUM	May I resume normal working?	Normal working may be resumed.
QUZ	May I resume restricted working?	Distress phase still in force; restricted working may be resumed.
	Search and Rescue	
QSE*	What is the estimated drift of the survival craft?	The estimated drift of the survival craft is … *(figures and units)*.

Abbre-viation	Question	Answer or Advice
	Search and Rescue (cont.)	
QSF*	Have you effected rescue?	I have effected rescue and am proceeding to … base (with … persons injured requiring ambulance).
QTD*	What has the rescue vessel or rescue aircraft recovered?	… *(identification)* has recovered… 1….. *(number)* survivors 2. wreckage 3. … *(number)* bodies.
QTW*	What is the condition of survivors?	Survivors are in … condition and urgently need …
QTY*	Are you proceeding to the position of incident and if so when do you expect to arrive?	I am proceeding to the position of incident and expect to arrive at … hours (on … *(date)*).
QTZ*	Are you continuing the search?	I am continuing the search for … (aircraft, ship, survival craft, survivors or wreckage).
QUN	1. *When directed to all stations:* Will vessels in my immediate vicinity … *or* (in the vicinity of … latitude, … longitude) *or* (in the vicinity of …) please indicate their position, TRUE course and speed? 2. *When directed to a single station:* Please indicate your position, TRUE course and speed.	My position, TRUE course and speed are …

Abbre-viation	Question	Answer or Advice
	Search and Rescue (cont.)	
QUO*	Shall I search for … 1. aircraft 2. ship 3. survival craft in the vicinity of … latitude, … longitude *(or according to any other indication)*?	Please search for … 1. aircraft 2. ship 3. survival craft in the vicinity of … latitude, … longitude *(or according to any other indication)*.
QUP*	Will you indicate your position by … 1. searchlight 2. black smoke trail 3. pyrotechnic lights?	My position is indicted by … 1. searchlight 2. black smoke trail 3. pyrotechnic lights.
QUR*	Have survivors … 1. received survival equipment 2. been picked up by rescue vessel 3. been reached by ground rescue party?	Survivors … 1. are in possession of survival equipment dropped by … 2. have been picked up by rescue vessel 3. have been reached by ground rescue party.
QUS*	Have you sighted survivors or wreckage? If so, in what position?	Have sighted … 1. survivors in water 2. survivors on rafts 3. wreckage in position … latitude, … longitude *(or according to any other indication)*.
QUT*	Is position of incident marked?	Position of incident is marked by … 1. flame or smoke float 2. sea marker 3. sea marker dye 4. … *(specify other marking)*.

Abbre-viation	Question	Answer or Advice
	Search and Rescue (cont.)	
QUU*	Shall I home ship or aircraft to my position?	Home ship or aircraft … *(name and/or call sign)* … 1. to your position by sending your call sign and long dashes on ... kHz (*or* MHz) 2. by sending on … kHz (*or* MHz) TRUE track to reach you.
QUW*	Are you in the search area designated as … *(designator or latitude and longitude)*?	I am in the … *(designation)* search area.
QUY*	Is position of survival craft marked?	Position of survival craft was marked at … hours by … 1. flame or smoke float 2. sea marker 3. sea marker dye 4. … *(specify other marking)*.
QUZ	May I resume restricted working?	Distress phase still in force; restricted working may be resumed.
	Identification	
QTT		The identification signal which follows is superimposed on another transmission.

Section II. Miscellaneous Abbreviations and Signals

Abbre-viation or signal	Definition
AA	All after … *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
AB	All before … *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
ADS	Address *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
$\overline{\text{AR}}$	End of transmission.
$\overline{\text{AS}}$	Waiting period.
BK	Signal used to interrupt a transmission in progress.
BN	All between … and … *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
BQ	A reply to an RQ.
$\overline{\text{BT}}$	Signal to mark the separation between different parts of the same transmission.
C	Yes *or* "The significance of the previous group should be read in the affirmative".
CFM	Confirm (*or* I confirm).
CL	I am closing my station.
COL	Collate (*or* I collate).
CORREC-TION	Cancel my last word *or* group. The correct word *or* group follows *(used in radiotelephony, spoken as KOR-REK-SHUN)*.
CP	General call to two or more specified stations *(see Recommendation ITU-R M.1170)*.
CQ	General call to all stations.
CS	Call sign *(used to request a call sign)*.

Note: When used in radiotelegraphy, a bar over the letters composing a signal denotes that the letters are to be sent as one signal.

Abbre-viation or signal	Definition
DE	"From …" *(used to precede the name or other identification of the calling station)*.
DF	Your bearing at … hours was … degrees, in the doubtful sector of this station, with a possible error of … degrees.
DO	Bearing doubtful. Ask for another bearing later (*or* at … hours).
DSC	Digital selective calling.
E	East (cardinal point).
ETA	Estimated time of arrival.
INTERCO	International Code of Signals groups follow *(used in radiotelephony, spoken as IN-TER-CO)*.
K	Invitation to transmit.
$\overline{\text{KA}}$	Starting signal.
KTS	Nautical miles per hour *(knots)*.
MIN	Minute (*or* Minutes).
MSG	Prefix indicating a message to or from the master of a ship concerning its operation or navigation.
MSI	Maritime safety information.
N	North (cardinal point).
NBDP	Narrow-band direct-printing telegraphy.
NIL	I have nothing to send to you.
NO	No *(negative)*.
NW	Now.
NX	Notice to Mariners (*or* Notice to Mariners follows).
OK	We agree (*or* It is correct).
OL	Ocean letter.
P	Prefix indicating a private radiotelegram.
PBL	Preamble *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
PSE	Please.
R	Received.

Abbre-viation or signal	Definition
RCC	Rescue coordination centre.
REF	Reference to … (*or* Refer to …).
RPT	Repeat (*or* I repeat) (*or* Repeat …).
RQ	Indication of a request.
S	South (cardinal point).
SAR	Search and Rescue.
SIG	Signature *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
SLT	Radiomaritime Letter.
SVC	Prefix indicating a service telegram.
SYS	Refer to your service telegram.
TFC	Traffic.
TR	Used by a land station to request the position and next port of call of a mobile station; used also as a prefix to the reply.
TU	Thank you.
TXT	Text *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
$\overline{\text{VA}}$	End of work.
W	West (cardinal point).
WA	Word after … *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
WB	Word before … *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
WD	Word(s) *or* Group(s).
WX	Weather report (*or* Weather report follows).
XQ	Prefix used to indicate the transmission of a service note.
YZ	The words which follow are in plain language.

RECOMMENDATION ITU-R M.1173-1*

Technical characteristics of single-sideband transmitters used in the maritime mobile service for radiotelephony in the bands between 1 606.5 kHz (1 605 kHz Region 2) and 4 000 kHz and between 4 000 kHz and 27 500 kHz

(1995-2012)

Scope

This Recommendation provides the technical characteristics for single sideband transmitters used in the MF/HF maritime mobile service bands.

The ITU Radiocommunication Assembly,

considering

a) that there is a need to describe the technical characteristics of single-sideband transmitters for the bands 1 606.5 kHz (1 605 kHz Region 2) to 4 000 kHz and 4 000 kHz to 27 500 kHz,

recommends

1 that single-sideband transmitters used in the maritime mobile service for radiotelephony in the bands between 1 606.5 kHz (1 605 kHz Region 2) and 4 000 kHz and between 4 000 kHz and 27 500 kHz should be designed to meet the technical characteristics shown in Annex 1.

Annex 1

Technical characteristics of single-sideband transmitters used in the maritime mobile service for radiotelephony in the bands between 1 606.5 kHz (1 605 kHz Region 2) and 4 000 kHz and between 4 000 kHz and 27 500 kHz

1 Power of the carrier:

For class J3E emissions the power of the carrier shall be at least 40 dB below the peak envelope power.

2 Coast and ship stations shall use only the upper sideband.

3 The transmitter audio-frequency band shall be 350 Hz to 2 700 Hz with a permitted amplitude variation of 6 dB.

4 The carrier frequencies shall be maintained within the tolerances specified in Appendix 2 to the Radio Regulations.

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* This Recommendation should be brought to the attention of the International Maritime Organization (IMO), the International Electrotechnical Commission (IEC) and the Comité International Radio Maritime (CIRM).

5 The unwanted frequency modulation of the carrier shall be sufficiently low to prevent harmful distortion.

6 When class H3E or J3E emissions are used, the power of any unwanted emission supplied to the antenna transmission line on any discrete frequency shall, when the transmitter is driven to full peak envelope power, be in accordance with the following table:

Separation Δ between the frequency of the unwanted emission and the assigned frequency (kHz)	**Minimum attenuation below peak envelope power**
$1.5 < \Delta \leq 4.5$	31 dB
$4.5 < \Delta \leq 7.5$	38 dB
$7.5 < \Delta$	43 dB without the unwanted emission power exceeding the power of 50 mW

Transmitters using suppressed carrier emission may, as far as concerns out-of-band emissions and those spurious emissions which are a result of the modulation process but do not fall in the spectrum of out-of-band emissions, be tested for compliance with this regulation by means of a two-tone-audio input signal with a frequency separation between the tones such that all intermodulation products occur at frequencies at least 1.5 kHz removed from the assigned frequency.

RECOMMENDATION ITU-R M.1174-4*

Technical characteristics of equipment used for on-board vessel communications in the bands between 450 and 470 MHz

(1995-1998-2004-2015-2019)

Scope

This Recommendation describes the technical characteristics for equipment operating in the maritime mobile services in accordance with the provisions of No. **5.287** of the Radio Regulations (RR) for on-board vessel communications. Provision is made for 25 kHz or 12.5 kHz channel spacing for analogue and digital technologies. In addition, 6.25 kHz channel spacing may also be used for digital technology.

Keywords

Maritime, on-board communication, territorial waters, channel spacing, frequency arrangement, UHF

Abbreviations/Glossary

Ch. Channel number

DCS: Digital coded squelch

FSK Frequency-shift keying modulation

The ITU Radiocommunication Assembly,

considering

a) that there is a need to describe the characteristics of equipment for on-board vessel communications in the bands between 450 and 470 MHz;

b) that changes have recently been made to the frequency availability,

recommends

1 that transmitters and receivers used in the maritime mobile service for on-board vessel communications in the bands between 450 and 470 MHz should conform to the technical characteristics shown in Annex 1;

2 that for analogue technology the use of continuous tone coded squelch systems or digital coded squelch (DCS) constitute an effective means of mitigating the impression of congestion to the user;

3 that for digital technology the use of DCS or a similar operational system should be used as a way to mitigate the impression of congestion to user;

4 that during operation, to detect whether there is an available channel for operation, it is advised that a method of listen before talk be employed as a possible mitigation technique;

5 that ship owners when replacing or installing communications equipment upon vessels are encouraged to fit equipment using 12.5 kHz or 6.25 kHz channel spacing.

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* This Recommendation should be brought to the attention of the International Maritime Organization and the International Maritime Radio Committee.

Annex 1

Technical characteristics of equipment used for on-board vessel communications in the bands between 450 and 470 MHz

1 The equipment should be fitted with sufficient channels for satisfactory operation in the area of intended use.

2 The effective radiated power should be limited to the maximum required for satisfactory operations, but should in no case exceed 2 W. Wherever practicable the equipment should be fitted with a suitable device to reduce readily the output power by at least 10 dB.

3 In the case of equipment installed at a fixed point on the ship, the height of its antenna should not be more than 3.5 m above the uppermost level of the deck.

	25 kHz channels analogue technology	**12.5 kHz channels analogue technology**
4	Only frequency modulation with a pre-emphasis of 6 dB/octave (phase modulation) should be used.	Only frequency modulation with a pre-emphasis of 6 dB/octave (phase modulation) should be used.
5	The frequency deviation corresponding to 100% modulation should approach ±5 kHz as nearly as practicable. In no event should the frequency deviation exceed ±5 kHz.	The frequency deviation corresponding to 100% modulation should approach ±2.5 kHz as nearly as practicable. In no event should the frequency deviation exceed ±2.5 kHz.
6	The frequency tolerance should be 5 parts in 10^6.	The frequency tolerance should be 2.5 parts in 10^6.
7	The audio-frequency band should be limited to 3 000 Hz.	The audio-frequency band should be limited to 2 550 Hz.

	12.5 kHz channels digital technology	**6.25 kHz channels digital technology**
8	Only constant-envelope modulation, entitled 4FSK (Four-level frequency-shift keying modulation) should be used.	Only constant-envelope modulation, entitled 4FSK (Four-level frequency-shift keying modulation) should be used.
9	The frequency deviation is limited to ±3 024 Hz.	The frequency deviation is limited to ±1 471 Hz.
10	The maximum transmit frequency error: ±2 ppm. The maximum time base clock drift error: ±2 ppm.	The maximum transmit frequency error: ±1.5 ppm. The maximum time base clock drift error: ±2 ppm.

11 Control, telemetry and other non-voice signals such as paging, should be coded in such a manner as to minimize the possibility of false response to interfering signals. The frequencies specified in § 15 below for on-board communications may be used for single frequency and two-frequency simplex operation.

12 When used in the duplex mode the base transmitter frequency should be selected from the lower range for improved operability.

13 In general, if the use of a repeater station is required on board a ship, the frequency bands described in RR Nos. **5.287** and **5.288** should be used. The detailed duplex frequency arrangement is described in § 15 below.

14 Within territorial waters, these frequencies should be used subject to national regulations.

15 Frequencies

The frequency bands specified in RR No. **5.287** (subject to national regulations) shall be used with the following arrangement:

Lower channel						Upper channel					
25 kHz channel		12.5 kHz channel		6.25 kHz channel		25 kHz channel		12.5 kHz channel		6.25 kHz channel	
Ch.	MHz	Ch.	MHz	Ch.	MHz	Ch.	MHz	Ch.	MHz	Ch.	MHz
1	457.525			102	457.515625	4	467.525			202	467.515625
		11	457.5250	111	457.521875			21	467.5250	211	467.521875
				112	457.528125					212	467.528125
		12	457.5375	121	457.534375			22	467.5375	221	467.534375
2	457.550			122	457.540625	5	467.550			222	467.540625
		13	457.5500	131	457.546875			23	467.5500	231	467.546875
				132	457.553125					232	467.553125
		14	457.5625	141	457.559375			24	467.5625	241	467.559375
3	457.575			142	457.565625	6	467.575			242	467.565625
		15	457.5750	151	457.571875			25	467.5750	251	467.571875
				152	457.578125					252	467.578125
				161	457.584375					261	467.584375

NOTE – The repeater station should be used as pairs of lower channel and upper channel with frequency separation exactly 10 MHz (e.g. Ch. 2 and Ch. 5, Ch. 11 and Ch. 21).

Interference from digital system to existing analogue system is concerned. Administrations are invited to consider the impact of analogue communication especially those operating lower channel.

RECOMMENDATION ITU-R M.1187-1

A method for the calculation of the potentially affected region for a mobile-satellite service network in the 1-3 GHz range using circular orbits

(Questions ITU-R 83/8 and ITU-R 201/8)

(1995-2006)

Scope

This Recommendation defines the term "active service arc" and provides a method for the calculation of an "affected region" when assigning frequencies to space stations of MSS systems operating between 1 and 3 GHz and for giving assistance in the identification of administrations whose assignments may be included within this "affected region".

The ITU Radiocommunication Assembly,

considering

a) that there is a need to develop Recommendations on coordination methods, the necessary orbital data relating to non-geostationary (non-GSO) satellite systems, and sharing criteria;

b) that non-GSO satellite systems implementing these MSS allocations may have different constellations, with different altitudes, and different inclination angles;

c) that "active service arc" needs to be defined;

d) that there is a need to define the area where other services, including MSS, might be affected and where coordination may be performed for which the relevant criteria and methods are not defined in this Recommendation;

e) that there is a need to further define the concept of an "affected region" (which is not to be confused with the "coordination area") for MSS operating between 1 and 3 GHz,

recognizing

1 that Chapter III of the Radio Regulations (RR) which includes the procedure for effecting coordination for MSS systems for certain bands within the Table of Frequency Allocations of the Radio Regulations within the frequency range of 1-3 GHz,

recommends

1 that "active service arc" should be defined as: the locus of orbital points in an MSS constellation that describes where the satellites are transmitting or receiving. The MSS operator calculates the arc utilizing those system specific characteristics such as the constellations orbits, spacecraft antenna characteristics, e.i.r.p., which achieves its service objectives for a particular service area;

2 that when a specific active service arc is published, the methodology in Annex 1 could be used to assist in the identification of administrations whose assignments may be included in the "affected region" as defined in Annex 1 (see Note 1).

NOTE 1 – This methodology could be further improved by taking into account more precise technical characteristics of the MSS system.

Annex 1

A method for the calculation of the potentially affected region for an MSS network in the 1-3 GHz range using circular orbits

1 Introduction

This Annex defines a methodology for calculating the "affected region". This affected region should be used to identify co-frequency MSS and other services with equal or higher status in other administrations that might be affected by operation of the MSS network. First, the locus of points of the satellite's orbital arc are plotted that correspond to points where the satellite would be active in order to cover its service area. Then, the corresponding sub-satellite locations are plotted on the Earth's surface. The affected region is then defined to be these areas on the Earth within visibility of the spacecraft and referenced to the perimeter of the sub-satellite locus.

This methodology to calculate the affected region identifies the administrations whose co-frequency assignments might be affected.

It is recognized that another methodology of determining affected frequency assignments of other administrations with respect to an MSS space station and its associated service area could be used and that the incorporation of this methodology into an ITU-R Recommendation would not make its use mandatory.

Use of this methodology for calculating an affected region does not change the status (primary or secondary) of the radio services within that region.

2 Calculation of the affected region

Let the quadrilateral A depicted in Fig. 1 represent the active sub-satellite area needed to serve an administration for a representative MSS system. Note that the sub-satellite area is not necessarily coincident with the borders of the administration. The distance, *D*, depicted in Fig. 1 is the distance from the outer perimeter of A to the field of view (FOV) point from the satellite. The FOV is defined as extending to the limits of the visible horizon as seen from the satellite. The total affected region is then the total area calculated from the edges of the sub-satellite area out to the distance *D*. For circular constellations distance *D* will be a constant great circle distance which increases with increasing satellite altitudes.

2.1 Calculation of width of affected region envelope

This section presents a methodology to calculate the distance that should be used to draw the outer perimeter around the active sub-satellite areas to create the affected region.

Figure 2 illustrates the calculation of the outer perimeter distance *D*, which is the distance from the edge of the sub-satellite area A to the FOV of the satellite at the active area outer edge. The affected region is defined as follows:

Affected region: an area on the Earth's surface calculated by defining a distance from the perimeter of the active sub-satellite area A, a distance *D* from the perimeter of the active sub-satellite sub-area, corresponding to the maximum field of view from the satellites at the perimeter of the active service arc. The region also includes administrations within the active sub-satellite area.

Active service arc and active sub-satellite area are defined as follows:

Active service arc: see the definition in *recommends* 1.

Active sub-satellite area: the projection down the nadir from the active service arc to points on the Earth's surface. The perimeter of this area is defined in geocentric coordinates (latitude/longitude).

FIGURE 1

Representation of an active sub-satellite area required to serve an administration and its corresponding affected region

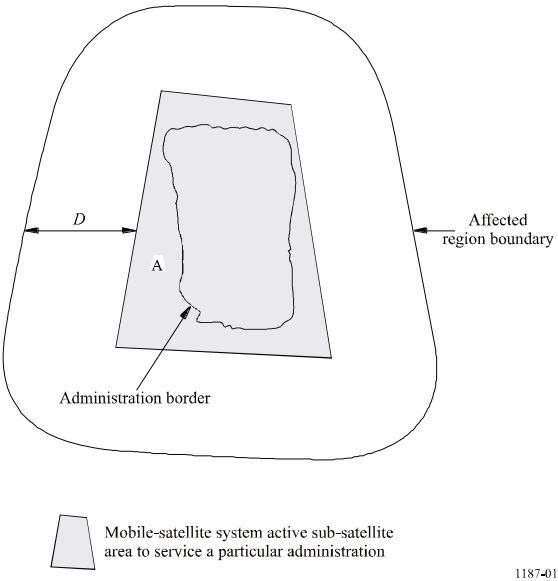
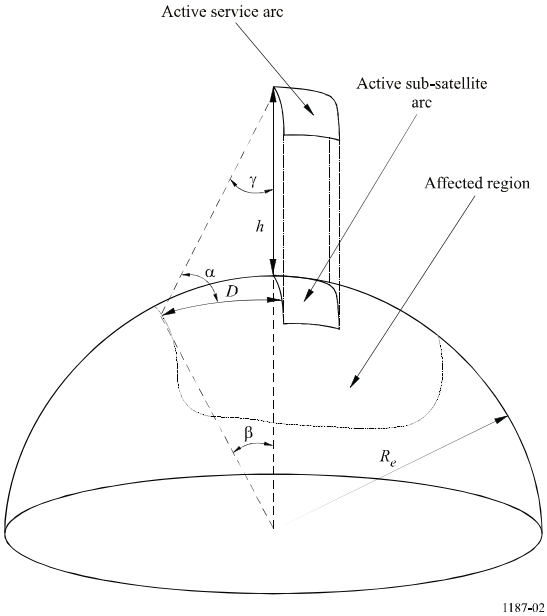


FIGURE 2

Geometry required to calculate *D*, envelope distance around sub-satellite area



Definition of variables:

R_e: Earth radius

h: satellite altitude

γ: nadir angle from satellite at sub-satellite perimeter edge to its field of view distance

β: geocentric angle from sub-satellite area edge to field of view distance

α: elevation angle

D: Earth distance from active sub-satellite area perimeter to 0° elevation angle point (maximum field of view limits).

The necessary formulae to calculate the distance D:

$$\beta = \cos^{-1} [R_e/(R_e + h)] \quad (1)$$

$$D = R_e \beta \qquad \text{rad} \quad (2)$$

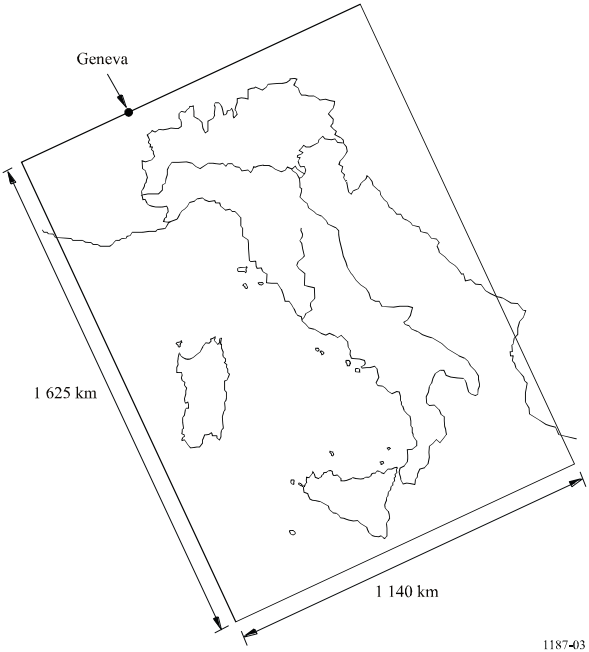
Once D has been calculated, it can be used to determine the affected region in conjunction with the sub-satellite area.

2.2 Example calculation of an affected region

This section gives an example of how to calculate the affected region for a mobile-satellite system intending to provide service within the territory of an administration. The example administration is Italy, and Fig. 3 illustrates the sub-satellite area for servicing Italy for the LEO A (see Recommendation ITU-R M.1184) mobile-satellite system.

FIGURE 3

Hypothetical sub-satellite active area for Italy



The necessary parameters to calculate the affected region are:

Satellite altitude:	780 km
Earth radius:	6 367 km
Sub-satellite area width:	1 140 km
Sub-satellite area length:	1 625 km

Note that the sub-satellite active area was chosen assuming the service area was the Italian administration and is only an example. The actual sub-satellite area for Italy of any mobile-satellite system may be quite different depending on the satellite networks system specific characteristics.

Using equations (1) and (2) for this case, $\beta = 27°$ and $D = 3\,000$ km, so the distance D to add around the sub-satellite area is 3 000 km. Therefore, for the example sub-satellite area in Fig. 3, the affected region would extend into North-Western Sudan, Western Russia (including Moscow), Northern Norway and Mauritania.

RECOMMENDATION ITU-R S.1256-0

METHODOLOGY FOR DETERMINING THE MAXIMUM AGGREGATE POWER FLUX-DENSITY AT THE GEOSTATIONARY-SATELLITE ORBIT IN THE BAND 6 700-7 075 MHz FROM FEEDER LINKS OF NON-GEOSTATIONARY SATELLITE SYSTEMS IN THE MOBILE-SATELLITE SERVICE IN THE SPACE-TO-EARTH DIRECTION

(Question ITU-R 206/4)

(1997)

The ITU Radiocommunication Assembly,

considering

a) that the band 6 700-7 075 MHz is allocated to the fixed-satellite service (FSS), in the space-to-Earth direction, on a primary basis, for the use by feeder links of non-geostationary satellite networks in the mobile-satellite service (MSS);

b) that the band 6 700-7 075 MHz is also allocated to the FSS in the Earth-to-space direction, on a primary basis, and the band 6 725-7 025 MHz is subject to the Allotment Plan of Appendix 30B of the Radio Regulations (RR) for geostationary satellite networks;

c) that, under No. S22.5A of the RR, the maximum aggregate power flux-density (pfd) produced within ± 5° of the geostationary-satellite orbit (GSO) by a non-geostationary satellite system in the FSS shall not exceed –168 dB(W/m^2) in any 4 kHz band;

d) that Resolution 115 of the World Radiocommunication Conference (Geneva, 1995) (WRC-95) invites ITU-R to establish a methodology to determine the maximum aggregate power flux-density at the GSO from a non-geostationary satellite network;

e) that non-geostationary satellite networks of the mobile-satellite service have orbital and transmission parameters available as specified in § A.3 vii) of Annex 1 to Resolution 46 (Rev.WRC-95),

recommends

1 that the methodology given in Annex 1 shall be followed to determine the maximum level of aggregate power flux-density (dB(W/m^2) in any 4 kHz band), at any location within ± 5° inclination of the GSO, from the feeder links of a non-geostationary satellite network operating in the band 6 700-7 075 MHz, in the space-to-Earth direction.

ANNEX 1

Methodology

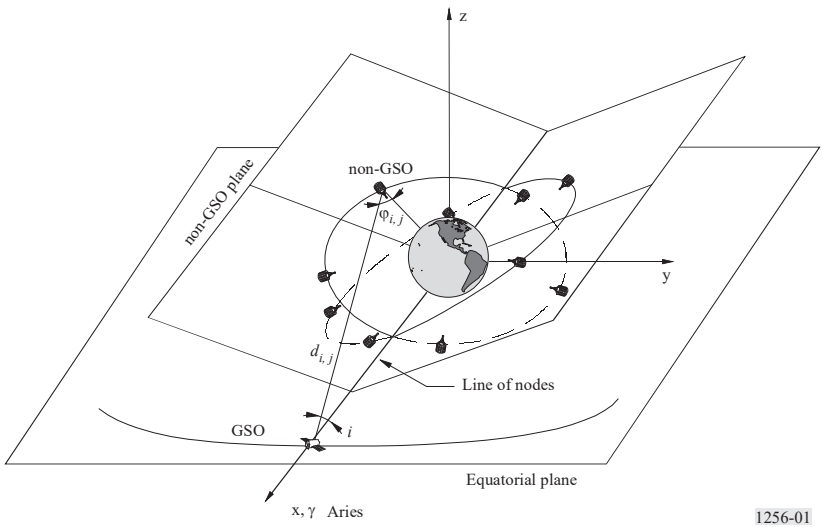
1 Description of methodology

To calculate the aggregate pfd from a non-geostationary orbiting satellite (non-GSO) network to a single test location at the GSO, computer modelling of the full non-GSO constellation and a test location at the GSO is needed.

Basically, noting that in an ordinary situation a GSO satellite will orbit the geostationary orbit with a period of about T_{GSO} = 24 h and that the orbital period of a non-GSO satellite ($T_{non\text{-}GSO}$) is not necessarily a submultiple of T_{GSO}, extensive time-consuming statistical simulations may be needed to assess the worst-case scenario that would lead to the maximum pfd level at the GSO location.

A simple and very much less time-consuming simulation can be performed to assess the maximum pfd at any GSO location. Instead of a real orbiting GSO satellite, a fixed test location at the GSO is considered whose orbital position is fixed with respect to a 0xyz Cartesian reference system (see Fig. 1) but not with respect to the rotating Earth reference system. With this in mind, since the non-GSO satellites have an orbital period $T_{non\text{-}GSO}$, it implies that the position of the non-GSO satellites, as seen from the fixed GSO test location (see Fig. 1), will be repeated at least once every orbital period $T_{non\text{-}GSO}$. Moreover, in the case where the non-GSO satellites are uniformly distributed on each orbital plane, the same geometrical disposition of the non-GSO satellites will be repeated with a period equal to $T_{non\text{-}GSO}/N_s$ (where N_s is the number of non-GSO satellites uniformly distributed on one plane). With these basic considerations, the aggregate pfd level (aggregated over the visible non-GSO satellites) at the GSO test location will have values that will be repeated within this period.

FIGURE 1
GSO/non-GSO constellation geometry to calculate pfd: ΔΩ = 0°



The aggregate pfd can be calculated for each time step and a maximum aggregate pfd, for the chosen GSO test location, can be derived during the simulation period from T_0 to $T_0 + T_{non\text{-}GSO}/N_s$.

The value found for the particular GSO test location in Fig. 1 is not necessarily the maximum pfd level. In order to find the highest possible maximum aggregate pfd level, the same procedure must be repeated to the other GSO test locations by incrementing the angle $\Delta\Omega$ (see Fig. 2) between the GSO test location and the non-GSO line of nodes. This second iteration will be done for angles of $\Delta\Omega$ between 0° and $\Delta\Omega_{max} = 360°/N_p$, where N_p is the number of non-GSO satellite orbital planes. In cases where N_p is even (as per LEO-F and LEO-D) then $\Delta\Omega_{max} = 180°/N_p$.

The method can also apply to any non-GSO constellation which does not meet the orbital requirements as stated above (e.g. non-uniform satellite distribution, elliptical orbits). In such cases the time simulation will be performed for a period of time equal to the minimum repeatability period of the constellation configuration, which in many cases is equal to the constellation period $T_{non\text{-}GSO}$.

The § 2 reports all the basic equations needed to arrive at the aggregate pfd level from a given non-GSO network to a given test location at the GSO and Fig. 3 shows the flow chart for the software implementation of the methodology here described.

FIGURE 2

GSO/non-GSO constellation geometry to calculate pfd: $\Delta\Omega \neq 0°$

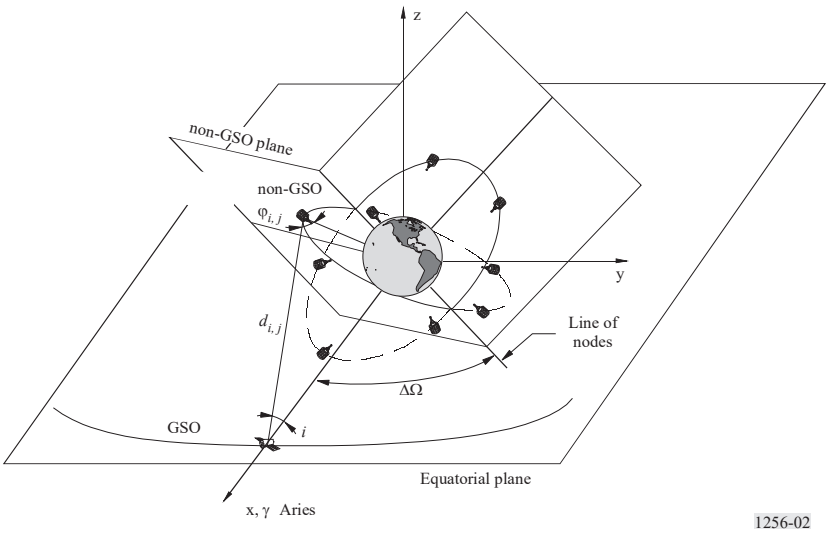
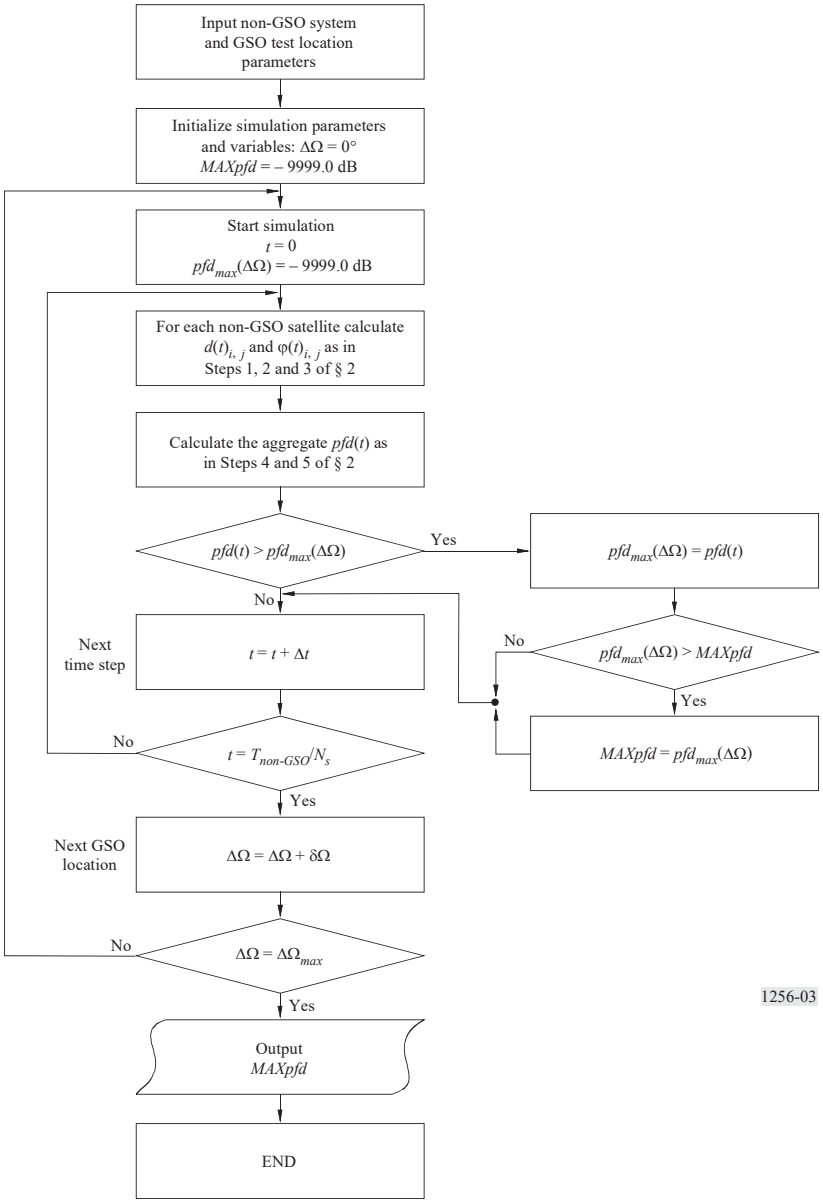


FIGURE 3

Methodology flow chart



2 Basic simulation steps

Step 1: Orbital position of the non-GSO satellites

FIGURE 4

Non-GSO orbit and reference systems

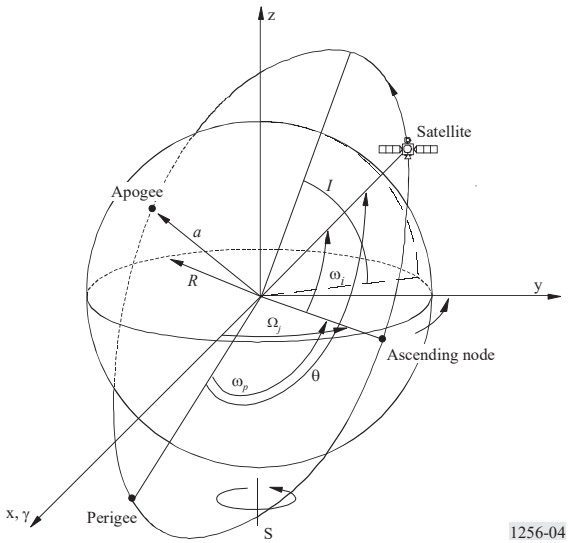


Figure 4 indicates the various parameters that are needed to fully assess at any instant the position of any non-GSO satellite on its orbit. These parameters are referenced in § A.3 vii) of Annex 1 to Resolution 46 (Rev.WRC-95):

a: semi-major axis, in case of a circular orbit the semi-major axis is constant and equal to the orbit radius;

I: inclination of the orbit relative to the equatorial plane

Ω_j: right ascension of the ascending node for the j-th orbital plane, measured counter-clockwise in the equatorial plane from the direction of the vernal equinox to the point where the satellite makes its south-to-north crossing of the equatorial plane ($0° \leq \Omega_j < 360°$)

ω_p: argument of perigee, for a circular orbit, the perigee is equal to the apogee and thus ω_p can be put to 0°

ω_i: initial phase angle of the i-th satellite in its orbital plane at reference time $t = 0$, measured from the point of ascending node ($0° \leq \omega_i < 360°$)

θ: true anomaly of the satellite.

For a constellation of non- GSO satellites using circular orbits, a and I will be constant and ω_p will be equal to zero, then the variation of the position of each satellite will be defined by Ω and θ.

For a circular orbit, the angular velocity of a satellite is constant, the angular position of a satellite is then equal to its true anomaly and is given by:

$$\theta(t)_{i,j} = \frac{360°}{T}\ t + \omega_{i,j} \tag{1}$$

for $i = 1$ to N_s and $j = 1$ to N_p where N_s is the number of satellites in each orbital plane, N_p is the number of orbital planes and T is the orbital period in seconds given by:

$$T = 2\,\pi\ \sqrt{a^3/\mu} \tag{2}$$

where μ is the geocentric gravitational constant and is equal to 3.986 E14(m^3s^{-2}).

The various values of Ω_j will depend on the geometry of the constellation and will be given in the set of elements found in § A.3 vii) of Annex 1 to Resolution 46 (Rev.WRC-95). The same principal applies to the values of $\omega_{i,j}$.

Knowing for each satellite its true anomaly $\theta_{i,j}(t)$ and the right ascension of its ascending node Ω_j, its geocentric coordinates are given by:

$$x(t)_{i,j} = a\left[\cos\Omega_j\ \cos\theta(t)_{i,j} - \cos I\ \sin\Omega_j\ \sin\theta(t)_{i,j}\right] \tag{3}$$

$$y(t)_{i,j} = a\left[\sin\Omega_j\ \cos\theta(t)_{i,j} + \cos I\ \cos\Omega_j\ \sin\theta(t)_{i,j}\right] \tag{4}$$

$$z(t)_{i,j} = a\left[\sin I\ \sin\theta(t)_{i,j}\right] \tag{5}$$

The position of the GSO test location with respect to the line of nodes of the non-GSO constellation is determined by $\Delta\Omega$ (see § 1). Hence, in equations (3), (4) and (5) $\Omega_j = \Omega_{j,0} + \Delta\Omega$, where $\Delta\Omega$ ranges from 0 to $\Delta\Omega_{max}$ (see § 1) and $\Omega_{j,0} = \Omega_j$ for $\Delta\Omega = 0$.

Step 2: Distance between the non-GSO satellite and the test location at the GSO

x_{GSO}, y_{GSO} and z_{GSO} are the geocentric coordinates of the GSO test location given by:

$$x_{GSO} = a_{GSO} \cdot \cos I_{GSO} \tag{6}$$

$$y_{GSO} = 0 \tag{7}$$

$$z_{GSO} = a_{GSO} \cdot \sin I_{GSO} \tag{8}$$

where:

a_{GSO}: semi-major axis of the geostationary orbit (42 164 km)

I_{GSO}: inclination of the geostationary orbit ($-5° \le I_{GSO} \le 5°$).

These equations remain constant during the simulation since it is simpler to vary Ω_j in equations (3), (4) and (5) by incrementing the offset $\Delta\Omega$.

The distance between a non-GSO satellite and the GSO test location can then be calculated using Pythagora's theorem:

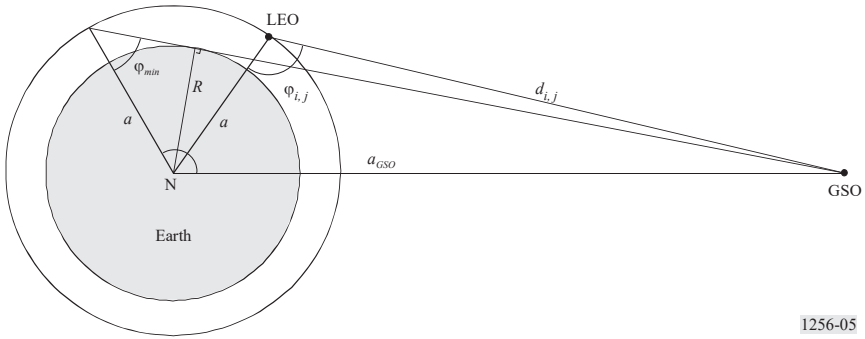
$$d(t)_{i,j} = \sqrt{\left(x_{GSO} - x(t)_{i,j}\right)^2 + y(t)_{i,j}^2 + \left(z_{GSO} - z(t)_{i,j}\right)^2} \tag{9}$$

Step 3: Calculation of the non-GSO antenna off-axis angle to the test location at the GSO

Fig. 5 shows the geometry, represented in a two-dimensional diagram, of the non-GSO satellite off-axis angle relative to the test location at the GSO.

FIGURE 5

Calculation of $\varphi_{i,j}$



The non-GSO antenna off-axis angle can be determined using Carnot's theorem (known also as the "cosine" theorem):

$$\varphi(t)_{i,j} = \arccos\left(\frac{a^2 + d(t)_{i,j}^2 - a_{GSO}^2}{2\,a\,d(t)_{i,j}}\right) \tag{10}$$

Step 4: Calculation of the non-GSO off-axis antenna gain toward the test location at the GSO

Taken the off-axis angle calculated in equation (10), for each visible satellite it is possible to calculate the off-axis antenna gain $G(\varphi(t)_{i,j})$. However, as seen in Fig. 5, this is only necessary if $\varphi(t)_{i,j}$ is higher than a minimum value of φ_{min} given by:

$$\varphi_{min} = \arcsin\left(R/a\right) \tag{11}$$

Step 5: Calculation of the aggregate pfd level towards the GSO test location

The aggregate pfd level can be expressed as:

$$pfd(t) = \frac{P_{peak,\,4\,kHz}}{4\pi} \sum_{i \cdot j = 1 \text{ to } N(t)_v} \frac{G\left(\varphi(t)_{i,j}\right)}{d(t)_{i,j}^2} \qquad \text{for} \quad \varphi(t)_{i,j} \geq \varphi_{min} \tag{12}$$

where:

$P_{peak,\,4\,kHz}$: peak power in the worst 4 kHz band at the input of the non-GSO satellite antenna, assumed constant and equal for all the non-GSO satellites

$N(t)_v$: number of visible non-GSO satellites from the GSO test location at the time t.

3 Total number of simulation steps and simulation step increments

Two simulation steps are needed to perform the calculation of the maximum aggregate pfd toward the GSO from a non-GSO network, the time step Δt and the right ascension step $\delta\Omega$.

Since there is no direct in-line interference from the non-GSO satellites (either they use isoflux low gain antenna or interference comes from the side lobes of the transmitting antenna), various simulations (for LEO-D and LEO-F) have shown that an angular step of no more than 0.5° is sufficient to get valid results. The calculation steps will then be:

$$\Delta t = \frac{T\,(\mathrm{s}) \times 0.5°}{360°}$$

$$\delta\Omega = 0.5°$$

The total simulation time for each GSO test location and the total number of GSO test locations are given in § 1.

RECOMMENDATION ITU-R RS.1260-2

Feasibility of sharing between active spaceborne sensors and other services in the range 420-470 MHz

(Question ITU-R 218/7)

(1997-2003-2017)

Scope

This Recommendation provides the technical and operational characteristics to be respected by EESS (active) sensors operating in the band 432-438 MHz in order to ensure protection of the other primary services operating in the band.

Keywords

EESS, active sensors, Synthetic Aperture Radar (SAR), space object tracking radar, exclusion zone

Related Recommendations and Reports

Recommendations ITU-R F.758, ITU-R F.1108 ITU-R M.1462, ITU-R M.1462.

The ITU Radiocommunication Assembly,

considering

a) that synthetic aperture radars (SARs) can measure soil moisture, forest biomass, can detect buried geologic structures such as faults, fractures, synclines and anticlines, and can map and measure the depth of Antarctic ice, and hydrogeological properties of arid and semiarid regions;

b) that experimental SARs mounted on aircraft have demonstrated the potential for making these measurements;

c) that these spaceborne SARs must operate at frequencies below 500 MHz in order to penetrate dense vegetation and the Earth's surface on a worldwide repetitive basis;

d) that frequency bands between 420-470 MHz are currently allocated to the radiolocation, fixed, amateur, space operations and mobile services;

e) that within the amateur service weak-signal operations (including Earth-Moon-Earth) are conducted centred around 432 MHz, and amateur-satellite operations (both uplink and downlink) are conducted in the band 435-438 MHz;

f) that other uses are made of portions of these bands including:

– wind profilers in the range 440-450 MHz, and in case of incompatibility between wind profiler radars and other applications, in the bands 420-435 MHz and 438-440 MHz (Resolution **217 (WRC-97)**);

– launch vehicle range safety command destruct receivers in the band 449.75-450.25 MHz (No. **5.286** of the Radio Regulations (RR)), as well as around 421.0, 425.0, 427.0, 440.0 and 445.0 MHz in the United States of America and Brazil and, in the French Overseas Departments in Region 2 and India, the band 433.75-434.25 MHz (RR No. **5.281**);

g) that certain spaceborne SARs could produce pfd's at the Earth's surface in excess of the pfd levels that may be required to protect the fixed service and the land mobile service allocated in this frequency range;

h) that co-frequency sharing with wind profilers is likely to be unfeasible due to interference to the spaceborne active sensor;

i) that SARs and the amateur service (primary in Region 1 and secondary in Regions 2 and 3, except as in RR No. **5.278**) can coexist in the band 430-440 MHz, by taking appropriate technical and operational measures defined in Annex 1 to this Recommendation;

j) that in addition, the provisions of RR Nos **5.274**, **5.275**, **5.276**, **5.277**, **5.278**, **5.281** and **5.283** list countries that have defined portions of the band between 430 and 440 MHz as having primary status for the fixed, mobile, space operation and/or the amateur services;

k) that some sharing studies have indicated that co-frequency sharing between the amateur services and some proposed SARs in the Earth exploration-satellite service (EESS) is possible for some amateur modes of transmission such as FM and time division multiple access (TDMA), but would be difficult with continuous wave and single sideband modes of operation;

l) that Recommendation ITU-R M.1462 contains the technical and operational characteristics of, and protection criteria for, radars (airborne, shipborne, and space object tracking) operating in the radiolocation service operating in the band 420-450 MHz;

m) that there is a potential for unacceptable interference from some spaceborne SARs to terrestrial space object tracking radars operating in the band 420-450 MHz if the spaceborne SAR radar is within the view of the terrestrial radars (i.e. above the radars' visible horizon);

n) that some spaceborne SARs will be tracked by terrestrial space object tracking radars, and that the resultant unwanted received power level at a spaceborne SAR can approach its maximum power-handling capability;

o) that there is a potential for unacceptable interference from some spaceborne SARs to airborne and shipborne radars operating in 420-450 MHz, the probability and severity of which is highly dependent upon the characteristics of the SARs;

p) that any harmful interference, even for very short periods, by SARs into launch vehicle command destruct receivers could impede the safety of life and property;

q) that given the complexity of the EESS (active) instruments implementation in these low frequencies, very few such platforms are expected to be in orbit at the same time,

recommends

1 that active spaceborne sensors operating in the bands used by the amateur service, the amateur satellite service, the fixed, radiolocation, space operation, mobile services and the MSS in the range 420-470 MHz, respect the technical and operational constraints provided in Annex 1 to this Recommendation;

2 that spaceborne active sensors operating in the range 420-450 MHz not be put into operation within view of the terrestrial space object tracking radars listed in Table 2, unless detailed analysis, on a case-by-case basis, to include consideration of the effects of the radars' receiver processing upon unwanted SAR signals, and possibly field testing have been performed to confirm compatibility with the mutual agreement of the affected administrations;

3 that a spaceborne SAR intended for operation in the 420-450 MHz band be designed to tolerate the unwanted signal power levels that will result from being tracked by terrestrial space object tracking radars;

4 that sufficient frequency and geographical separation between spaceborne SARs and wind profilers operating in the ranges 420-432 MHz and 438-450 MHz may need to be provided;

5 that spaceborne active sensor frequency bands be selected in such a way as not to overlap with launch vehicle range safety command destruct receive frequency bands listed in *considering f)*;

6 that in cases where *recommends* 5 becomes difficult to implement, spaceborne active sensors operating in the frequency ranges allocated for launch vehicle range safety command destruct receive frequency bands should not be put into operation within the specific distance of locations where launch vehicle commands are used, in order to avoid interference from spaceborne active sensors into launch vehicle receivers.

Annex 1

Technical and operational constraints for EESS (active) operating in the range 420-470 MHz

For the purposes of protecting stations operating in the existing services, SAR transmissions from stations in the EESS (active) operating in the frequency range 420-470 MHz are subject to the technical and operational constraints specified in this Annex.

The following constraints are based on ITU-R studies. Annex 2 provides information on the feasibility of sharing between active spaceborne sensors and other services in the range of 420-470 MHz.

1 Technical constraints

TABLE 1

Technical constraints for EESS (active) instruments in the range 420-470 MHz

Parameter	Value
Peak pfd on Earth's surface from antenna main lobe	–140 dB(W/(m^2 · Hz))
Maximum mean pfd on Earth's surface from antenna main lobe	–150 dB(W/(m^2 · Hz))
Maximum mean pfd on Earth's surface from 1st antenna side lobe	–170 dB(W/(m^2 · Hz))

2 Operational constraints

EESS (active) operating in the band 420-450 MHz shall not transmit within view of the terrestrial space object tracking radars listed in Table 2, unless detailed analysis, to include consideration of the effects of the radars' receiver processing upon unwanted SAR signals, and possibly field testing, have been performed to confirm compatibility.

As a consequence of the above constraints, EESS (active) instruments shall be designed in such a way as to allow programmable turning off of all RF emissions over geographical areas or countries where ITU regulations or national regulations do not allow their operations.

The EESS (active) instruments operation profile shall be campaign-oriented, targeted to specific geographical areas and shall limit the instrument active time to the minimum required to achieve the campaign objectives. Thus, the measurements carried out by the instrument do not require continuous operation of the instrument, and intervals of months between successive measurements on the same area can be expected.

The operational duty cycle in campaign-mode will be 15% maximum (typically 10%). While not in campaign-mode, the instrument will be switched off.

FIGURE 1

Example of exclusion zone around space object tracking radars for a SAR in a 665 km orbit (Land masses outside of exclusion zone are shown in "red")

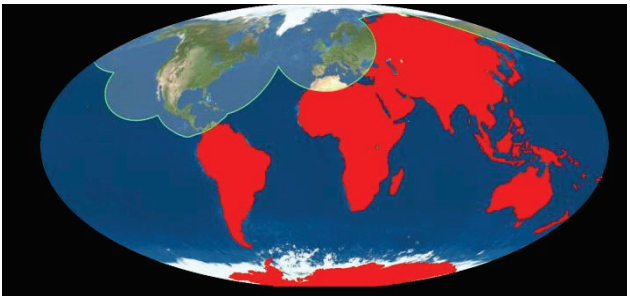


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TABLE 2

Space object tracking radars operating in 430-440 MHz

Radar location	Latitude	Longitude
Massachusetts (United States of America)	41.8º N	70.5º W
Texas (United States of America)	31.0º N	100.6º W
California (United States of America)	39.1º N	121.5º W
Georgia (United States of America)	32.6º N	83.6º W
Florida (United States of America)	30.6º N	86.2º W
North Dakota (United States of America)	48.7º N	97.9º W
Alaska (United States of America)	64.3º N	149.2º W
Thule (Greenland)	76.6º N	68.3º W
Fylingdales Moor (United Kingdom)	54.5º N	0.4º W

3 Protection criteria for existing services in the frequency range 420-470 MHz

Not all protection criteria mentioned in this section are contained in ITU-R Recommendations. Therefore, some of these protection criteria have been derived from information provided in ITU-R studies. Table 3 reflects the information available at the time of the development of this Recommendation.

It should be noted that any future Recommendation describing the protection criteria for any given service, has preference above the value listed in the table as derived from ITU-R studies.

TABLE 3

Protection criteria for services in the range 420-470 MHz

Frequency range (MHz)	RR services	The time percentages and criteria in columns 4 and 5 are to be applied only in the following geographical areas	Maximum percentage of time that the criteria may be exceeded(1)	Interference criteria at receiving stations	Sources
430-440	Amateur	Within line-of-sight (LoS) of terrestrial amateur stations located in regions defined in *considering i)*	1%	pfd = −204 dB(W/(m^2 · Hz))(2)	ITU-R studies
435-438	Amateur satellite	Within LoS of satellite amateur earth stations located in regions defined in *considering i)*	1%	pfd = −197 dB(W/(m^2 · Hz))	ITU-R studies
435-438	Amateur satellite	Within LoS of receivers of amateur space stations	1%	pfd = −187 dB(W/(m^2 · Hz))	ITU-R studies
420-470(3)	Fixed	Within LoS of stations of the fixed service including stations located in regions defined in *considering j)*	Not applicable	$(I/N)_{MEAN}$ = −20 dB (equivalent to 1% fractional degradation in performance)	Recs. ITU-R F.758 and ITU-R F.1108
420-432 and 438-450	Radio-location	Within LoS of wind profiler radars	(4)	$(I/N)_{PEAK}$ = −6 dB	Rec. ITU-R M.1462
420-450	Space operation	Within LoS of launch vehicle command destruct receivers located in regions defined in *considering j)*	Frequency or geographical separation required		ITU-R studies
420-450	Radio-location	Within LoS of terrestrial space object tracking radars(5)	(4)	$(I/N)_{PEAK}$ = −6 dB	Rec. ITU-R M.1462
420-450	Radio-location	Within LoS of shipborne radars	(4)	$(I/N)_{PEAK}$ = −6 dB	Rec. ITU-R M.1462
420-450	Radio-location	Within LoS of airborne radars	(4)	$(I/N)_{PEAK}$ = −6 dB	Rec. ITU-R M.1462
420-470(3)	Mobile	Within LoS of mobile stations including stations located in Regions defined in *considering j)*	0.1%	pfd = −204 dB(W/(m^2 · Hz))(2)	ITU-R studies

Notes to Table 3:

(1) Considering all active SARs in this frequency range.

(2) The maximum aggregate pfd specified for the band 430-440 MHz has been based on the maximum acceptable interference level received by the average side lobe of an amateur receiving antenna.

(3) In the frequency range 430-440 MHz, the fixed and mobile services are allocated only in some countries by footnote.

(4) The criterion given in Recommendation ITU-R M.1462 is based on the protection of radiolocation systems from noise-like interference. Sharing may be possible between radiolocation systems and spaceborne active sensors at interference levels greater than those given in Recommendation ITU-R M.1462 through the use of signal processing techniques to filter out unwanted pulsed emissions. Recommendation ITU-R M.1372 provides a description of some of these interference suppression techniques.

(5) The EESS (active) operating in the band 420-450 MHz shall not transmit within view of the terrestrial space object tracking radars listed in Table 2, unless detailed analysis, on a case-by-case basis, to include consideration of the effects of the radars' receiver processing upon unwanted SAR signals, and possibly field testing, have been performed to confirm compatibility with the mutual agreement of the affected administrations.

Annex 2

Methodology for interference assessment and mitigation

1 Introduction

A methodology is presented that allows an estimate to be made as to whether or not the unwanted signal received by other services in the band 420-470 MHz from an active spaceborne sensor may cause difficulties if operated in common frequency bands. Much of the content of this Annex has been extracted from Annex 1 of Recommendation ITU-R RS.1280 – Selection of active spaceborne sensor emission characteristics to mitigate the potential for interference to terrestrial radars operating in the frequency bands 1-10 GHz. The calculations highlight a number of parameters of the sensor that can be chosen such that the sharing situation is improved.

2 Calculation of interference to other services

The average interfering signal pfd, I_{pfd} (dB(W/(m^2 · Hz))) and average interfering signal power level, I (dBW), received by the other services from spaceborne active sensors is calculated from the following:

$$I_{pfd} = 10 \log P_t + 10 \log (\tau\, PRF) + G_t - (130.99 + 20 \log R + 10 \log B) + OTR - PG \qquad (1a)$$

and

$$I = 10 \log P_t + 10 \log (\tau\, PRF) + G_t + G_r - (32.44 + 20 \log (f\, R)) + OTR - PG \qquad (1b)$$

where:

P_t: peak space borne sensor transmitter power (W)

τ: spaceborne sensor pulse width (s)

PRF: spaceborne sensor pulse repetition frequency (Hz)

G_t: spaceborne sensor antenna gain towards other service (dBi)

R: slant range between sensor and radar (km)

B: bandwidth of sensor (MHz)

OTR: receiver on-tune rejection (dB)

PG: processing gain (dB), rejection of unwanted signals due to receiver signal processing (assumed to be zero if not known)

f: frequency (MHz).

Equation (1a) gives the average interference signal pfd level and equation (1b) gives the average interference signal power level. The average interference power level is used when it can be determined that such use is appropriate. For example, a radar that performs a fast Fourier transform (FFT) on the received signal will "smear" the dissimilar pulsed signal across a number of bins, resulting in an averaged interfering signal level. The on-tune rejection term is calculated from:

$$OTR = 10 \log (B_r/B_t) \qquad \text{for } B_r \le B_t \tag{2a}$$

$$= 0 \qquad \text{for } B_r > B_t \tag{2b}$$

where:

B_r: receiver bandwidth

B_t: bandwidth of the transmitted interfering signal.

If the peak interfering signal is of interest, then the second term of equation (1) should be left out, and on-tune rejection is calculated from the following:

Input pulse with no frequency modulation:

$$OTR = 20 \log (B_r \tau) \qquad \text{for } B_r \tau < 1 \tag{3a}$$

$$= 0 \qquad \text{for } B_r \tau > 1 \tag{3b}$$

Input pulse with frequency modulation:

$$OTR = 10 \log \left(\frac{B_r^2 \tau}{B_c} \right) \qquad \text{for } \frac{B_r^2 \tau}{B_c} < 1 \tag{4a}$$

$$= 0 \qquad \text{for } \frac{B_r^2 \tau}{B_c} > 1 \tag{4b}$$

where:

B_r: other service receiver IF bandwidth

B_c: chirp bandwidth of spaceborne sensor

τ: sensor pulse width.

3 Interference criteria for other services

Specific criteria for specific systems in the other services are given in Table 1 in terms of the maximum aggregate pfd limits at the receiving stations (dB(W/(m^2 · Hz))) and also the maximum percentage of time that the pfd limits may be exceeded. There are several instances where a different criteria is used as follows.

3.1 Surveillance radars in radiolocation service

It will be assumed that the received *S*/*N* of the surveillance radars may not be degraded by more than 0.5 dB longer than a single scan time, taken to be 10 s. This equates to an *I*/*N* power ratio of –9 dB at the receiver IF stage. The average interfering signal power level is considered to be of interest in the case of the surveillance radars.

3.2 Tracking radars in radiolocation service

Tracking radars often use "range gates" to exclude all returns other than those at specific ranges of interest. An important consideration in determining the susceptibility of a tracking radar to an interfering pulse train is the fraction of interfering pulses that are coincident with the range gate. The coincidence of interfering pulses with the range gate will depend upon whether the desired and undesired PRFs are related by integer multiples (Case I) or not (Case II). The fraction of coinciding pulses, f_c, is found from:

$$f_c = \frac{GCF(PRF_i, PRF_g)}{PRF_g} \qquad \text{for Case I} \tag{5a}$$

$$f_c = PRF_i(\tau_g + \tau_i) \qquad \text{for Case II} \tag{5b}$$

where:

PRF_i: interfering PRF

PRF_g: gate PRF

$GCF\ (PRF_i, PRF)_g$: greatest common factor of PRF_i and PRF_g

τ_i: interfering pulse width

τ_g: gate width.

Note that when $\tau_i > \tau_g$ and the desired and undesired PRFs are not related by integer multiples (Case II), f_c is approximately the duty cycle of the interfering pulses. This situation is considered to be the typical case, and is used in the following determination of degradation threshold for a tracking radar.

To obtain highly accurate position data on objects of interest, tracking radars use high gain antennas with well-defined, narrow mainbeams. A servo mechanism attempts to keep the boresight of the antenna mainbeam on the target; the servo mechanism is driven by an error signal generated by the angle error between the target and the antenna boresight. Undesired signals entering the radar can increase this bias error.

A degradation threshold for a tracking radar, expressed as an allowed fraction of coincident interfering pulses, f_c, as a function of the *S*/*I* ratio at the IF output is given as:

$$f_c = \frac{a^2 - 1}{\dfrac{90 B_r \tau}{(S/I - 1)} - 1} \qquad \text{when } S/I > 1 \tag{6a}$$

$$f_c = \frac{a^2 - 1}{\dfrac{90 B_r \tau}{(S/I - 1)} - 1} \qquad \text{when } S/I < 1 \tag{6b}$$

where:

a: factor associated with total tracking error, with degradation due to interference included (e.g. $a = 1.1$ allows a 0.1%, or 10% increase due to interference)

B_r: 3 dB bandwidth of the radar IF filter

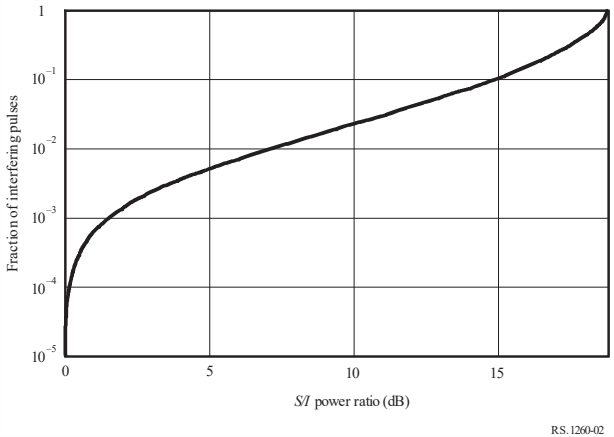
τ: length of the target pulses (note $B_r\,\tau \cong 1$ for a tracking radar)

S/I: S/I power ratio at the radar IF output (not in dB).

Figure 2 is a plot of the fraction of coincident pulses versus S/I at the radar IF output, allowing a 10% increase in the radar tracking error due to interference. The fraction of coincident pulses is approximately the sensor's duty cycle (6%), so an S/I of 13 dB corresponds to a 10% tracking error. It will be assumed that the S/I must be ≥ 13 dB for periods of time longer than 3 s. (Since the interference criterion has been developed based upon an interfering pulse being coincident with the radar's range gate, the peak interfering signal power should be used.)

FIGURE 2

Radar S/I as a function of fraction of coincident interfering pulses (10% increase in tracking error)



4 Example analysis of the unwanted signal from a spaceborne sensor to other services

4.1 Technical characteristics

4.1.1 Spaceborne sensor

Table 4 gives the technical characteristics of the representative spaceborne sensor used in the following analysis.

TABLE 4

Spaceborne SAR1 characteristics

Parameter	Value
Orbit height (km)	750
Orbit inclination (degrees)	98.4
Peak radiated RF power (W)	400
Average radiated RF power (W)	4.4
Pulse width (μs)	50
PRF (Hz)	2 200
Modulation of pulse	Linear FM
Pulse bandwidth (MHz)	4.8
Antenna peak gain (dB)	27.9
Antenna orientation (degrees)	37 from nadir
Antenna 1st side lobe (dB)	–17.6 from peak
Antenna 5th side lobe (dB)	–34 from peak

4.1.2 Airborne radars

Recommendation ITU-R M.1462 provides the characteristics and protection criteria for radars operating in the frequency band 420-450 MHz. Previous analyses concluded that spaceborne active sensors are not technically compatible with highly sensitive land-based space object tracking radars.

The computer simulation analysis considered the compatibility of spaceborne SARs with airborne radars in this frequency band. Shipboard radar results are similar to those of the airborne radar. The draft revision to the Recommendation lists the airborne receiver bandwidth as 1 MHz, and the radar antenna as a 22 dBi gain planar array. For the purposes of analysis, the antenna was assumed to be scanning in azimuth at a 0º elevation angle. The protection criterion for the radars is an I/N of –6 dB.

4.2 Analysis approach and results

4.2.1 Computer simulations

4.2.1.1 Processing gain

The analysis of the potential interference from spaceborne SARs into the radiolocation service receivers assumed no processing gain (that is, ability to reject the interference due to receiver signal processing). For the radiolocation systems, it may be appropriate to examine the potential response of the receiver to pulsed interfering signals such as from the SARs.

The details of a radar's resistance to interfering pulsed signals are generally not published. However, many modern radar receivers, particularly those which need to perform a surveillance function in the presence of significant clutter, will do digital Doppler processing in order to resolve targets against the clutter background. The effect of the FFT on the incoming pulsed interference will be to "smear" the peak pulse power over the neighbouring range/Doppler bins, and result in an averaged interfering power effect.

4.2.1.2 Radar interference criterion

An *I*/*N* equal to –6 dB is given as the protection criterion for the airborne radars in Recommendation ITU-R M.1462. No per cent of time or duration of time is given as permissible for interference to exceed this value. It is not appropriate to apply the concept of an allowed per cent of time that interference can exceed this value to radars, and particularly to surveillance radars such as the airborne radars considered in this analysis. The concept of data loss or permitted "outage" can be applied to a communications link or sensor system, but target detection – a basic and critical radar system function – occurs at an instant in time, and thus long-term outages are not relevant.

An approach used in a number of similar analyses in ITU-R, is to examine the simulation results with the assumption that a surveillance radar cannot be degraded for a period of time exceeding a single antenna scan. This means that a target may go undetected during the first scan period that detection may otherwise have successfully been accomplished. The airborne radars in this analysis have antenna rotation times on the order of 10 s. Thus, interference should not exceed $I/N = -6$ dB for longer than 10 s. (Under this assumption, a target with an 800 km/h velocity approaches another ~2 km after detection should have happened in the absence of interference. This may or may not be acceptable, depending upon the situation.) Upon examination of the results of the simulations (using both peak as well as average interfering power into the radars), it is evident that frequency sharing may be difficult between the spaceborne SARs and the radars.

4.2.1.3 Computer simulation results

Simulations were performed using the SAR1 type (see Table 5). Table 6 provides the results of computer simulations of the expected interference environment from spaceborne SAR1 into radiolocation service systems. All simulations were conducted in 2s time increments over a 60-day period. Note that two results with respect to the per cent of time that interference occurs are also given in Table 6.

The first is the per cent of time that the interference criterion is exceeded during periods when one or more SARs are visible (i.e. above the horizon) to the earth station(s); the second is the per cent of time that the interference criterion is exceeded out of the entire period simulated (i.e. including the times when no SAR is visible on some portions of the Earth).

TABLE 5

Peak/average pfd interference from main lobes and side lobes of P-band SAR1 at Earth's surface

Parameter	Value	dB
Transmitted power (W)	400.00	26.02
Peak main lobe antenna gain (dBi)	27.90	27.90
Antenna side-lobes level (dBi)	–6.10	–6.10
$1/(4\pi)$	7.96×10^{-2}	–10.99
$1/(\text{distance})^2$ (km)	972.80	–119.76
1/Bandwidth (MHz)	1/4.80	–66.81
Pulse width (μs)	50	
PRF (Hz)	2 200	
Peak power density in main lobe (dBW)		–75.86
Peak power density in side lobe (dBW)		–109.86
Peak pfd in main lobe (dB(W/(m^2 · Hz)))		–143.6

TABLE 5 (*end*)

Parameter	Value	dB
Average pfd in main lobe (dB(W/(m^2 · Hz)))		–153.2
Peak pfd in side lobes (dB(W/(m^2 · Hz)))		–177.6
Average pfd in side lobes (dB(W/(m^2 · Hz)))		–187.2

TABLE 6

Computer simulation results

Receiver	Criterion	SAR1
Airborne radar	*I*/*N*, worst (dB)	36.2
	I/*N*, average (dB)	–4.4
	Per cent of time *I*/*N* > –6 dB (SAR visible) (%)	12.0
	Per cent of time *I*/*N* > –6 dB (All times) (%)	0.6
	Maximum time *I*/*N* > –6 dB (min)	4.8
	Average time *I*/*N* > –6 dB (s)	7.3
	Number of times *I*/*N* > –6 dB (events)	3 823

5 Procedure to use methodology

The average pfd of an active spaceborne sensor should be examined during the design stages. Equations (1) to (4) can be examined to determine parameters that can potentially be adjusted during the design of the spaceborne sensor, in order to improve sharing with the other services. Transmitter power, antenna gain (particularly side-lobe levels), pulse width and repetition rate, and chirp bandwidth are all likely candidates for adjustment.

When compatibility between a spaceborne sensor and a particular service system is analysed, the processing gain, if any, of the receiving system should be considered since the analysis assumed that there was none. This assumption is valid for the general case since not all receiving stations have processing gain.

For example, consider two radars operating in 420-450 MHz:

– a tracking radar with a 0.1 MHz IF bandwidth (radar 1)

– an airborne intercept radar with a 1 MHz IF bandwidth (radar 2).

If the spaceborne sensor of Table 4 can be operated with a different pulse width and chirp bandwidth such as in Table 7, then a significant reduction in the unwanted signal power level can be achieved.

TABLE 7

Example of reduction in received unwanted sensor power, via changes in sensor pulse width and chirp bandwidth

	New parameter values for SAR1		ΔOTR (dB)	ΔP_{avg} (dB)	ΔI (dB)
	τ (μs)	B_c (MHz)			
Radar 1	25	6	–4.0	Not available(1)	–4.0
Radar 2	25	6	–0.0	–3.0	–3.0

(1) It has been deemed appropriate to use average interference signal power for the airborne radar, and peak interference signal power for the tracking radar.

6 Conclusion

It has been demonstrated that it should be possible to reduce the pfd to improve the emission characteristics of active spaceborne sensor in order to enhance the compatibility with other services. Sensor transmitter power, antenna gain pattern, pulse width, PRF, and chirp bandwidth (if frequency modulation is used) are all possible characteristics that can be adjusted to improve compatibility.

RECOMMENDATION ITU-R BO.1293-2

Protection masks and associated calculation methods for interference into broadcast-satellite systems involving digital emissions

(Question ITU-R 223/11)

(1997-2000-2002)

The ITU Radiocommunication Assembly,

considering

a) that protection ratios and associated protection masks are essential characteristics for the television signals in the broadcasting-satellite service (BSS) and associated feeder links;

b) that the Radio Regulations (RR) Appendices 30 and 30A Plans have been developed by using values of protection ratio and interference calculation methods based on fixed frequency offsets and given types of signal;

c) that new systems submitted to the Radiocommunication Bureau (BR) for implementation in these plans propose to use new types of signals for which no protection masks and only limited interference calculation methods are available;

d) that the BR has requested Radiocommunication Study Group 6 to provide additional methodologies and protection criteria to assess interference from and to these new types of signals;

e) that the definition of protection masks and associated calculation methods provides very useful technical information when revising the RR Appendices 30 and 30A Plans for Regions 1 and 3;

f) that several studies have now been carried out by various administrations and organisations that validate the proposed interference calculation method,

recognizing

a) that protection masks extend the usefulness of protection ratios, which are themselves associated with fixed frequency offsets;

b) that appropriate protection masks for interference calculation between digital emissions can be derived by using the methodology provided in Annex 3;

c) that the World Radiocommunication Conference (Istanbul, 2000) (WRC-2000) has established new BSS and associated feeder-link plans for Regions 1 and 3, based on digital modulation, and new Regions 1 and 3 Lists, thus updating Appendices 30 and 30A;

d) that Administrations are entitled to implement their Plan assignments at any time without any further restrictions with respect to the characteristics on which the plans are based,

recommends

1 that for any EPM/OEPM compatibility analysis carried out under Articles 4 and 5 of Appendices 30 and 30A, Annex 1 should be applied;

2 that the associated interference calculation methods of EPM/OEPM provided in Annex 2, should be used for the compatibility analyses referred to in *recommends* 1.

NOTE 1 – The calculation method to generate protection masks provided in Annex 3 for BSS networks employing all types of digital phase shift keyed emissions may be applied in compatibility analyses for bilateral coordination between administrations.

NOTE 2 – Further studies are needed to develop masks for interference between other types of emission (i.e. for analogue into analogue, digital into analogue and analogue into digital interference). Until such time as these masks are available, the method described in Annex 1 should be used when calculating interference between emissions when the interference is digital.

ANNEX 1

Calculation of digital interference in the absence of appropriate protection masks

When applying the calculation method of Annex 2, it is desirable to apply the most appropriate protection mask for the digital interference situation under consideration (i.e. the most appropriate value for $D_i\,(fo_i)$ in Annex 2). For example, for digital interference into a digital emission, this mask can be derived using the calculation method given in Annex 3.

Further studies are required to derive suitable generic protection masks for the case of digital into analogue interference.

Until such time as these masks are available, the method given below should be used to calculate the interference between two emissions, where the interferer is a digital emission.

The value for $D(fo)$ is calculated as follows:

$$D(fo) = 10 \log_{10}\big(B/b(fo)\big) + K$$

where:

$b(fo)$: overlapping bandwidth between the interfering carrier and the wanted carrier (MHz)

B: necessary bandwidth of the interfering digital carrier (MHz)

K: positive weighting coefficient.

In general, a protection mask calculation method such as that given in Annex 3 quantifies the value K which may vary depending upon the wanted and interfering signal parameters and the frequency offset between the two signals (in fact, the method of Annex 3 does not explicitly calculate the factor K but rather calculates directly the value $-D(fo)$).

In the absence of suitable protection masks which quantify the factor K, either directly or indirectly, it should be assumed that $K = 0$ which corresponds to the worst case.

ANNEX 2

Interference calculation methods associated with Annexes 1 and 3*

1 Introduction

The purpose of this Annex is to define a generic method to calculate the interference situation in the BSS Plans, taking into account different categories of interference (e.g. co-channel, adjacent-channel, etc.).

The generic interference calculation method defined below, associated with the appropriate protection mask calculation methods, should be applied to establish the values necessary to assess the interference situation between different emissions of the BSS Plans.

2 Terminology, symbols and operators

In order to simplify this Annex and to facilitate its understanding, the following terminology, symbols and operators are defined:

Single entry, se: a single interfering carrier is considered

Aggregate, ag: all interfering carriers are considered

Equivalent, eq: combination of co-frequency and frequency offset interference

Overall, ov: combination of feeder-link (up) and downlink (dn) interference

fo: frequency offset = difference between the centre frequencies of two carriers

C/I: carrier-to-interference ratio (dB)

PR: protection ratio (dB)

EPM: equivalent protection margin (dB)

OEPM: overall equivalent protection margin (dB)

* This method has been developed to carry out the compatibility analysis of assignments, submitted to the BR under the provision of RR Appendices 30 and 30A, with parameters different from those used in the establishment of the Plans (channel bandwidth, centre frequency, type of emission, etc.).

X: reduction of the overall C/I due to interference in the feeder link (dB)

Operator ⊕: $A \oplus B = -10 \log\left(10^{-A/10} + 10^{-B/10}\right)$

Operator ©: $A © B = -10 \log\left(10^{-A/10} - 10^{-B/10}\right)$

Operator Σ⊕: $\sum_{n=1}^{N} \oplus A_n = -10 \log\left(10^{-A_1/10} + 10^{-A_2/10} + ... + 10^{-A_n/10}\right)$

3 Interference calculation methods

In order to calculate the interference situation of an assignment, two major elements are needed:

– the equivalent aggregate carrier to interference ratio, $C/I_{eq,\,ag}$, on both up and downlinks, $C/I_{eq,\,ag,\,up}$, $C/I_{eq,\,ag,\,dn}$, respectively;

– the overall co-channel (or co-frequency) protection ratios of the wanted carrier, PR_{ov}.

In addition, definitions for the EPM (see Note 1) and OEPM are required.

NOTE 1 – EPM is not needed in case of application of this method to the Region 2 BSS Plan.

3.1 The first elements, i.e. the equivalent aggregate carrier to interference ratios, are calculated as follows for both the up and downlinks:

$$C/I_{eq,\,ag,\,up} = \sum_{i=1}^{m} \oplus \left(C/I_{i,\,se,\,up} + D_i(fo_i)\right)$$

$$C/I_{eq,\,ag,\,dn} = \sum_{i=1}^{n} \oplus \left(C/I_{i,\,se,\,dn} + D_i(fo_i)\right)$$

where:

m: number of interfering carriers on the feeder link

n: number of interfering carriers on the downlink

fo: frequency offset between the centre frequencies of the wanted carrier and one interfering carrier; a positive or negative value (MHz)

$D(fo)$: difference (dB) between the appropriate protection mask's value with no frequency offset (i.e. the centre value at 0 MHz) and the protection mask's value with a frequency offset of fo MHz.

For the case of a digital wanted carrier and a digital interfering carrier, the value $D(fo) = -I(fo)$, where $I(fo)$ ($\equiv I(\Delta f)$) is defined in Annex 3 assuming a linear or non-linear channel.

For other combinations of wanted and interfering carrier types (digital into analogue interference) appropriate masks remain to be defined. Until such time as these masks are available, the model given in Annex 1 should be applied to evaluate $D(fo)$.

From these first elements the overall equivalent aggregate carrier-to-interference ratio (denoted $C/I_{ov,\,eq,\,ag}$) can be calculated as follows:

$$C/I_{ov,\,eq,\,ag} = C/I_{eq,\,ag,\,up} \oplus C/I_{eq,\,ag,\,dn}$$

3.2 The second major element, i.e. the overall protection ratio, PR_{ov}, is associated to the type of the wanted carriers.

In addition to this second element, a feeder-link protection ratio and a downlink protection ratio, PR_{up} and PR_{dn} respectively, can be defined. Assuming a given increase, X, in the downlink protection ratio to allow for interference in the feeder link, PR_{up} and PR_{dn} are defined as follows:

$$PR_{dn} = PR_{ov} + X$$

$$PR_{up} = PR_{ov} © PR_{dn}$$

3.3 ***EPM_{up}, EPM_{dn}* and OEPM definitions**

$$OEPM = C/I_{ov,\,eq,\,ag} - PR_{ov}$$

$$EPM_{up} = C/I_{eq,\,ag,\,up} - PR_{up}$$

$$EPM_{dn} = C/I_{eq,\,ag,\,dn} - PR_{dn}$$

ANNEX 3

Calculation of protection masks for interference between various types of digital carriers

1 Method

It is assumed that the interfering digital carrier can, for interference calculation purposes, be modelled as a white noise source followed by a square-root, raised cosine pulse shaping filter. The roll-off factor, α_i, of this filter may be freely specified in the range $0 \le \alpha_i \le 1$ (0% to 100% roll-off). The filter's 3 dB bandwidth is specified by the transmitted symbol rate, R_i, for the interfering digital signal.

The level of digital interference affecting the wanted digital signal is dependent upon:

– the frequency offset between the wanted and interfering signals, Δf;

– the characteristics of the receiver's filter;

– the characteristics of the transmission channel that carries the interfering signal.

The receiver's filter is also modelled as a square-root, raised cosine filter with a roll-off factor, α_w, where ($0 \le \alpha_w \le 1$), and a 3 dB bandwidth specified by the wanted signal symbol rate R_w.

High power amplification of the interfering signal causes spectral side lobe re-growth. The interference contributed by the side lobes is negligible for low values of Δf, but becomes increasingly significant as the frequency offset is increased.

Only the first two side lobes need to be considered. The interference contribution from higher order side lobes is negligible in all practical transmission scenarios.

The level of each side lobe is adjusted with respect to the main spectral lobe to reflect the characteristics of the non-linear channel. The relative level of each side lobe comprises two components L_s and X:

– A value L_s that is dependent upon the non-linear characteristics of the high power amplifier (HPA) and upon the amplifier's drive level (backoff). The value of L_s is different for each side lobe.

– A value X that represents the effect of filtering at the output of the HPA. This attenuation value is assumed to be the same for all spectral side lobes. This approach is conservative, since the gain of the post-HPA filter is not flat, but rolls off with increasing frequency offset from the channel centre frequency.

The parameters L_s and X are expressed in decibels.

The parameters R_i and R_w are expressed in Msymbol/s. The total bandwidths of the wanted and interfering signals are given by $R_w(1 + \alpha_w)$ MHz and $R_i(1 + \alpha_i)$ MHz respectively. The frequency difference parameter Δf is expressed in MHz. The interference at the output of the receiver filter is assumed to be noise-like.

A common algorithm is used to calculate the wanted signal power at the input to the receiver and the interference power contributions from the main spectral lobe and from each of the spectral side lobes. The procedure for calculating each power contribution is as follows (see § 3 for definitions of the terms used below):

a) set the input parameters (R_i, R_w, α_i, α_w, δf, L_s and X) to the appropriate values for the power contribution to be calculated (wanted signal, interfering signal main spectral lobe or interfering signal spectral side lobe);

b) calculate the nine pairs of limits (U_n, L_n, $n = 1, \ldots, 9$);

c) calculate the five power contribution terms (C_m, $m = 1, \ldots, 5$);

d) calculate the total received power, P:

$$P = 10^{\frac{L_s - X}{10}} \sum_{m=1}^{5} C_m$$

The level of interference power $I(\Delta f)$, measured at the output of the receiver's filter and expressed relative to the wanted carrier power for a reference link C/I of 0 dB (i.e. assuming equal wanted and interfering carrier powers), is calculated as follows.

Step 1: Calculate the wanted signal power, P_w, at the output of the receiver filter using the above algorithm and setting the input parameter values as follows:

$$R_i = R_w, \quad \alpha_i = \alpha_w, \quad \delta f = 0, \quad L_s = 0, \quad X = 0$$

Step 2: Calculate the interfering signal power contribution from the main spectral lobe, P_0, at the output of the receiver filter using the same algorithm and setting the input parameters as follows:

$$\delta f = \Delta f, \quad L_s = 0, \quad X = 0$$

Step 3: Calculate the interfering signal power contribution from the first spectral side lobe, P_1, with the input parameters set as follows:

$$\delta f = |\Delta f| - R_i, \quad L_s = L_1 \neq 0, \quad X \neq 0$$

The value for L_s depends upon the non-linear characteristics of the HPA and its drive level. The value of X depends upon the out-of-band attenuation characteristics of the post-HPA filter.

Step 4: Calculate the interfering signal power contribution from the second spectral side lobe, P_2, with the input parameters set as follows:

$$\delta f = |\Delta f| - 2R_i, \quad L_s = L_2 \neq L_1 \neq 0, \quad X \neq 0$$

The value for L_s again depends upon the non-linear characteristics of the HPA and its drive level. The value of X is the same as in Step 3.

Step 5: Calculate the relative interference power for the given signal parameters and frequency offset:

$$I(\Delta f) = 10 \log \left(\frac{P_0 + P_1 + P_2}{P_w} \right) \qquad \text{dB}$$

2 Example calculation of a protection mask

As an (arbitrary) example, it is assumed that the wanted and interfering signal parameters are as follows:

Wanted digital signal:

Symbol rate, $R_w = 27.5$ Msymbol/s

Roll-off factor, $\alpha_w = 0.35$ (35% cosine roll-off).

Interfering digital signal:

Symbol rate, $R_i = 27.5$ Msymbol/s

Roll-off factor, $\alpha_i = 0.35$ (35% cosine roll-off).

Side lobe levels:

First side lobe level, $L_{s1} = -17.0$ dB

Second side lobe level, $L_{s2} = -27.5$ dB.

Post-HPA filtering:

Side lobe attenuation, $X_f = 12.0$ dB.

The frequency offset between the wanted and interfering signals, Δf, is assumed to be 38.36 MHz. The application of the calculation method described in § 1 of this Annex, and detailed in § 3 of this Annex, gives the following:

Step 1: Calculate the wanted signal power, P_w, at the output of the receiver filter:

$$R_i = R_w, \quad \alpha_i = \alpha_w, \quad L_s = 0, \quad X = 0, \quad \delta f = 0$$

$$L_1 = U_8 = U_9 = -8.937$$

$$U_1 = L_2 = U_2 = L_3 = U_3 = L_4 = U_4 = L_5 = U_5 = L_6 = L_7 = L_8 = L_9 = 8.937$$

$$U_6 = U_7 = 18.563$$

$$C_1 = 0.825, \quad C_2 = 0, \quad C_3 = 0, \quad C_4 = 0.088, \quad C_5 = 0$$

$$P_w = 0.913$$

Step 2: Calculate the interfering signal power, P_0, due to the main spectral lobe at the output of the receiver filter:

$$L_s = 0, \quad X = 0, \quad \delta f = \Delta f$$

$$L_1 = L_3 = L_4 = 29.422, \quad U_1 = L_2 = L_5 = L_7 = 8.937, \quad L_6 = L_9 = 47.297, \quad L_8 = -18.563$$

$$U_9 = -8.937, \quad U_2 = U_5 = -29.422, \quad U_3 = U_4 = U_6 = 18.563, \quad U_7 = U_8 = -19.797$$

$$C_1 = 0, \quad C_2 = 0, \quad C_3 = 0, \quad C_4 = 0, \quad C_5 = 0$$

$$P_0 = 0$$

Step 3: Calculate the interfering signal power, P_1, due to the first spectral side lobe at the output of the receiver filter:

$$L_s = L_{s1}, \quad X = X_f, \quad \delta f = |\Delta f| - R_i$$

$$L_1 = 1.923, \quad U_1 = L_2 = L_3 = L_4 = L_5 = L_7 = 8.937, \quad U_2 = U_5 = L_8 = -1.923$$

$$U_3 = U_4 = U_6 = 18.563, \quad L_6 = L_9 = 19.797, \quad U_7 = 7.703, \quad U_8 = U_9 = -8.937$$

$$C_1 = 0.605, \quad C_2 = 0, \quad C_3 = 0, \quad C_4 = 0, \quad C_5 = 0$$

$$P_1 = 7.618 \times 10^{-4}$$

Step 4: Calculate the interfering signal power, P_2, due to the second spectral side lobe at the output of the receiver filter:

$$L_s = L_{s2}, \quad X = X_f, \quad \delta f = |\Delta f| - 2R_i$$

$$L_1 = U_8 = U_9 = -8.937, \quad U_1 = U_3 = U_4 = L_9 = -7.703, \quad L_2 = L_3 = L_4 = L_5 = L_6 = 8.937$$

$$U_2 = U_5 = U_7 = 18.563, \quad L_7 = L_8 = 25.578, \quad U_6 = 1.922$$

$$C_1 = 0.395, \quad C_2 = 0, \quad C_3 = 0, \quad C_4 = 0, \quad C_5 = 0$$

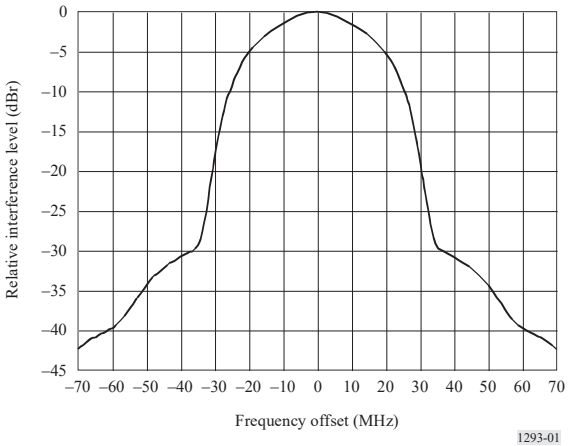
$$P_2 = 4.431 \times 10^{-5}$$

Step 5: Calculate the total interference power relative to the wanted signal power:

$$I(\Delta f) = -30.5$$

Following this procedure for a range of frequency offsets results in the example protection mask given in Fig. 1.

FIGURE 1



3 Algorithms: Calculation of the received (wanted or interfering) signal power

3.1 Limits

$A = (1 - \alpha_w)\,\frac{R_w}{2}$ $\quad B = (1 + \alpha_w)\,\frac{R_w}{2}$ $\quad C = (1 - \alpha_i)\,\frac{R_i}{2}$ $\quad D = (1 + \alpha_i)\,\frac{R_i}{2}$

$L_1 = max\,(-A;\ \delta f - C)$ $\quad L_4 = max\,(A;\ \delta f - C)$ $\quad L_7 = max\,(A;\ -\delta f + C)$

$U_1 = min\,(A;\ \delta f + C)$ $\quad U_4 = min\,(B;\ \delta f + C)$ $\quad U_7 = min\,(B;\ -\delta f + D)$

$L_2 = max\,(-A - \delta f\,;\ C)$ $\quad L_5 = max\,(A;\ -\delta f - C)$ $\quad L_8 = max\,(-B;\ -\delta f + C)$

$U_2 = min\,(A - \delta f\,;\ D)$ $\quad U_5 = min\,(B;\ -\delta f + C)$ $\quad U_8 = min\,(-A;\ -\delta f + D)$

$L_3 = max\,(-A + \delta f\,;\ C)$ $\quad L_6 = max\,(A;\ \delta f + C)$ $\quad L_9 = max\,(-B;\ \delta f + C)$

$U_3 = min\,(A + \delta f\,;\ D)$ $\quad U_6 = min\,(B;\ \delta f + D)$ $\quad U_9 = min\,(-A;\ \delta f + D)$

NOTE 1:

max (*a*; *b*): maximum value of *a* and *b*

min (*a*; *b*): minimum value of *a* and *b*

δf = frequency of interfering signal – frequency of wanted signal.

3.2 Functions

When $1 \le n \le 3$:

$$p_n(a,b) = f_n(a) - f_n(b) \quad \text{for } a > b$$
$$= 0 \quad \text{for } a \le b$$

$$f_1(x) = \left(\frac{x}{R_i}\right) \qquad f_2(x) = \frac{\alpha_i}{2\pi}\cos\left(\frac{\pi}{2}\frac{2x-R_i}{\alpha_i R_i}\right) \qquad f_3(x) = \frac{\alpha_w R_w}{2\pi R_i}\cos\left(\frac{\pi}{2}\frac{2x-R_w}{\alpha_w R_w}\right)$$

When $4 \le n \le 5$:

$$p_n(a,b,\delta f) = f_n(a,\delta f) - f_n(b,\delta f) \quad \text{for } a > b$$
$$= 0 \quad \text{for } a \le b$$

$$f_4(x,y) = f_{4a}(x,y) \quad \text{for } \alpha_w R_w = \alpha_i R_i$$
$$= f_{4b}(x,y) \quad \text{for } \alpha_w R_w \ne \alpha_i R_i$$

$$f_5(x,y) = f_{5a}(x,y) \quad \text{for } \alpha_w R_w = \alpha_i R_i$$
$$= f_{5b}(x,y) \quad \text{for } \alpha_w R_w \ne \alpha_i R_i$$

$$f_{4a}(x,y) = \frac{1}{16\pi R_i}\left(2\pi\, x\cos\left(\frac{\pi}{2}\frac{2y+R_i-R_w}{\alpha_i R_i}\right) - \alpha_i R_i \sin\left(\frac{\pi}{2}\frac{4x-2y-R_i-R_w}{\alpha_i R_i}\right)\right)$$

$$f_{4b}(x,y) = \frac{\alpha_i \alpha_w R_w}{4\pi\left(\alpha_i^2 R_i^2 - \alpha_w^2 R_w^2\right)}\left(\alpha_i R_i \cos\left(\frac{\pi}{2}\frac{2x-R_w}{\alpha_w R_w}\right)\sin\left(\frac{\pi}{2}\frac{2y-2x+R_i}{\alpha_i R_i}\right) + \alpha_w R_w \sin\left(\frac{\pi}{2}\frac{2x-R_w}{\alpha_w R_w}\right)\cos\left(\frac{\pi}{2}\frac{2y-2x+R_i}{\alpha_i R_i}\right)\right)$$

$$f_{5a}(x,y) = \frac{1}{16\pi R_i}\left(\alpha_i R_i \sin\left(\frac{\pi}{2}\frac{4x-2y-R_i+R_w}{\alpha_i R_i}\right) - 2\pi x\cos\left(\frac{\pi}{2}\frac{2y+R_i+R_w}{\alpha_i R_i}\right)\right)$$

$$f_{5b}(x,y) = \frac{\alpha_i \alpha_w R_w}{4\pi\left(\alpha_i^2 R_i^2 - \alpha_w^2 R_w^2\right)}\left(\alpha_i R_i \cos\left(\frac{\pi}{2}\frac{2x+R_w}{\alpha_w R_w}\right)\sin\left(\frac{\pi}{2}\frac{2x-2y-R_i}{\alpha_i R_i}\right) - \alpha_w R_w \sin\left(\frac{\pi}{2}\frac{2x+R_w}{\alpha_w R_w}\right)\cos\left(\frac{\pi}{2}\frac{2x-2y-R_i}{\alpha_i R_i}\right)\right)$$

3.3 Power contributions

$$C_1 = p_1(U_1, L_1) + \frac{1}{2}\sum_{n=2}^{5} p_1(U_n, L_n) + \frac{1}{4}\sum_{n=6}^{9} p_1(U_n, L_n)$$

$$C_2 = p_2(U_2, L_2) + p_2(U_3, L_3) + \frac{1}{2}\left[p_2(U_6 - \delta f, L_6 - \delta f) + p_2(U_7 + \delta f, L_7 + \delta f) + p_2(U_8 + \delta f, L_8 + \delta f) + p_2(U_9 - \delta f, L_9 - \delta f)\right]$$

$$C_3 = p_3(U_4, L_4) + p_3(U_5, L_5) + \frac{1}{2}\left[p_3(U_6, L_6) + p_3(U_7, L_7) + p_3(-L_8, -U_8) + p_3(-L_9, -U_9)\right]$$

$$C_4 = p_4(U_6, L_6, \delta f) + p_4(U_7, L_7, -\delta f)$$

$$C_5 = p_5(U_8, L_8, -\delta f) + p_5(U_9, L_9, \delta f)$$

3.4 Total received signal power

$$\text{Power} = 10^{\frac{L_s - X}{10}} \sum_{m=1}^{5} C_m$$

APPENDIX 1

TO ANNEX 3

Notification of parameters associated to digital emissions

Application of the method described in Annex 3 for calculation of protection masks for interference between digital emissions requires the notification of parameters associated with each digital emission. These parameters are:

– the digital modulation type (this method is applicable only to phase shift keyed signals);

– the transmitted symbol rate (Msymbol/s);

– the roll-off factor of the digital pulse shaping filter (assumed to be a cosine roll-off filter or an approximation thereof), a value in the range 0 to 1;

– the relative levels of the first and second side lobes, L_{s1} and L_{s2} (dB);

– the side lobe attenuation, X (dB) resulting from post-HPA filtering.

The first three of these items are already required by RR Appendix 4. In addition, the last two items are recommended to be provided to be added to RR Appendix 4 by a future competent conference.

Most downlink digital TV carriers occupy the whole of the transponder bandwidth and the transponder is operated at saturation for maximum downlink power. Studies have shown that, under these conditions, suitable side lobe relative levels are –18 dB and –30 dB respectively. Furthermore, since there is always filtering (an output multiplexer) at the output of the on-board HPA (travelling wave tube amplifier (TWTA), the parameter X is non-zero. The precise value of X will vary from system to system. A value of 12 dB seems to be a conservative minimum value that should be exceeded by all new systems implementing contiguous co-polar channels.

For uplinks there is typically no post-HPA filter but the HPA is operated with a backoff to control the out-of-band side lobe levels. Side lobe levels of –29 dB and –39.5 dB are unlikely to be exceeded in feeder links to BSS systems.

RECOMMENDATION ITU-R S.1340-0*,**

Sharing between feeder links for the mobile-satellite service and the aeronautical radionavigation service in the Earth-to-space direction in the band 15.4-15.7 GHz

(Question ITU-R 243/4)

(1997)

The ITU Radiocommunication Assembly,

considering

a) that Resolution 117 of the World Administrative Radio Conference (Geneva, 1995) (WARC-95) calls for studies by the ITU-R of the sharing situation between feeder links (Earth-to-space) for the mobile-satellite service (MSS) and the aeronautical radionavigation service in the band 15.45-15.65 GHz;

b) that the band 15.4-15.7 GHz is allocated to the aeronautical radionavigation service on a primary basis and that No. S4.10 of the Radio Regulations (RR) applies;

c) that the WRC-95 has added an allocation to the fixed-satellite service (FSS) in the band 15.45-15.65 GHz for feeder links of non-geostationary (non-GSO) satellite networks in the MSS in the Earth-to-space direction;

d) that the requirements for feeder links (Earth-to-space) of non-GSO satellite systems in the MSS need to be accommodated in this band;

e) that emissions from stations in the aeronautical radionavigation service can cause unacceptable interference to satellites;

f) that administrations operating stations in the aeronautical radionavigation service are urged to limit the average e.i.r.p. to 42 dBW in order to limit interference to non-GSO satellites; this value is subject to review and study by the ITU-R (see RR No. S5.511C);

g) that coordination of emissions from aeronautical radionavigation stations with feeder-link space stations is not considered practical;

h) that emissions from feeder-link earth stations propagated along the Earth's surface can cause harmful interference to aeronautical radionavigation stations;

j) that certain limitations have been placed on the fixed-satellite service for the protection of the aeronautical radionavigation service in accordance with RR No. S5.511C;

k) that there is fairly extensive use of this band by the aeronautical radionavigation service for airborne, land and ocean based stations;

l) that aircraft stations are not permitted to transmit in the band 15.45-16.45 GHz in accordance with RR No. S5.511B;

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* This Recommendation should be brought to the attention of Radiocommunication Study Group 8.

** Radiocommunication Study Group 4 made editorial amendments to this Recommendation in 2001 in accordance with Resolution ITU-R 44 (RA-2000).

m) that the technical and operational characteristics of the aeronautical radionavigation stations are reasonably well known;

n) that the technical and operational characteristics of feeder links are not well defined;

o) that methods are needed to determine the coordination and separation distances required between feeder-link earth stations and aeronautical radionavigation stations in order to protect the aeronautical radionavigation stations;

p) that studies have been made with respect to the preceding *considerings*,

recommends

1 that feeder links for the MSS should be limited to the band 15.43-15.63 GHz (see Note 1);

2 that the emissions expressed as effective e.i.r.p. (E_{eff}) from aeronautical radionavigation stations should not exceed the following:

2.1 for aircraft landing systems and for feeder-link bandwidths greater than 3 MHz:

$$E_{eff} = \begin{cases} 53 & \text{dBW} \quad \text{for} \quad 0 \le \varphi < 8 \\ 53 - 0.833\,(\varphi - 8) & \text{dBW} \quad \text{for} \quad 8 \le \varphi < 14 \\ 48 & \text{dBW} \quad \text{for} \quad 14 \le \varphi < 32 \\ 48 - 9\,(\varphi - 32) & \text{dBW} \quad \text{for} \quad 32 \le \varphi < 34 \\ 30 & \text{dBW} \quad \text{for} \quad 34 \le \varphi < 40 \\ 30 - 0.2\,(\varphi - 40) & \text{dBW} \quad \text{for} \quad 40 \le \varphi \le 90 \end{cases}$$

2.2 for general purpose aircraft radars and for feeder-link bandwidths greater than 1 MHz:

$$E_{eff} = \begin{cases} 62 & \text{dBW} \quad \text{for} \quad 0 \le \varphi < 20 \\ 62 - 0.56\,(\varphi - 20)^2 & \text{dBW} \quad \text{for} \quad 20 \le \varphi < 25 \\ 48 & \text{dBW} \quad \text{for} \quad 25 \le \varphi < 29 \\ 71.86 - 25 \log (\varphi - 20) & \text{dBW} \quad \text{for} \quad 29 \le \varphi < 68 \\ 29.8 & \text{dBW} \quad \text{for} \quad 68 \le \varphi \le 90 \end{cases}$$

where:

$$E_{eff} = E_p - 15 \log (1 + 5/PW) \qquad \text{dBW}$$

E_{eff}: e.i.r.p. which causes the same level of interference to a phase modulated signal as a continuous noise like interferer

E_p: peak pulse e.i.r.p. (dBW) of the aeronautical radionavigation station

PW: pulse duration (μs) of the aeronautical radionavigation station

φ: angle of elevation (degrees) above the local horizontal plane;

3 that feeder links in the Earth-to-space direction should be designed to operate in the interference environment defined in *recommends* 2;

4 that with *recommends* 2 and 3 coordination of emissions from aeronautical radionavigation stations with satellite receiving stations is not required;

5 that the e.i.r.p. transmitted toward the local horizontal plane by a feeder-link earth station should not exceed 54 dB(W/MHz) (see Note 2);

6 that surface based radars as described in Annex 1 should not operate in the 15.43-15.63 GHz band;

7 that the coordination distances required to protect the aeronautical radionavigation stations from harmful interference from feeder-link earth station emissions are:

– 515 km from the aircraft landing surface for aircraft landing systems (ALS);

– 600 km from aircraft using general purpose radars (MPR);

– 270 km from the aircraft landing for radar sensing and measurement systems;

8 that additional information is contained in Annexes 1, 2 and 3.

NOTE 1 – The frequency band given in *recommends* 1 is slightly different to that allocated by the WRC-95. This difference is recommended to facilitate sharing between the non-GSO MSS feeder links and the aeronautical radionavigation service. *recommends* 1 will be reviewed at a later date in accordance with the outcome of a future WRC.

NOTE 2 – Additional design and operational constraints may be placed on MSS Earth-to-space feeder links in order to take into account the threshold levels for the radio astronomy service given in Recommendation ITU-R RA.769.

ANNEX 1

Aeronautical radionavigation systems in the 15.4-15.7 GHz band

1 Surface based radars (SBR)

The land and ship based SBR are used for the detection, location and movement of aircraft and other vehicles on the surface of airports and other aircraft landing areas.

1.1 Antenna patterns

– Nominal 3 dB beamwidth: <3.5° vertical, inverted cosecant to –31°
0.35° horizontal

– Frequency range: 15.65-16.7 GHz

– Polarization: circular

– Typical gain: 43 dBi

– Maximum side-lobe level: 25 dB below peak gain

– Maximum back-lobe level: 35 dB below peak gain

– Vertical tilt range: ±1.5°

– Maximum horizontal scan range: 360°.

1.1.1 Antenna elevation envelope pattern

Based on measured data and side-lobe level specifications and with the peak gain directed at +1.5°, an elevation envelope gain pattern is defined as follows where φ is the elevation angle (degrees):

$$G(\varphi) = \begin{cases} 43 & \text{dBi} \quad \text{for} \quad 0 \le \varphi < 4 \\ 43 - 5\,(\varphi - 4) & \text{dBi} \quad \text{for} \quad 4 \le \varphi < 9 \\ 18 & \text{dBi} \quad \text{for} \quad 9 \le \varphi < 16 \\ 43.2 - 21 \log \varphi & \text{dBi} \quad \text{for} \quad 16 \le \varphi < 48 \\ 8 & \text{dBi} \quad \text{for} \quad 48 \le \varphi \le 90 \end{cases}$$

1.1.2 Antenna azimuth envelope pattern

Based on measured data and side-lobe level specifications, the azimuth gain pattern is defined as follows where φ is the relative azimuth angle (degrees):

$$G(\varphi) = \begin{cases} 43 - 110\,\varphi^2 & \text{dBi} \quad \text{for} \quad 0 \le \varphi < 0.4767 \\ 18 & \text{dBi} \quad \text{for} \quad 4.4767 \le \varphi < 0.72 \\ 17.07 - 6.5 \log \varphi & \text{dBi} \quad \text{for} \quad 0.72 \le \varphi < 48 \\ 8 & \text{dBi} \quad \text{for} \quad 48 \le \varphi \le 180 \end{cases}$$

1.2 Other characteristics

1.2.1 Transmitting

– Peak e.i.r.p.: 86 dBW

– Pulse repetition frequency: 8 192 Hz

– Pulse duration: 0.04 μs

– Pulse 3.5 dB bandwidth: 25 MHz.

1.2.2 Receiving

– Typical antenna gain: 43 dBi

– Typical noise figure: 6.2-6.9 dB.

2 Aircraft landing systems (ALS)

These ALS are general purpose systems and are used on ships, as portable or permanent land based systems and for shuttle landings. The microwave scanning beam landing system (MSBLS) is one such system. Some of the characteristics vary with the particular applications.

2.1 Surface based station antenna patterns

The antenna patterns are similar for all applications including the MSBLS. The scanning ranges vary with application. The scanning ranges given below cover all applications.

The antenna complement of the ALS consists of an elevation antenna and an azimuth antenna.

The elevation antenna portion of the ALS is used to transmit vertical angle data to the aircraft.

– nominal 3 dB beamwidths: 1.3° vertical
40° horizontal

– frequency range: 15.4-15.7 GHz

– polarization: horizontal and vertical

– typical gain: 28 dBi

– maximum side-lobe level: 17 dB below peak gain in both planes

– maximum vertical scan range: 0 to 30°.

The azimuth antenna portion of the ALS is used to transmit azimuth information to the aircraft.

– nominal 3 dB beamwidths: 2.0° horizontal
6.5° vertical

– the vertical pattern is spoiled to achieve at least a 20 dBi gain at 20° above the horizon

– frequency range: 15.4-15.7 GHz

– polarization: horizontal and vertical

– typical gain: 33 dBi

– maximum side-lobe level: 17 dB below peak gain in both planes

– maximum horizontal scan range: ±35°.

2.1.1 Combined antenna elevation envelope pattern

A combined vertical envelope gain pattern based on measured data is defined as follows where φ is the elevation angle (degrees):

$$G(\varphi) = \begin{cases} 33 & \text{dBi} \quad \text{for} \quad 0 \le \varphi < 8 \\ 33 - 0.833\,(\varphi - 8) & \text{dBi} \quad \text{for} \quad 8 \le \varphi < 14 \\ 28 & \text{dBi} \quad \text{for} \quad 14 \le \varphi < 32 \\ 28 - 9\,(\varphi - 32) & \text{dBi} \quad \text{for} \quad 32 \le \varphi < 34 \\ 10 & \text{dBi} \quad \text{for} \quad 34 \le \varphi < 40 \\ 10 - 0.2\,(\varphi - 40) & \text{dBi} \quad \text{for} \quad 40 \le \varphi \le 90 \end{cases}$$

2.1.2 Azimuth antenna patterns

The azimuth envelope pattern of the elevation antenna is defined as follows where φ is the relative azimuth angle (degrees):

$$G(\varphi) = \begin{cases} 28 - 0.0062\,\varphi^2 & \text{dBi} \quad \text{for} \quad 0 \le \varphi < 70 \\ -2.37 & \text{dBi} \quad \text{for} \quad 70 \le \varphi \le 180 \end{cases}$$

The azimuth envelope pattern of the azimuth antenna is defined as follows where φ is the relative azimuth angle (degrees):

$$G(\varphi) = \begin{cases} 33 - 2\,\varphi^2 & \text{dBi} \quad \text{for} \quad 0 \le \varphi < 3 \\ 15 & \text{dBi} \quad \text{for} \quad 3 \le \varphi < 5 \\ 32.5 - 25 \log \varphi & \text{dBi} \quad \text{for} \quad 5 \le \varphi < 48 \\ -9.53 & \text{dBi} \quad \text{for} \quad 48 \le \varphi \le 180 \end{cases}$$

2.2 Other characteristics

2.2.1 Transmitting

– Peak e.i.r.p.: 71 dBW

– Pulse repetition frequency: 3 334 Hz

– Pulse duration: 0.333 μs

– Pulse 3.5 dB bandwidth: 3 MHz.

2.2.2 Receiving

– Typical antenna gain: 8 dBi

– Typical noise figure: 8 dB.

3 Aircraft multipurpose radars (MPR)

The aircraft MPR is a radionavigation, radiolocation and weather radar.

3.1 Antenna patterns

The antenna is a parabola of approximately 0.3 m diameter which is scanned vertically and horizontally with respect to the heading and attitude of the aircraft:

– nominal 3 dB beamwidth: 4.5°

– frequency range: 15.4-15.7 GHz

– polarization: vertical

– typical gain: 30 dBi

– maximum horizontal scan range: ±45°

– maximum vertical scan range: ±20°.

The envelope pattern of the antenna is defined as follows where φ is the relative azimuth angle (degrees):

$$G(\varphi) = \begin{cases} 30 & \text{dBi} \quad \text{for} \quad 0 \le \varphi < 20 \\ 30 - 0.56\,(\varphi - 20)^2 & \text{dBi} \quad \text{for} \quad 20 \le \varphi < 25 \\ 16 & \text{dBi} \quad \text{for} \quad 25 \le \varphi < 29 \\ 39.86 - 25 \log (\varphi - 20) & \text{dBi} \quad \text{for} \quad 29 \le \varphi < 68 \\ -2.17 & \text{dBi} \quad \text{for} \quad 68 \le \varphi \le 180 \end{cases}$$

3.2 Other characteristics

3.2.1 Transmitting

– Peak e.i.r.p.: 70 dBW

– Pulse repetition frequency: 800 Hz

– Pulse duration: 2 μs

– Pulse 3.5 dB bandwidth: 0.5 MHz.

3.2.2 Receiving

– Typical antenna gain: 30 dBi

– Typical noise figure: 8 dB.

4 Radar sensing and measurement system (RSMS)

Measurement techniques using radar technology at 15 GHz are particularly suited to smaller aircraft, including helicopters, offering the benefits of compact, light, equipment with good antenna directivity and more than adequate performance for many operational radionavigation applications which are not practicable at lower frequencies due to propagation or other reasons. For use in a height measurement mode this higher frequency band confers system design benefits, such as lower cross coupling and absence of triangulation effects, which are particularly important for accurate measurement at very low (metric) separations. For some operational applications they present the only viable technical solution.

Systems using these techniques are widely used in certain parts of the world where they make an important contribution to the safety of aircraft operation. Measurement of height and ground clearance is one of the most critical parameters in the operation of aircraft when used to assist the final stages in a landing. High accuracy and interference free operation are vital to success and the enhancement of safety.

RSMS are essentially used in low level operations up to a nominal height of around 1 500 m. An antenna mounting which transmits and receives vertically downwards would be used in the great majority of applications. Power reduction proportional to height above terrain is employed to reduce scatter and other undesirable effects.

4.1 RSMS characteristics

4.1.1 Transmitter

– Frequency range: 15.63-15.65 GHz

– Peak power: 30 dBmW

– Antenna gain: 13 dBi, back lobes < 5 dBi

– PRF (pulse repetition frequency): 58 kHz

– Pulse length (max.): 500 ns

– Duty cycle (max.): 3%

– Pulse 3.5 dB bandwidth: 2 MHz.

4.1.2 Receiver

– Antenna gain: 13 dBi, back lobes < 5 dBi

– Noise figure: 6 dB.

ANNEX 2

Emission criteria for the aeronautical radionavigation service and sharing feasibility with feed links for the MSS (Earth-to-space) in the 15.4-15.7 GHz band

1 Introduction

A basic method for protecting non-GSO satellites from unacceptable interference is to establish maximum limits on the e.i.r.p. from aeronautical radionavigation stations and minimum e.i.r.p. limits on the emissions from the feeder-link earth stations.

Alternatively, only maximum e.i.r.p. limits on the aeronautical radionavigation stations can be established which define the interference environment in which the feeder links must be able to operate. This alternative appears more attractive in that it is simpler and allows maximum freedom for the design and operation of feeder links. This approach is addressed in the following sections.

Either of these methods is an effective way to eliminate the need for coordination. Coordination is not practical for this case.

2 Characteristics of aeronautical radionavigation systems

Several systems are identified that operate in this band. These include surface based radars (SBR) used on land and ships for the detection, location and movement of aircraft and other vehicles on aircraft landing areas, ALS, MPR and RSMS. The antenna patterns of these systems is an important element in determining the e.i.r.p. as a function of elevation angle. Antenna envelope gain patterns and other pertinent characteristics are given in Annex 1.

3 Analyses

3.1 Pulsed interference into digital carriers

Task Group 4/4 studied the interference from radars into digital carriers. Measurements were made over a wide range of pulse repetition frequencies (PRF), (1-100 kHz) and duty cycles, *d*, (0.01%-100%) for radar and data rates from 2 Mbit/s to 45 Mbit/s for 3/4 rate forward error correction (FEC) coded QPSK digital carriers operating at a bit error rate (BER) of 1×10^{-6}. An

empirical equation was developed from the measurement data which can be used to relate the peak pulsed radar e.i.r.p., E_p, to an effective e.i.r.p., E_{eff}, i.e., an e.i.r.p. which would cause the same level of interference (see Recommendation ITU-R S.1068). The actual average e.i.r.p., E_{ave}, is equal to the peak e.i.r.p. times the duty cycle. Under these conditions the empirical equation is:

$$E_{eff} = E_p - 15 \log (1 + 0.5(PRF/d)) \qquad \text{dBW} \qquad (1)$$

where PRF is in kHz and d is in per cent.

Since the pulse width, PW, is equal to (d/PRF), equation (1) can be expressed as:

$$E_{eff} = E_p - 15 \log (1 + 5/PW) \qquad \text{dBW} \qquad (2)$$

where PW is in microseconds.

With a $[(\sin x)/x]^2$ power spectral density function the peak power density is approximately 3.5 dB greater than the power density averaged over a $2/PW$ bandwidth. The 3.5 dB bandwidth (BW) (MHz) is approximately $1/PW$. With this, the effective e.i.r.p. density E_{eff}/MHz, for feeder-link carrier bandwidths (BW) (MHz) that are less than $1/PW$ is:

$$E_{eff}/\text{MHz} = E_p - 10 \log (2/PW) + 3.5 - 15 \log (1 + 5/PW) \qquad \text{dBW} \qquad (3)$$

and for (BW) equal to or greater than ($1/PW$) the (E_{eff}/MHz) averaged over (BW) is:

$$E_{eff}/\text{MHz} = E_p - 10 \log (2/PW) + 3.5 - 15 \log (1 + 5/PW) - 10 \log [(BW)(PW)] \qquad \text{dBW} \qquad (4)$$

3.2 Emission limits on aeronautical radionavigation stations

The SBRs can be accommodated in the band 15.63-15.7 GHz. By shifting the 15.45-15.65 GHz band to 15.43-15.63 GHz, interference to feeder links in the Earth-to-space direction does not need to be considered.

The dominant area of operation of the MPR is over the ocean which in most cases will be beyond the coordination distance of feeder-link earth stations, and thus would not require coordination with feeder-link earth stations. Therefore, the operation of the MPR in the 15.4-15.7 GHz band would be permitted even though geographical constraints would apply (see Annex 3). The RSMS currently operates in the 15.4-15.7 GHz band and geographical constraints may also apply.

The parameter values for equations (2), (3) and (4) for the ALS, MPR and RSMS aeronautical radionavigation systems are given in Annex 1 along with the antenna envelope gain functions. With this information the values of E_{eff} can be computed as a function of the elevation angle. The peak e.i.r.p. and PW are limited by equations (2), (3) and (4). The elevation angle, φ, is in degrees.

3.2.1 ALS E_{eff} limits

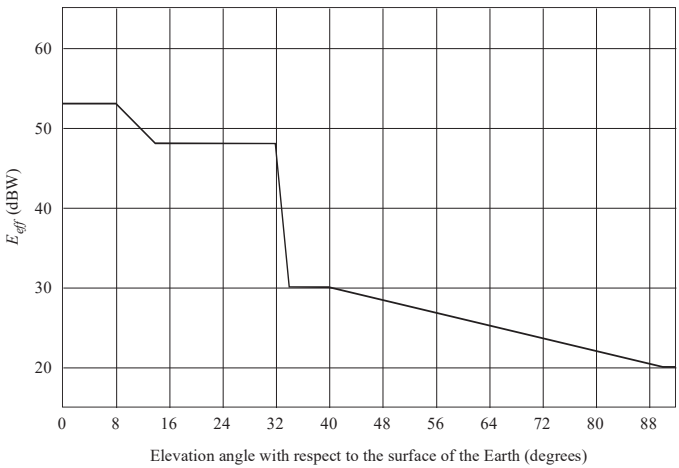
For feeder-link carrier bandwidths greater than 3 MHz:

$$E_{eff} = \begin{cases} 53 & \text{dBW} \quad \text{for} \quad 0 \le \varphi < 8 \\ 53 - 0.833\,(\varphi - 8) & \text{dBW} \quad \text{for} \quad 8 \le \varphi < 14 \\ 48 & \text{dBW} \quad \text{for} \quad 14 \le \varphi < 32 \\ 48 - 9\,(\varphi - 32) & \text{dBW} \quad \text{for} \quad 32 \le \varphi < 34 \\ 30 & \text{dBW} \quad \text{for} \quad 34 \le \varphi < 40 \\ 30 - 0.2\,(\varphi - 40) & \text{dBW} \quad \text{for} \quad 40 \le \varphi \le 90 \end{cases}$$

This function is shown in Fig. 1.

FIGURE 1

ALS effective e.i.r.p., E_{eff}, limits



1340-01

3.2.2 MPR E_{eff} limits

For feeder-link carrier bandwidths greater than 1 MHz:

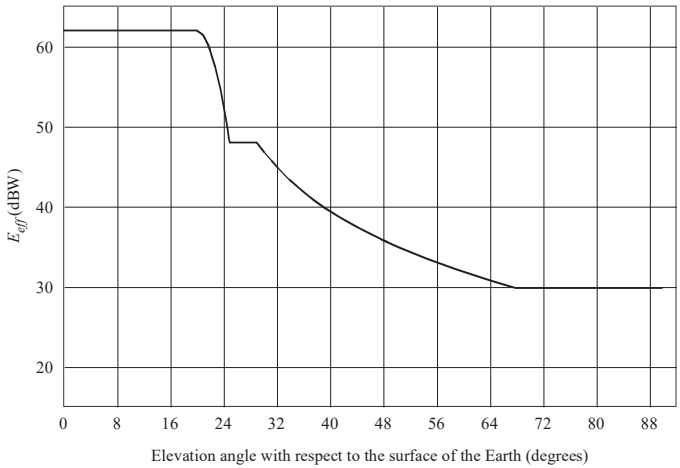
$$E_{eff} = \begin{cases} 62 & \text{dBW} \quad \text{for} \quad 0 \le \varphi < 20 \\ 62 - 0.56\,(\varphi - 20)^2 & \text{dBW} \quad \text{for} \quad 20 \le \varphi < 25 \\ 48 & \text{dBW} \quad \text{for} \quad 25 \le \varphi < 29 \\ 71.86 - 25 \log\,(\varphi - 20) & \text{dBW} \quad \text{for} \quad 29 \le \varphi < 68 \\ 29.8 & \text{dBW} \quad \text{for} \quad 68 \le \varphi \le 90 \end{cases}$$

This function is shown in Fig. 2.

The E_{eff} for the RSMS for elevation angles above 0° is –13.1 dBW.

FIGURE 2

MPR effective e.i.r.p., E_{eff}, limits



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3.3 Impact on feeder link up path e.i.r.p.

Protection from up-path interference due to aeronautical radionavigation stations can be achieved by providing adequate up-path e.i.r.p. from the earth station.

For the case of interference to a rate 3/4 FEC QPSK carrier, the carrier-to-interference, C/I, ratio for a 1×10^{-6} BER was about 9 dB for the measurements described in Section 3.1. This C/I is for the condition where interference from other sources is not significant. Since the percentage of time that a radionavigation station is operating and the –3 dB contour of its antenna is in conjunction with a satellite is very low, it is assumed that a C/I of 9 dB can be tolerated for this small percentage of time. For an uncoded QPSK carrier the C/I is about 12 dB.

The up-path e.i.r.p. required to overcome these interference envelopes as a function of the feeder-link carrier bandwidth can be computed by assuming that only one entry of one type will occur at any one time. In general, e.i.r.p. values in the 60 to 70 dBW range may be required.

4 Summary

– The effective e.i.r.p. limits given in § 3.2 are consistent with the operation of currently existing aeronautical radionavigation systems.

– Specifying the maximum interference environment which must be accepted by MSS feeder links allows the feeder-link designers and operators maximum flexibility to meet their service requirements and eliminates any need to specify orbit altitudes, satellite antenna pattern etc., which may be involved in specifying minimum e.i.r.p.s.

– The minimum feeder-link earth station e.i.r.p.s required to operate in the maximum interference environment given in § 3.3 in the Earth-to-space direction are readily achievable.

ANNEX 3

Coordination distances between feeder-link earth stations in the MSS operating in the Earth-to-space direction and stations in the aeronautical radionavigation service in the band 15.4-15.7 GHz

1 Aeronautical radionavigation system characteristics

Several systems are identified that operate in this band. These include aircraft landing systems (ALS) and airborne multipurpose radars (MPR). The characteristics and analyses necessary to determine coordination distances are given in the following section.

2 Coordination distances

2.1 Analyses

The coordination distance, D_c, necessary to ensure protection against interference from feeder-link earth stations in the MSS into stations operating in the aeronautical radionavigation service is computed as shown in the following paragraphs.

$$D_c = D_{fsl} + D_{oth} + D_{as} \qquad \text{km} \tag{5}$$

where:

D_{fsl}: total radio line-of-sight distance (km)

D_{oth}: over-the-horizon distance corresponding to the necessary over the horizon loss (km)

D_{as}: distance from aircraft to landing surface (km) (applies to ALS and RSMS)

$$D_{fsl} = (2r\,h_1)^{0.5} + (2r\,h_2)^{0.5} \qquad \text{km} \tag{6}$$

where:

r: radius of the Earth taken as 4/3 geometric to account for atmospheric refraction (8 500 km)

h_1: ARNS station height (km)

h_2: feeder-link earth station height (km)

$$L_{oth} = E_{esd} + 168.6 - L_{fsl} + G/T - I/N \quad \text{dB} \tag{7}$$

where:

L_{oth}: over-the-horizon propagation loss added to L_{fsl} (dB) (this function is shown in below and in Fig. 1 which is derived from the 5% functions for 15 GHz in Recommendation ITU-R P.528; i.e. loss exceeded 95% of the time)

E_{esd}: maximum e.i.r.p. density of the feeder-link earth station toward the horizon (this is taken as 54 dB(W/MHz))

L_{fsl}: free space loss computed for D_{fsl} (dB)

G/T: gain/noise temperature of the ARNS station (dB)

I/N: acceptable interference/noise of the ARNS station (dB).

The values of L_{oth} as a function of D_{oth} are as indicated in Table 1.

TABLE 1

D_{oth} (km)	L_{oth} (dB)	D_{oth} (km)	L_{oth} (dB)	D_{oth} (km)	L_{oth} (dB)
0	0	175	78	350	104
25	24	200	82	375	107
50	45	225	86	400	110
75	57	250	90	425	113
100	64	275	94	450	116
125	69	300	98	475	118
150	74	325	101	500	120

Values of D_{oth} for values of L_{oth} between those given may be extrapolated by:

$$D_{oth} = D_{ith} + 25[(L_{oth} - L_{ith})/(L_{jth} - L_{ith})] \quad \text{km} \tag{8}$$

where:

L_{ith}: next lower value of L_{oth} in Table 1, from L_{oth} determined by equation (7)

L_{jth}: next higher value of L_{oth} in Table 1, from L_{oth} determined by equation (7).

2.2 Computed coordination distances

Given the equations and computation methods plus some parameter values in § 2.1 and the other necessary parameter values, coordination values are computed as indicated in Table 2:

TABLE 2

Parameter	ALS	MPR	RSMS
h_1 (km)	7.6	15	1.5
h_2 (km)	0.01	0.01	0.01
D_{fsl} (km)	372	518	172.7
D_{as} (km)	100	0	40
L_{fsl} (dB)	167.7	170.6	160.9
G/T (dB)	–22.7	–2.0	–24.4
I/N (dB)	–10	–10	–10
L_{oth} (dB)	42.2	60	47.3
D_{oth} (km)	46.7	85.7	54.8
D_c (km)	518.7	603.7	267.5

A coordination distance of 600 km can be used for the MPR. The dominant mode of operation of the MPR is over ocean areas, which in most cases will be beyond 600 km of feeder-link earth stations and this would not require coordination. If feeder-link earth stations were located inland the areas of operation over the ocean would be enhanced.

2.3 Reduction of earth station limits

Reducing the maximum e.i.r.p. density limit toward the horizon of the feeder-link earth station should reduce the coordination distance. Using the function in Fig. 3, coordination distances versus E_{esd} are as indicated in Table 3:

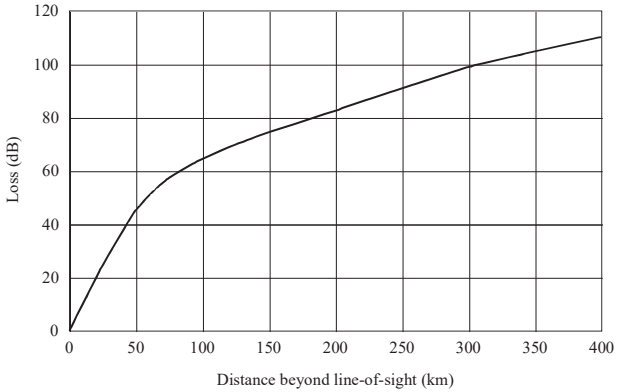
TABLE 3

E_{esd} (dB(W/MHz))	ALS (km)	MPR (km)	RSMS (km)
54	519	604	268
44	507	573	254
34	495	561	242
24	485	549	231

It is evident that the coordination distance for the ALS, MPR and RSMS where the distance is largely line-of-sight is not very sensitive to the e.i.r.p. density radiated toward the horizon.

FIGURE 3

Loss added to free space loss at line-of-sight



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3 Summary

– The maximum emissions from a feeder-link earth station in the local horizontal plane should be limited to 54 dB(W/MHz).

– With this limit a coordination threshold distance of about 515 km is needed to protect ALS stations operating in the aeronautical radionavigation service from unacceptable interference from feeder-link earth station emissions. The distance is about 600 km for the MPR and 270 km for the RSMS.

– The coordination threshold distance for the ALS, MPR and RSMS are not significantly reduced by reducing the maximum allowable emissions from feeder-link earth stations.

The method above can be used in conjunction with other mitigation techniques to minimize the separation distances during coordination.

4 Mitigation factors for reducing the separation distance within the coordination distance

The following considerations should be taken into account where it is necessary for a feeder-link earth station operating in the Earth-to-space direction to be located within the coordination distance:

– Typically, feeder-link earth stations will have antenna beamwidths of less than 1° and operate at elevation angles of more than 5°. This will reduce the e.i.r.p. towards the aeronautical radionavigation station and thus reduce the separation distance.

– If the horizontal scan limits of the ALS aircraft landing system do not include the azimuth toward the feeder-link earth station, the air space for the aircraft landing system in not in line with the feeder-link earth station which potentially could reduce the separation distance by up to 100 km.

– Use of an earth mound specifically constructed around the feeder-link earth station antenna(s) to provide additional isolation toward the aeronautical radionavigation station.

– The geographical location of the feeder-link earth station can be considered to take advantage of natural terrain blocking which will increase the propagation path loss.

– Any aircraft antenna discrimination that would exist when the aircraft is in the air space of the aircraft landing system and is using the landing system.

RECOMMENDATION ITU-R S.1428-1

Reference FSS earth-station radiation patterns for use in interference assessment involving non-GSO satellites in frequency bands between 10.7 GHz and 30 GHz

(Question ITU-R 42/4)

(2000-2001)

The ITU Radiocommunication Assembly,

considering

a) that for earth station antennas in the fixed-satellite service (FSS), Recommendation ITU-R S.465 prescribes a reference antenna radiation pattern which represents an envelope of the side-lobe peaks;

b) that peak envelope antenna reference patterns are necessary for interference calculations involving a non-mobile receiver and a single non-mobile interference source to ensure that the worst case is covered, and that in the FSS such circumstances predominated in the past;

c) that in circumstances where there are multiple interfering sources or receivers whose positions vary substantially with time, the level of interference received inevitably depends on the troughs as well as the peaks in the antenna side lobe gain pattern of the victim or source of interference, respectively, and that the occurrence of such circumstances is rapidly increasing in the FSS;

d) that for FSS earth stations a suitable reference antenna radiation pattern is needed for use in calculations of interference from moving sources or receivers;

e) that to facilitate its use in computer simulations of interference, the reference antenna pattern should cover all off-axis angles from 0° to ±180° in all planes which include the principal axis;

f) that the reference antenna pattern should be consistent both with antenna theory and with the results of measurements on as wide a range of FSS earth station antennas as practicable;

g) that it might be appropriate to establish different reference antenna patterns for different ranges of D/λ and for different FSS frequency bands;

h) that for the purpose of specifying antenna performance, the peak envelope reference patterns in Recommendation ITU-R S.580 are appropriate;

j) that the use of the reference antenna pattern should lead to interference levels that would be representative of those received by antennas meeting relevant ITU-R antenna pattern Recommendations,

recommends

1 that for interference calculations involving moving interfering sources and/or victim receivers of FSS interference, the following reference earth station radiation antenna pattern should be employed:

for $20 \le \frac{D}{\lambda} \le 25$:

$$G(\varphi) = G_{max} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda}\varphi\right)^2 \quad \text{dBi} \qquad \text{for } 0 < \varphi < \varphi_m$$

$$G(\varphi) = G_1 \qquad \text{for } \varphi_m \le \varphi < \left(95\frac{\lambda}{D}\right)$$

$$G(\varphi) = 29 - 25 \log \varphi \quad \text{dBi} \qquad \text{for } 95\frac{\lambda}{D} \le \varphi < 33.1°$$

$$G(\varphi) = -9 \quad \text{dBi} \qquad \text{for } 33.1° < \varphi \le 80°$$

$$G(\varphi) = -5 \quad \text{dBi} \qquad \text{for } 80° < \varphi \le 180°$$

for $25 < \frac{D}{\lambda} \le 100$:

$$G(\varphi) = G_{max} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda}\varphi\right)^2 \quad \text{dBi} \qquad \text{for } 0 < \varphi < \varphi_m$$

$$G(\varphi) = G_1 \qquad \text{for } \varphi_m \le \varphi < \left(95\frac{\lambda}{D}\right)$$

$$G(\varphi) = 29 - 25 \log \varphi \quad \text{dBi} \qquad \text{for } 95\frac{\lambda}{D} \le \varphi \le 33.1°$$

$$G(\varphi) = -9 \quad \text{dBi} \qquad \text{for } 33.1° < \varphi \le 80°$$

$$G(\varphi) = -4 \quad \text{dBi} \qquad \text{for } 80° < \varphi \le 120°$$

$$G(\varphi) = -9 \quad \text{dBi} \qquad \text{for } 120° < \varphi \le 180°$$

where:

D: antenna

λ: wavelength expressed in the same unit*

φ: off-axis angle of the antenna (degrees)

$$G_{max} = 20 \log \left(\frac{D}{\lambda}\right) + 7.7 \quad \text{dBi}$$

$$G_1 = 29 - 25 \log \left(95\frac{\lambda}{D}\right)$$

$$\varphi_m = \frac{20\lambda}{D}\sqrt{G_{max} - G_1} \quad \text{degrees}$$

* D is the equivalent diameter for non-symmetric antennas.

for $\frac{D}{\lambda} > 100$:

$$G(\varphi) = G_{max} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda}\varphi\right)^2 \quad \text{dBi} \qquad \text{for } 0 < \varphi < \varphi_m$$

$$G(\varphi) = G_1 \qquad \text{for } \varphi_m \leq \varphi < \varphi_r$$

$$G(\varphi) = 29 - 25 \log \varphi \quad \text{dBi} \qquad \text{for } \varphi_r \leq \varphi < 10°$$

$$G(\varphi) = 34 - 30 \log \varphi \quad \text{dBi} \qquad \text{for } 10° \leq \varphi < 34.1°$$

$$G(\varphi) = -12 \quad \text{dBi} \qquad \text{for } 34.1° \leq \varphi < 80°$$

$$G(\varphi) = -7 \quad \text{dBi} \qquad \text{for } 80° \leq \varphi < 120°$$

$$G(\varphi) = -12 \quad \text{dBi} \qquad \text{for } 120° \leq \varphi \leq 180°$$

where:

$$G_{max} = 20 \log \left(\frac{D}{\lambda}\right) + 8.4 \quad \text{dBi}$$

$$G_1 = -1 + 15 \log \frac{D}{\lambda} \quad \text{dBi}$$

$$\varphi_m = \frac{20\lambda}{D}\sqrt{G_{max} - G_1} \quad \text{degrees}$$

$$\varphi_r = 15.85 \left(\frac{D}{\lambda}\right)^{-0.6} \quad \text{degrees}$$

NOTE 1 – For the purposes of calculation or computer simulation of the total power at the antenna output due to multiple interfering sources at varied polarizations, it should be assumed that the contribution of the cross-polar components at off-axis angles up to 30° and in the spill-over regions up to 120° is negligible. Outside these angular regions, even though a paraboloid antenna exhibits very little polarization discrimination, for the purpose of non-GSO/GSO interference calculations the contribution of cross-polar components can be ignored.

NOTE 2 – This Recommendation is based on studies of a range of paraboloid antennas. Further study is required of the applicability of the recommended reference patterns to planar array antennas.

NOTE 3 – This Recommendation may require revisions in the future when data on measured performance of antennas in the 20/30 GHz range becomes available.

NOTE 4 - Within this Recommendation, the use of the term moving when applied to an FSS earth station denotes a tracking earth station in the FSS and not a mobile earth station.

RECOMMENDATION ITU-R BO.1443-3

Reference BSS earth station antenna patterns for use in interference assessment involving non-GSO satellites in frequency bands covered by RR Appendix 30*

(Question ITU-R 280/4)

(2000-2002-2006-2013)

Scope

This Recommendation intends to provide tri-dimensional reference earth station antenna patterns for the broadcasting-satellite service (BSS) that can be used for the calculation of interference generated by non-GSO FSS satellites into BSS earth station antennas.

Keywords

Gain pattern, GSO, BSS.

Abbreviations/Glossary

The gain pattern is defined in the form:

$$\text{Gain} = G(\varphi,\theta)$$

where:

φ: off-axis angle of the antenna relative to boresight (degrees)

θ: planar angle of the antenna (degrees) (0° azimuth is the horizontal plane).

Related ITU Recommendations, Reports

Recommendation ITU-R S.672-4	Satellite antenna radiation pattern for use as a design objective in the fixed-satellite service employing geostationary satellites
Recommendation ITU-R S.1428-1	Reference FSS earth-station radiation patterns for use in interference assessment involving non-GSO satellites in frequency bands between 10.7 GHz and 30 GHz
Recommendation ITU-R S.1503-1	Functional description to be used in developing software tools for determining conformity of non-geostationary-satellite orbit fixed-satellite system networks with limits contained in Article 22 of the Radio Regulations

* The basis for the patterns contained in this Recommendation, including the methodology for analysing and plotting the data which measures the goodness of fit of the data sets to the recommended pattern are contained in Report ITU-R BO.2029 – Broadcasting-satellite service earth station antenna pattern measurements and related analyses. This Report along with the raw data sets and the spread sheets used to perform the graphical analysis are contained on a CD-ROM available from ITU.

The ITU Radiocommunication Assembly,

considering

a) that for earth station antennas in the BSS the reference antenna radiation patterns for GSO BSS receive antennas in Annex 5 to RR Appendix 30 were used to develop the BSS Plans and prescribe a reference radiation pattern which represents an envelope of the side lobes;

b) that such reference radiation patterns are necessary for interference calculations involving fixed or transportable BSS receivers and GSO satellites to ensure adequate protection of the BSS Plans;

c) that in circumstances where there are multiple interfering sources whose positions vary substantially with time, the level of interference received inevitably depends on the troughs as well as the peaks in the gain pattern of the victim BSS earth station antenna;

d) that for BSS earth stations, suitable reference radiation patterns are needed for use in assessing interference from non-GSO FSS systems;

e) that to facilitate computer simulations of interference, the reference patterns should cover all off-axis angles from 0° to ±180° in all planes;

f) that the reference patterns should be consistent with the results of measurements on a wide range of consumer BSS earth station antennas;

g) that it is appropriate to establish different reference patterns for different ranges of antenna sizes;

h) that the patterns may exhibit characteristics that may be important when modelling non-GSO interference, for example in the case of small offset-fed antennas,

recommends

1 that for calculations of interference generated by non-GSO FSS satellites into BSS earth station antennas, the reference earth station antenna radiation patterns described in Annex 1 should be employed;

2 that the methodology described in Annex 2 be used to convert the relative azimuth and elevation angle of the non-GSO satellite under investigation into the same coordinate system as employed for the three-dimensional antenna pattern;

3 that the following Notes be considered part of this Recommendation:

NOTE 1 – The cross-polarization radiation pattern may be of importance in non-GSO interference calculations. This issue requires further study.

NOTE 2 – This Recommendation is based on measurements and analysis of paraboloid antennas. If new earth station antennas are developed or are considered for use in the BSS, the reference antenna patterns in this Recommendation should be updated accordingly.

Annex 1

Reference BSS antenna radiation patterns

For 11 ≤ D/λ ≤ 25.5

$$G(\varphi) = G_{max} - 2.5 \times 10^{-3} \left(\frac{D\varphi}{\lambda} \right)^2 \quad \text{for} \quad 0 \le \varphi < \varphi_m$$

$$G(\varphi) = G_1 \quad \text{for} \quad \varphi_m \le \varphi < 95\lambda/D$$

$$G(\varphi) = 29 - 25 \log(\varphi) \quad \text{for} \quad 95\lambda/D \le \varphi < 36.3°$$

$$G(\varphi) = -10 \quad \text{for} \quad 36.3° \le \varphi < 50°$$

For 56.25° ≤ θ < 123.75°

$$G(\varphi) = M_1 \cdot \log(\varphi) - b_1 \quad \text{for} \quad 50° \le \varphi < 90°$$

$$G(\varphi) = M_2 \cdot \log(\varphi) - b_2 \quad \text{for} \quad 90° \le \varphi < 180°$$

where:

$$M_1 = \frac{2 + 8 \cdot \sin(\theta)}{\log\left(\frac{90}{50}\right)} \quad \text{and} \quad b_1 = M_1 \cdot \log(50) + 10$$

where:

$$M_2 = \frac{-9 - 8 \cdot \sin(\theta)}{\log\left(\frac{180}{90}\right)} \quad \text{and} \quad b_2 = M_2 \cdot \log(180) + 17$$

For 0° ≤ θ < 56.25° and 123.75° ≤ θ < 180°

$$G(\varphi) = M_3 \cdot \log(\varphi) - b_3 \quad \text{for} \quad 50° \le \varphi < 120°$$

$$G(\varphi) = M_4 \cdot \log(\varphi) - b_4 \quad \text{for} \quad 120° \le \varphi < 180°$$

where:

$$M_3 = \frac{2 + 8 \cdot \sin(\theta)}{\log\left(\frac{120}{50}\right)} \quad \text{and} \quad b_3 = M_3 \cdot \log(50) + 10$$

where:

$$M_4 = \frac{-9 - 8 \cdot \sin(\theta)}{\log\left(\frac{180}{120}\right)} \quad \text{and} \quad b_4 = M_4 \cdot \log(180) + 17$$

For 180° ≤ θ < 360°

$$G(\varphi) = M_5 \cdot \log(\varphi) - b_5 \quad \text{for} \quad 50° \le \varphi < 120°$$

$$G(\varphi) = M_6 \cdot \log(\varphi) - b_6 \quad \text{for} \quad 120° \le \varphi < 180°$$

where:

$$M_5 = \frac{2}{\log\left(\frac{120}{50}\right)} \qquad \text{and} \qquad b_5 = M_5 \cdot \log(50) + 10$$

where:

$$M_6 = \frac{-9}{\log\left(\frac{180}{120}\right)} \qquad \text{and} \qquad b_6 = M_6 \cdot \log(180) + 17$$

where:

D: antenna diameter

λ: wavelength expressed in the same unit as the diameter

G: gain

φ: off-axis angle of the antenna relative to boresight (degrees)

θ: planar angle of the antenna (degrees) (0° azimuth is the horizontal plane).

$$G_{max} = 20 \log\left(\frac{D}{\lambda}\right) + 8.1 \qquad \text{dBi}$$

$$G_1 = 29 - 25 \log\left(95 \frac{\lambda}{D}\right) \qquad \text{dBi}$$

$$\varphi_m = \frac{\lambda}{D} \sqrt{\frac{G_{max} - G_1}{0.0025}} \qquad \text{degrees}$$

For 25.5 < D/λ ≤ 100

$G(\varphi) = G_{max} - 2.5 \times 10^{-3} (D\varphi/\lambda)^2$	dBi	for	$0 < \varphi < \varphi_m$
$G(\varphi) = G_1$		for	$\varphi_m \le \varphi < (95\lambda D)$
$G(\varphi) = 29 - 25 \log \varphi$	dBi	for	$(95\lambda/D) \le \varphi < 33.1°$
$G(\varphi) = -9$	dBi	for	$33.1 < \varphi \le 80°$
$G(\varphi) = -4$	dBi	for	$80 < \varphi \le 120°$
$G(\varphi) = -9$	dBi	for	$120 < \varphi \le 180°$

where:

$G_{max} = 20 \log (D/\lambda) + 8.1$ dBi

$G_1 = 29 - 25 \log (95\lambda/D)$ dBi

$$\varphi_m = (\lambda/D) \sqrt{\frac{G_{max} - G_1}{0.0025}}$$

For D/λ > 100

$G(\varphi) = G_{max} - 2.5 \times 10^{-3} (D\varphi/\lambda)^2$	dBi	for	$0 < \varphi < \varphi_m$
$G(\varphi) = G_1$		for	$\varphi_m \le \varphi < \varphi_r$
$G(\varphi) = 29 - 25 \log \varphi$	dBi	for	$\varphi_r \le \varphi < 10°$
$G(\varphi) = 34 - 30 \log \varphi$	dBi	for	$10 \le \varphi < 34.1°$
$G(\varphi) = -12$	dBi	for	$34.1° \le \varphi < 80°$

$G(\varphi) = -7$ dBi for $80° \le \varphi < 120°$

$G(\varphi) = -12$ dBi for $120° \le \varphi < 180°$

where:

$$G_{max} = 20 \log (D/\lambda) + 8.1 \quad \text{dBi}$$

$$G_1 = -1 + 15 \log (D/\lambda) \quad \text{dBi}$$

$$\varphi_m = (\lambda/D)\sqrt{\frac{G_{max} - G_1}{0.0025}}$$

$$\varphi_r = 15.85 (D/\lambda)^{-0.6} \quad \text{degrees}$$

Annex 2

Geometric conversions for use with the 3-D antenna model

Definition of θ

θ is defined as the planar angle of the non-GSO satellite relative to the zero degree plane of the antenna model (corresponding to the standard bottom-mounted offset feed assembly). As seen by the earth station, the θ = 0 line is to the right, and θ increases in an anticlockwise direction.

Calculation approach

Figure 1 shows a geometric approach to calculate the planar angle θ. All calculations are shown using degrees, though typically these must be converted into radians when computing trigonometric values.

Inputs

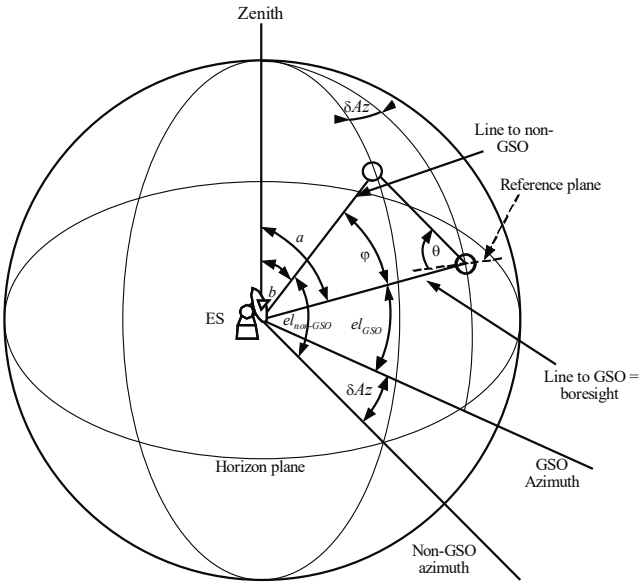
GSO satellite (az, el)

Non-GSO satellite (az, el)

NOTE 1 – What is required is the difference in azimuth, so if that is available the actual azimuths would not be needed.

The following section shows how to calculate these parameters from the vectors of each station.

FIGURE 1



BO.1443-01

From Fig. 1:

$$a = 90 - el_{GSO}$$

$$b = 90 - el_{non\text{–}GSO}$$

$$\delta Az = Az_{non\text{–}GSO} - Az_{GSO}$$

δAz should be set to be in the range {–180 to +180}

Then the off-axis angle φ (topocentric separation angle between the satellites) can be calculated by using the spherical geometry formula:

$$\cos(c) = \cos(a)\cos(b) + \sin(a)\sin(b)\cos(C)$$

with $C = \delta Az$ and $c = \varphi$.

The same formula can be used to define an angle B:

$$\cos(B) = \frac{\cos(b) - \cos(c)\cos(a)}{\sin(c)\sin(a)}$$

from which the planar angle θ can be derived:

if ($\delta Az > 0$ and $B < 90$) $\theta = 90 - B$

if ($\delta Az > 0$ and $B > 90$) $\theta = 450 - B$

if ($\delta Az < 0$) $\theta = 90 + B$

In the case that both satellites have the same azimuth and so $\delta Az = 0$, then

$$\varphi = \left| el_{GSO} - el_{non\text{–}GSO} \right|$$

if $el_{GSO} > el_{non\text{–}GSO}$ $\theta = 270$

else $\theta = 90$

Example data

For the following positions:

Station	Latitude (degrees)	Longitude (degrees)	Height (km)
Earth station	10	20	0
GSO sat	0	30	35 786.055
Non-GSO sat	0	–5	1 469.200

Then for the earth station, the following az/els can be calculated (with respect to the earth station horizon and north direction):

Station	Azimuth (degrees)	Elevation (degrees)
GSO sat	134.5615	73.4200
Non-GSO sat	–110.4248	10.0300

Hence, the off-axis angles and planar angles are:

Station	φ (off-axis) (degrees)	θ (planar) (degrees)
Non-GSO sat	87.2425	26.69746

Calculation of azimuth and elevation

The following can be used to calculate azimuth and elevation from the vectors involved.

Given:

Position vector of earth station: $\underline{r}_G$

Position vector of GSO satellite: $\underline{r}_S$

Position vector of non-GSO satellite: $\underline{r}_N$

Then create:

Vector from earth station to GSO $\underline{r}_{GS} = \underline{r}_S - \underline{r}_G$

Vector from earth station to non-GSO $\underline{r}_{GN} = \underline{r}_N - \underline{r}_G$

Unit vector of earth station position vector $\hat{\underline{r}}_G$

Then the elevation angles are:

$$el_S = 90 - \angle(\underline{r}_{GS}, \underline{r}_G)$$

$$el_N = 90 - \angle(\underline{r}_{GN}, \underline{r}_G)$$

To calculate the difference in azimuth, convert vectors from earth station to GSO/non-GSO to be in the horizontal plane that is perpendicular to the zenith vector, i.e.

$$\underline{r}'_{GS} = \underline{r}_{GS} - \left(\hat{\underline{r}}_G \cdot \underline{r}_{GS}\right)\hat{\underline{r}}_G$$

$$\underline{r}'_{GN} = \underline{r}_{GN} - \left(\hat{\underline{r}}_G \cdot \underline{r}_{GN}\right)\hat{\underline{r}}_G$$

Then:

$$\delta Az = \angle(\underline{r'_{GS}}, \underline{r'_{GN}})$$

The sign of δAz will be the same as the sign of the difference in longitude of the two satellites.

RECOMMENDATION ITU-R RA.1513-2*

Levels of data loss to radio astronomy observations and percentage-of-time criteria resulting from degradation by interference for frequency bands allocated to the radio astronomy service on a primary basis

(2001-2003-2015)

Scope

This Recommendation addresses the levels of data loss to radio astronomy observations and percentage-of-time criteria resulting from degradation by interference for frequency bands allocated to the radio astronomy service on a primary basis. It includes studies of sharing situations for terrestrial and space-based applications, as well as an extensive section on measurement of data loss from weak, pulsed interference.

The ITU Radiocommunication Assembly,

considering

a) that research in radio astronomy depends critically upon the ability to make observations at the extreme limits of sensitivity and/or precision, and that the growing use of the radio spectrum increases the possibility of interference detrimental to the radio astronomy service (RAS);

b) that for some radio astronomy observations, such as those involving the passage of a comet, an occultation by the moon, or a supernova explosion, a high probability of success is desirable because of the difficulty or impossibility of repeating them;

c) that since interference to radio astronomy can result from unwanted emissions of services in adjacent, nearby, or harmonically related bands, interference from several services or systems may occur in any single radio astronomy band;

d) that burden sharing may be necessary to facilitate the efficient use of the radio spectrum;

e) that mitigation techniques are a part of burden sharing, and more advanced techniques are being developed for future implementation, to allow more efficient use of the radio spectrum;

f) that threshold levels of interference (assuming 0 dBi antenna gain) detrimental to the RAS for 2 000 s integration times are given in Recommendation ITU-R RA.769, but that no acceptable percentage of time has been established for interference from services with transmissions randomly distributed in time and either sharing a frequency band with the RAS, or producing unwanted emissions that fall within a radio astronomy band;

g) that administrations may require criteria for evaluation of interference between the RAS and other services in shared, adjacent, nearby, or harmonically related bands;

h) that methods (e.g. the Monte Carlo method) have been developed to determine the appropriate separation distance between radio astronomy sites and an aggregate of mobile earth stations, and that these methods require the specification of an acceptable percentage of time during which the aggregate interference power exceeds the threshold levels detrimental to the RAS;

i) that studies of sharing scenarios and experience gained from long practice have led to values of tolerable time loss due to degradation of sensitivity, on time scales of a single observation, which are explained in more detail in Annex 1,

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* Radiocommunication Study Group 7 made editorial amendments to this Recommendation in the year 2017 in accordance with Resolution ITU-R 1.

recommends

1 that, for evaluation of interference, a criterion of 5% be used for the aggregate data loss to the RAS due to interference from all networks, in any frequency band allocated to the RAS on a primary basis, noting that further studies of the apportionment between different networks are required;

2 that, for evaluation of interference, a criterion of 2% be used for data loss to the RAS due to interference from any one network, in any frequency band, which is allocated to the RAS on a primary basis;

3 that the percentage of data loss, in frequency bands allocated to the RAS on a primary basis be determined by using one of the following: (1) Recommendation ITU-R S.1586; (2) Recommendation ITU-R M.1583, or (3) the percentage of integration periods of 2 000 s in which the average spectral pfd at the radio telescope exceeds the levels defined (assuming 0 dBi antenna gain) in Recommendation ITU-R RA.769, whichever is appropriate;

4 that the criteria described in § 3.3.2 of Annex 1 be used for evaluation of interference, in any frequency band allocated to the RAS on a primary basis, from unwanted emissions produced by any non-GSO satellite system at radio astronomy sites.

Annex 1

Data loss resulting from interference

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1 Introduction

An important parameter for all radiocommunication services is the percentage of time lost to interference. Administrations may need quantitative criteria relative to radio astronomy operations with active services operating in the same, adjacent, nearby, or harmonically related bands. For example, Recommendation ITU-R M.1316 uses this percentage of time lost to interference in the calculation of the separation distance by default between stations operating in the MSS (Earth-to-space) and a radio astronomy observatory, by using the Monte Carlo methodology.

Existing limits to the aggregate time losses tolerated by various other «science» services are given in Table 1, for comparison.

TABLE 1

Example of criteria for aggregate percentage of time of data loss use for other science services

Earth exploration-satellite service (EESS) (passive sensors) (%) (Recommendation ITU-R SA.1029-2): – 3-D atmospheric sounding – All other sensors	 0.01 1.0-5.0
Command and data transmission systems operating in the earth exploration-satellite and meteorological-satellite services (%) (Recommendation ITU-R SA.514-3)	0.1-1.0
EES and MetSat services using spacecraft in geostationary orbit (%) (Recommendation ITU-R SA.1161-1)	0.0025-0.1
Space operations systems $S/N > 20$ dB for > 99% of time (%) (Recommendation ITU-R SA.363-5)	1.0

Radio telescopes are designed to operate continuously, following a schedule of observing programs requested by astronomers. As a rule, access to radio telescopes is on a competitive basis, with research proposals often exceeding available telescope time by a factor of 2-3. Virtually all radio astronomy installations are operated out of public funds, and must be used very efficiently. Some loss of observing time resulting from maintenance or upgrading of hardware or software, however, cannot be avoided. Experience over many years of operation with major instruments by one administration

shows that such losses need not exceed 5% of time, for example one 8 h day per week. Considerations of overall efficiency and cost of operation indicate that the additional aggregate time loss due to interference should be limited to a similar 5% figure.

In order to achieve the figures shown in Table 1, individual services should design their systems and control their operations to an appropriate fraction of these figures. Prudence dictates that individual systems be allowed only a fraction of the interference budget, depending on factors related to the actual allocation situation, such as band sharing and the interference potential due to unwanted emissions from other services.

It should be noted that the concept of aggregate data loss is not fully developed at present. Simulation tools, such as the one described in Recommendation ITU-R M.1316, allow the case of interference resulting from a single system to be considered. Other methodologies for single systems are also being developed. At this time there is no similar tool for the case of aggregate data loss resulting from several systems. A method that takes into account the characteristics of several systems may be difficult to develop. A particular difficulty is the apportionment of the aggregate data loss among the various systems. Further studies of these problems are needed.

The advent of radio services using space stations and high-altitude platform stations requires reassessment of the measures by which the RAS is protected from interference. Frequency sharing with such services is normally impossible, but potentially negative effects upon the RAS by services in nearby bands arise through two factors:

a) unwanted emissions falling in bands allocated to the RAS;

b) intermodulation and departures from linearity in radio telescope systems due to strong signals in adjacent bands.

It is assumed that the satellite operators will use all practical means to minimize unwanted emissions, and radio astronomers all practical methods to minimize sensitivity to signals in adjacent or nearby bands. Nevertheless, item b) should be an important consideration when operating systems in bands adjacent or close to bands allocated to the RAS.

2 Data loss and sky blockage

Whenever data loss is mentioned in this Recommendation, it refers to data that have to be discarded because they are contaminated by the aggregate interference, from one or more sources that exceeds the levels of Recommendation ITU-R RA.769, under the assumptions stated therein. The term blockage is used here to indicate antenna directions in which the level of interference received exceed those given for detrimental interference in Recommendation ITU-R RA.769. In the presence of such interference, data useful for research at the frontiers of knowledge is generally not obtainable. Data loss may result from loss of part of the observing band, part of the observing time or from blockage of part of the sky. All of these can be expressed as loss of effective observing time.

It is stated in Recommendation ITU-R RA.1031 that many radio astronomy measurements can tolerate interference from a shared service which exceeds the thresholds given in Recommendation ITU-R RA.769, for 2% of time. It should be noted that such observations, which can tolerate enhanced measurement errors, represent observations such as solar radio flare patrols. Observations of significance in radio astronomy are those which result in new knowledge of astronomical phenomena, which either require making observations of objects not previously studied, or observing known objects with increased precision. Both such cases call for observations at the highest achievable sensitivity. As radio astronomy has matured, the usefulness of data which is limited in accuracy by the presence of interference has declined, and it is the usual practice of astronomers to delete data for which there is any evidence of interference. Thus it is a matter of

practical reality that interference occurring at any identifiable level results in loss of the contaminated data.

The 0 dBi contour of the pattern for large antennas between 2 GHz and about 30 GHz defined in Recommendation ITU-R SA.509 has a radius of 19°. When a radio telescope points less than 19° from a transmitter, emitting in a radio astronomy band at the detrimental level defined in Recommendation ITU-R RA.769, interference results. This effectively blocks radio astronomy observation within a region of the sky 19° in angular radius. Fractional sky blockage is the ratio of sky blockage (above the horizon), as defined above, to the solid angle of the visible hemisphere.

Figure 1 shows the effect of a hypothetical transmitter on the horizon at the origin of the azimuth scale, which just meets the spectral pfd level of Recommendation ITU-R RA.769 at a radio astronomy station. The contours in the figure show the decibel level by which the received power from the transmitter exceeds the level at which it is detrimental to radio astronomy, as a function of the pointing angle of the radio astronomy antenna. The received transmission causes detrimental interference when it is received in sidelobes of the radio astronomy antenna with gain greater than 0 dBi. Table 2 shows the percentage of sky receiving such detrimental interference, for pointing angles of the antenna at elevations above 5°. Since radio astronomy antennas are rarely pointed below 5°, this is the lowest elevation considered. For a source of interference above an elevation angle of 19° (such as an airborne or space transmitter) for which the spectral pfd at a radio astronomy station just meets the level in Recommendation ITU-R RA.769, a circular area of sky, with a radius of 19° centred on the source of interference, is blocked from radio astronomy observation at useful levels of sensitivity. This area subtends a solid angle of 0.344 sr, which is 5.5% of the 2π sr of sky above the horizon.

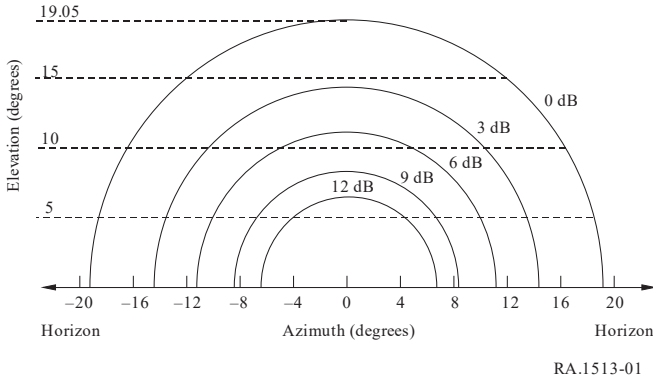
The application of the concept of sky blockage in a non-stationary environment (e.g. non-GSO satellite systems or mobiles) requires further study.

3 Sharing situations

In assessing interference it is useful to distinguish between transmissions of terrestrial origin, particularly in cases where there is no line-of-sight (LoS) path, and those coming from aircraft, high-altitude platforms and space-based transmitters in LoS of the affected radio telescope. Concerning the percentage of observing time lost, one should distinguish between interference from distant transmitters due to variable propagation conditions (i.e. beyond human control) and interference from active applications where the emission is effectively random with respect to the power level and the angle of arrival at a radio telescope (see § 3.1).

FIGURE 1

The effect of a source of interference at the detrimental level for the RAS, on the horizon at zero azimuth



The curves show the decibel level by which the interference received by the radio astronomy receiver exceeds the detrimental level for different pointing angles of the radio astronomy antenna. Note that radio astronomy observations are generally made with pointing angles above 5° elevation.

TABLE 2

Percentage of sky in which sensitive observations are precluded by interference received above the detrimental level, as a function of pointing elevation of the radio telescope, for the interfering source in Fig. 1

Minimum elevation (degrees)	Blockage (%)
5	2.0
10	1.3
15	0.6
20	0

3.1 Interference due to variable propagation conditions

3.1.1 Terrestrial applications

In cases where the strength of an interfering signal varies as a result of time-varying propagation conditions, a percentage of time must be specified for propagation calculations. A number of 2% is given in Recommendation ITU-R RA.1031. However, this does not automatically lead to a 2% data loss for radio astronomy observations. Propagation conditions vary episodically, typically over periods of a few days. It should therefore be noted that over periods of weeks at a time, the period for which data are contaminated by interference may be only a few days. These effects occur primarily at longer wavelengths, i.e. below about 1 GHz. Periods of data loss can be reduced by dynamic rescheduling of radio astronomy observations.

3.1.2 Space-based applications

Time variable tropospheric propagation conditions need not be considered under LoS conditions.

3.2 In-band sharing, where the transmission is variable in time and location

3.2.1 Terrestrial applications

To maximize the efficiency with which radio telescopes are used, loss of observing time due to interference by other users of the spectrum should be avoided. However, some small loss may be inevitable. An example is unwanted emissions from mobile (earth) stations in the MSS. An acceptable practical level of data loss from such a system is 2%. Recommendation ITU-R M.1316 provides an example of coordination between the RAS and the MSS (Earth-to-space). In this Recommendation, the percentage of observing time loss is used in the calculation of the separation distance by default between mobile earth stations in the MSS (Earth-to-space) and the radio astronomy station, using the Monte Carlo methodology.

3.2.2 Space-based applications

Sharing with satellite downlinks is not possible in bands where the RAS has a primary allocation.

3.2.3 Space-based radio astronomy applications

Space-based radio astronomy requires individual analysis appropriate to the application.

3.3 Unwanted emissions into a radio astronomy frequency band, where the transmission is variable in time and/or direction of arrival

3.3.1 Terrestrial applications

Time-sharing between terrestrial applications and radio astronomy is not usually considered operationally feasible. Filtering of transmitters and geographical separation are employed to suppress unwanted emission levels into the radio astronomical band to below the Recommendation ITU-R RA.769 threshold values at the location of a radio telescope. There is a potential for interference when the radio astronomy beam is pointed closer than 19° to a terrestrial source (see Fig. 1). The levels in Recommendation ITU-R RA.769 are based on the assumption that the interference source is at the isotropic contour. As shown in Fig. 1, a terrestrial source on the horizon (elevation = 0°) can cause detrimental interference in up to 2% of the visible hemisphere for a telescope that can point within 5° of the horizon. However, as a rule, radio telescopes are pointed within 5° of the horizon for only a portion of their total observing time. Some sources of interference are known and can be avoided. In practice, a level of up to 2% data loss could be tolerated from one interfering system. It should be noted that as a radio telescope is pointed at very low elevation angles the system noise increases which reduces the sensitivity. This is not taken into account in Recommendation ITU-R RA.769, since the usual elevation limit of 5°-10° results in very little time being spent in the region of degraded sensitivity.

The methodology described in Recommendation ITU-R M.1316 may also be used to evaluate the effect of terrestrial unwanted emissions into a radio astronomy band.

3.3.2 Space-based applications

Protection of radio astronomy in the presence of GSO satellites is covered by Recommendation ITU-R RA.769.

To address the compatibility between non-GSO constellations and RAS sites two Recommendations were developed by the ITU-R:

Recommendation ITU-R S.1586 – Calculation of unwanted emission levels produced by a non-geostationary fixed-satellite service system at radio astronomy sites.

Recommendation ITU-R M.1583 – Interference calculations between non-geostationary mobile-satellite service or radionavigation-satellite service systems and radio astronomy telescope sites.

These Recommendations provide a methodology to evaluate the levels of unwanted emissions produced by non-GSO constellations and some other systems at radio astronomy sites prior to their bringing into use. In particular, these Recommendations provide methods to determine compatibility between radio astronomy sites and satellite systems, during the construction phase and prior to the launch of the latter, in response to *resolves* 1 and 2 of Resolution **739 (Rev.WRC-07)**.

The first step of this approach is to divide the sky into cells. First, a random choice is made for a pointing direction of the RAS antenna, which will lie within a specific cell on the sky. Then, the starting time of the constellation is randomly chosen. The average epfd corresponding to this trial is then calculated for the chosen pointing direction and starting time of the constellation using the following equation to determine epfd corresponding to each time sample:

$$epfd_{G_r = 0\,\mathrm{dBi}} = 10 \log_{10}\left[\sum_{i=1}^{N_a} 10^{\frac{P_i}{10}} \cdot \frac{G_t(\theta_i)}{4\pi d_i^2} \cdot G_r(\phi_i)\right] \quad (1)$$

where:

N_a: number of non-GSO space stations that are visible from the radio telescope;

i: index of the non-GSO space station considered;

P_i: RF power of the unwanted emission at the input of the antenna (or RF radiated power in the case of an active antenna) of the transmitting space station considered in the non-GSO satellite system (dBW) in the reference bandwidth;

θ_i: off-axis angle between the boresight of the transmitting space station considered in the non-GSO satellite system and the direction of the radio telescope;

$G_t(\theta_i)$: transmit antenna gain (as a ratio) of the space station considered in the non-GSO satellite system in the direction of the radio telescope;

d_i: distance (m) between the transmitting station considered in the non-GSO satellite system and the radio telescope;

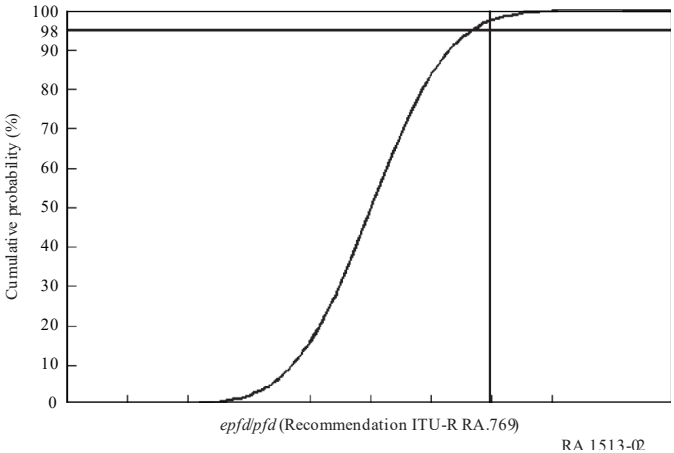
ϕ_i: off-axis angle between the pointing direction of the radio telescope and the direction of the transmitting space station considered in the non-GSO satellite system;

$G_r(\phi_i)$: receive antenna gain (as a ratio) of the radio telescope, in the direction of the transmitting space station considered in the non-GSO satellite system.

For each of these cells, a statistical distribution of the epfd is determined. Then, these epfd distributions may be compared with pfd levels given in Recommendation ITU-R RA.769 (defined assuming a 0 dBi receiving antenna gain in the direction of interference and given a 2 000 s integration time) so that the percentage of trials during which this criterion is met may be determined for each of the cells which were defined.

FIGURE 2

Comparison between the pfd levels given in Recommendation ITU-R RA.769 and the epfd distribution given for a cell



From the pfd threshold levels of interference detrimental to radio astronomy given in Recommendation ITU-R RA.769, epfd threshold levels can be derived taking into account the maximum radio astronomy antenna gain, G_{max}, assumed in the calculations, through the following equation:

$$epfd_{threshold} = pfd_{\mathrm{RA.769}} - G_{max}$$

Over the sky, for elevations higher than the minimum operating elevation angle of the radio telescope, the epfd threshold level defined above should not be exceeded for more than 2% of the time.

This methodology was initially developed to cover the case of non-GSO satellite systems, however it may also be used for some airborne systems, e.g. in the aeronautical MSS.

3.4 Measurement of data loss from weak, pulsed interference

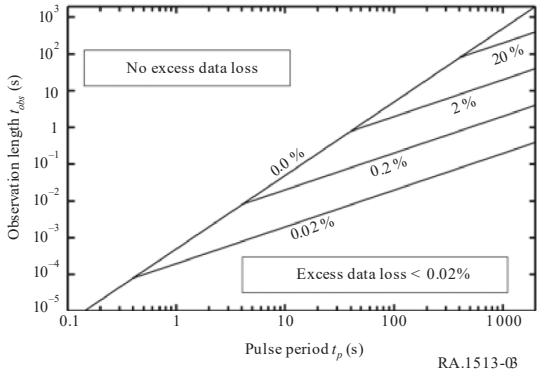
This section specifies the measurement of excess data loss from pulsed interference meeting the 2 000 s average detrimental spectral-line threshold level specified by Recommendation ITU-R RA.769. This is the weak interference case. There is a significant difference in the interference behaviour of pulsed and continuous signals. Continuous, time-invariant interference that falls at or below the detrimental level thresholds described in Recommendation ITU-R RA.769 for 2 000 second integrations will not harm shorter observations, as the interference to noise ratio is largest in long integrations. This is not always the case for time variable signals. We define here those situations in which pulsed signals satisfy the threshold level provided by a 2 000 s integration, while still causing some excess data loss for shorter observations.

For periodic interference, the excess data loss measurement depends on two time scales, the interfering pulse period, t_p, and the observing interval over which astronomical data are averaged, t_{obs}, making an individual measurement. Technical and scientific reasons determine t_{obs}, which is typically a few seconds in duration. In the case where t_{obs} is greater than 0.8 s, excess data loss > 2% is possible, but only if the interfering pulse period is longer than 40 s, as is shown by the calculations below.

The data loss measurements are summarized in Fig. 3.

FIGURE 3

Excess data loss *L*% from pulsed interference



Excess Data Loss depends only on the combination of pulse period and observation length, as shown in Fig. 3. An observation is considered to be lost when it contains a signal stronger than 1/10th of the system noise, averaged over the observation length. We find that the maximum excess data loss is less than the duration of one pulse period per 2 000 s. Therefore, radar and other short period pulsed signals do not create significant excess data loss.

3.4.1 Method

Consider the case of periodic pulses that average over time to the detrimental threshold levels for data loss over 2 000 s given in Recommendation ITU-R RA.769. It is apparent that, unlike the case of interference that is constant in time, observations that by their very nature are shorter than 2 000 s (e.g. pulsars, that are periodic emitters on time scales much shorter than 2 000 s) will suffer data loss in some cases, because the interfering pulse energy may be concentrated in one or a few of these shorter observations.

For example, a single interfering pulse every 2 000 s will fall in one out of every two observations in a series lasting 1 000 s each. The interference-to-noise ratio is no longer 1/10, as required in Recommendation ITU-R RA.769, but $\sqrt{2}$ /10 in one observation and 0 in the other. This is an excess data loss of 50%. (The factor is $\sqrt{2}$ as the average interference is twice as strong in the affected observation, but the shorter observation's rms noise is only $\sqrt{2}$ higher.) This example gives the worst possible case of excess data loss, as will be shown below.

Excess Data Loss is derived as follows:

Let:

t_{obs} be the observation length, in seconds,

t_p be the pulse period, in seconds,

N_{obs} be the number of observations per 2 000 s, = 2 000/t_{obs},

N_p be the number of pulses per 2 000 s, = 2 000/t_p,

P be the average pulse power during the observation time interval t_{obs},

P_{sys} be the undisturbed system noise power averaged over 2 000 s,

L be the excess data loss, in seconds and,

$L\%$ be the percentage excess data loss.

The energy supplied by the pulse stream should be ≤ 1/10 of the undisturbed system energy (see Recommendation ITU-R RA.769), so:

$$N_p \, P \, t_{obs} \leq (2000 \, P_{sys})/10 \tag{2}$$

Now parameterize P as:

$$P = (a \, P_{sys}/10) \sqrt{(2000/t_{obs})} \tag{3}$$

so that the pulse average power is a factor above the detrimental threshold for RFI for the time interval t_{obs}.

From equations (2) and (3), one then derives an upper bound for the number of regular pulses in 2 000 s :

$$N_{p,max} = (1/a) \sqrt{(2000/\mathrm{t_{obs}})} \tag{4}$$

and the corresponding shortest allowed pulse period:

$$t_{p,min} = a\sqrt{(2000 t_{obs})} \tag{5}$$

This shows that the interfering pulse period must be more than the geometric mean of the observation length and 2 000 s for it to cause excess data loss in shorter observations, while at the same time meeting the $a = 1$ detrimental limit at 2 000 s set by Recommendation ITU-R RA.769. Thus, for example, there are exactly 100 observations with t_{obs} = 20 s within a 2 000 s interval, whereon (5) guarantees $t_{p,min}$ = 200 s. As $t_{p,min}$ is the longest period that satisfies the $a = 1$ requirement, fewer than 10 pulses can result in data loss, from at most 9 of the 100 twenty second observations.

The data loss is then:

$$L = N_p \, t_{obs} \text{ in seconds,} \tag{6}$$

and the percentage data loss is:

$$L\% = 100 \, L/2000 \tag{7}$$

From equations (5) and (6), one derives:

$$L(\textit{upper limit}) = t_{p,min} \text{ in seconds, and} \tag{8}$$

$$L\%(\textit{upper limit}) = 100 \, (t_{p,min}/2000) \tag{9}$$

It is clear from this short-period pulsed signals (t_p < 40 s) cannot cause significant excess data loss above the 2% limit.

The relationship between t_{obs}, t_p and $L\%$ is shown in Fig. 3, above, for excess data loss of 0, 0.02, 0.2, 2 and 20%.

3.4.2 Effect of regular pulses

Periodic pulses of interference of constant strength represent the worst case in terms of excess data loss. Pulses that are irregularly spaced in time or varying in strength cause at most the same level of data loss, again on the $a = 1$ requirement that their average does not exceed the detrimental threshold level after 2 000 s. In some cases, more than one interfering pulse could occur during a single observation, which does not, however, increase the total number of lost observations, since just one pulse suffices for that.

Likewise, interfering pulses that vary in strength may decrease the number of lost observations. This occurs when pulses falls far enough below the average as not to exceed the detrimental level. Hence neither case can cause more loss than periodic, constant-strength pulses.

3.4.3 Long period pulses

The only interfering pulse periods that cause significant excess data loss are those with very long, tens to hundreds of second, periods. Such pulse strings are rare in commercial practice, though 'push-to-talk' applications may have irregularly spaced transmissions near these rates.

The reason for the limitation to long pulse periods is shown by the following example. From equation (5), to cause excess data loss the pulse period must be greater than the geometric mean of the observation length and 2 000 s. For example, there are one hundred 20-second integrations in 2 000 s. Hence a single pulse averaged over 20 s can be 100 times the 2 000-second detrimental threshold level and still average down to that level, and cause 1% excess data loss. This excess power can be reduced by a factor $\sqrt{100}$=10 and distributed over at most 10 pulses before going below the 20-second detrimental level. That gives a minimum pulse period of 200 s.

3.4.4 Mitigation methods

Interference that is easily visible in an isotropic antenna at any integration interval of one second or longer already shows that the average power over 2 000 s will exceed the detrimental threshold level, as shown below.

For signals at or below the detrimental threshold ($a \leq 1$), the maximum pulse strength giving 2% data loss is a single pulse every 2 000 s that is 1.5 dB below the average noise in 40 s. That will damage one 40-second integration out of every 50, for 2% loss. The average noise in 40 s is $\sqrt{50}$ (8.5 dB) above the noise in 2 000 s, while the pulse can be 50 times (17 dB) above that level. The difference is 8.5 dB. This is still $\sqrt{2}$ fainter than the noise average in 40 s, so it will not be detectable in normal observations. Only very short (millisecond) observations can achieve a significant pulse detection, five sigma or more above the noise.

In all cases, detection of pulsed interference will require an antenna gain in the direction of the interference that is well above isotropic or, in the case of very brief pulses, high time resolution. As a corollary, interference that is visible in an isotropic antenna with a few seconds integration is guaranteed to exceed the detrimental limit when averaged over 2 000 s, even if no further interference occurs.

The discussion in this section assumes that no attempt has been made to synchronize the data acquisition rate with the pulse period. However, regular pulsed signals offer an exceptionally powerful mitigation method if this option is exercised. It is well known from pulsar detection work that an interference to noise enhancement proportional to the square root of the ratio of the pulse width to pulse period, typically 10 to 20 dB for radar, can be achieved.

3.4.5 Equivalence of rapid pulses and continuous emission

Rapid pulses, such as radar, can be treated as continuous interference corresponding in strength to the average pulse strength. In particular, pulsed interference that does exceed the Recommendation ITU-R RA.769 limit for a 2 000-second integration can be below the detrimental limit computed for a shorter integration. For example, consider a pulsed signal with a 20-second period that is 15 dB below the noise in each 20-second integration. The noise after 2 000 s will be 10 times weaker. Hence this signal, which is innocuous in each 20-second integration, will be 5 dB above the detrimental level after 2 000 s.

In other words, the pulsed signal is behaving in just the same way as a continuous signal. It is only pulse periods longer than the geometric mean of the integration time and 2 000 s that can cause excess data loss in the short integrations, while the pulsed interference does not exceed the Recommendation ITU-R RA.769 detrimental interference threshold for a 2 000-second integration. This may be a rare occurrence in practice.

3.4.6 Summary

These calculations show, on the assumption that the pulsed interference does not exceed the Recommendation ITU-R RA.769 detrimental interference threshold for a 2 000-second observation, the following:

1) Radar and other pulsed radiation, with periods less than 40 s, that average down to the detrimental level at 2 000 s set by Recommendation ITU-R RA.769 will not cause excess data loss > 2%.

2) For measurements with 40-second observing length, the worst-case pulse strength for > 2% excess data loss is 1.5 dB below the system noise, and then only for extremely infrequent pulses (1 in 2 000 s) in the absence of any mitigation effort that synchronizes data taking in anti-correlation to regular pulses.

3) Aperiodic and/or variable strength interference will cause data loss at or below periodic pulses of constant strength.

4 Conclusions

A practical criterion for the aggregate data loss resulting from interference to the RAS is considered to be 5% of time from all sources. The existence of multiple overlapping sources of interference is a practical aspect that should be accounted for. Further study of the apportionment of the aggregate interference between different networks is required.

The data loss from any one system should be significantly less than 5%. To comply with this requirement, 2% per system is a practical limit.

RECOMMENDATION ITU-R M.1583-1*

Interference calculations between non-geostationary mobile-satellite service or radionavigation-satellite service systems and radio astronomy telescope sites

(Question ITU-R 236/8)

(2002-2007)

Scope

This Recommendation describes a methodology to be used to calculate the amount of data loss due to interference produced by a non-GSO mobile-satellite or radionavigation-satellite service system at a radio astronomy site. This methodology is based on the calculation of the epfd produced by the considered active system at the radio astronomy site.

The ITU Radiocommunication Assembly,

considering

a) that, in some cases, the radio astronomy service and space services (space-to-Earth) have been allocated to adjacent or nearby frequency bands;

b) that the radio astronomy service is based on the reception of emissions at much lower power levels than are generally used in other radio services;

c) that, due to these low received power levels, the radio astronomy service is generally more susceptible to interference from unwanted emissions than other services;

d) that due to the characteristics of non-geostationary (non-GSO) satellite systems, and in particular to the time-varying nature of interference, the level of interference from such satellites into radio telescopes cannot be evaluated in the same way as for the case of GSO satellites,

recommends

1 that the determination of unwanted emission levels produced by a non-GSO radionavigation-satellite service (RNSS) or a mobile-satellite service (MSS) systems on radio astronomy sites should be based on the method described in Annex 1;

2 that when performing this determination, the antenna pattern described in Recommendation ITU-R RA.1631 should be used to model radio astronomy antennas;

3 that the percentage of time during which an equivalent power flux-density (epfd) threshold level is exceeded should also be determined in accordance with the method described in Annex 2.

* This Recommendation should be brought to the attention of Radiocommunication Study Group 7.

Annex 1

Calculation of unwanted emission levels produced by a non-GSO RNSS or an MSS system at radio astronomy sites

The methodology described here, based on the "equivalent power flux-density" (epfd) concept, is intended for use in calculating the power flux-density (pfd) levels produced by unwanted emissions of a non-GSO satellite system into radio telescopes, taking into account the characteristics of both the satellite system and the radio telescope antenna. The value of the epfd is the aggregate of the contributions from all satellite emissions expressed as the pfd of a single equivalent source on the boresight (peak of main beam) of the radio telescope.

1 Required parameters

Due to the particular characteristics of non-GSO satellite systems, it is clear that the level of the interference from such satellites into a radio telescope cannot be evaluated in the same way as for GSO satellites. A statistical approach is needed which takes into account the dynamic aspect of non-GSO satellites.

The evaluation of interference resulting from the satellites at the radio telescope during the integration time (2 000 s) should be based on statistical calculations and should take into account the parameters of both the satellites and the radio telescope.

Non-GSO satellite system parameters:

– the number of satellites visible in the sky at the radio astronomy station;

– the detailed orbital characteristics of the satellites;

– the pfd radiated by each satellite at the radio telescope within the radio astronomy band considered, which may be estimated using a model of unwanted emissions mask.

Radio telescope parameters:

– the antenna location;

– the antenna pattern and antenna gain;

– the practical range of pointing directions;

– the boresight pointing direction;

– the off-axis angles between the boresight of the antenna of the radio astronomy station and the directions of the transmitting satellites;

– the integration time (2 000 s).

2 Calculation of epfd at radio astronomy sites

The receiving gain of a radio telescope in the direction of a non-GSO satellite (as opposed to GSO) varies with time chiefly because of the movement of the satellite and the fine angular structure of the radio telescope's side-lobe pattern. There will be times when the telescope gain in the direction of a satellite is much higher than 0 dBi, and other times when it is less.

In addition, in the case of multiple satellites of a non-GSO system, all their contributions must be included and properly taken into account.

This may be done using the concept of epfd originally defined to assess possible sharing conditions between GSO and non-GSO systems. In the section below the concept is developed for the case of a radio astronomy station subject to interference from non-GSO satellites.

2.1 Definition of epfd

When an antenna receives power, within its reference bandwidth, simultaneously from transmitters at various distances, in various directions and at various levels of incident pfd, the epfd is that pfd which, if received from a single transmitter in the far field of the antenna in the direction of maximum gain, would produce the same power at the input of the receiver as is actually received from the aggregate of the various transmitters.

The instantaneous epfd is calculated using the following formula:

$$epfd = 10 \log_{10} \left[\sum_{i=1}^{N_a} 10^{\frac{P_i}{10}} \cdot \frac{G_t(\theta_i)}{4\pi d_i^2} \cdot \frac{G_r(\varphi_i)}{G_{r,max}} \right] \tag{1}$$

where:

N_a: number of non-GSO space stations that are visible from the radio telescope

i: index of the non-GSO space station considered

P_i: RF power of the unwanted emission at the input of the antenna (or RF radiated power in the case of an active antenna) of the transmitting space station considered in the non-GSO system (dBW) in the reference bandwidth

θ_i: off-axis angle (degrees) between the boresight of the transmitting space station considered in the non-GSO system and the direction of the radio telescope

$G_t(\theta_i)$: transmit antenna gain (as a ratio) of the space station considered in the non-GSO system in the direction of the radio telescope

d_i: distance (m) between the transmitting station considered in the non-GSO system and the radio telescope

φ_i: off-axis angle (degrees) between the pointing direction of the radio telescope and the direction of the transmitting space station considered in the non-GSO system

$G_r(\varphi_i)$: receive antenna gain (as a ratio) of the radio telescope, in the direction of the transmitting space station considered in the non-GSO system (see Recommendation ITU-R RA.1631)

$G_{r,max}$: maximum gain (as a ratio) of the radio telescope

$epfd$: instantaneous equivalent power flux-density (dB(W/m^2)) in the reference bandwidth at the radio telescope.

The epfd calculation in equation (1) assumes that the pfd due to all interfering sources is directed at the boresight of the receiving antenna, where the antenna gain is maximum. However, radio astronomy protection criteria are based on a 0 dBi contour of the radio astronomy antenna. Using the approach in equation (1), the pfd due to all interfering sources directed at the 0 dBi gain of the receiving antenna, can be determined as follows:

$$epfd_{G_r=0\,\text{dBi}} = 10 \log_{10} \left[\sum_{i=1}^{N_a} 10^{\frac{P_i}{10}} \cdot \frac{G_t(\theta_i)}{4\pi d_i^2} \cdot G_r(\varphi_i) \right] \tag{2}$$

The $epfd_{G_r = 0\,\mathrm{dBi}}$ values resulting from equation (2), averaged (in linear form) over a 2 000 s integration time, can be compared with pfd levels (defined assuming a 0 dBi receiving antenna gain in the direction of interference and given this integration time).

NOTE 1 – It is assumed that each transmitter is located in the far field of the radio telescope (that is, at a distance greater than $2D2/\lambda$ where D is the effective diameter of the radio telescope and λ is the observing wavelength). Though this may not always be satisfied, it is considered to be an adequate approximation.

NOTE 2 – For some telescopes, the direction of maximum gain (boresight direction) may not always coincide with the geometrical axis of the radio telescope.

NOTE 3 – In the case of active antennas, P_i should be taken as the radiated RF power rather than the power at the input to the antenna.

NOTE 4 – The antenna gain of the transmitting station, $G_t(\theta_i)$ is taken at the frequency of the radio astronomy band considered. This may differ from the gain at the frequencies of the intended transmissions.

Annex 2

Distribution of epfd levels

This Annex describes a way to derive epfd statistics over the whole sky.

1 Division of the sky into cells of approximately equal solid angle

The first step of this approach is to divide the sky into M rings parallel to the horizon and equally spaced in terms of elevation angle, from 0° to 90°. The width of each ring is $90/M$°. The next step is to divide these rings into cells whose azimuth width is chosen to provide an integer number of cells per ring and is approximately equal to:

$$\frac{90/M}{\cos(elevation)} \quad \text{degrees}$$

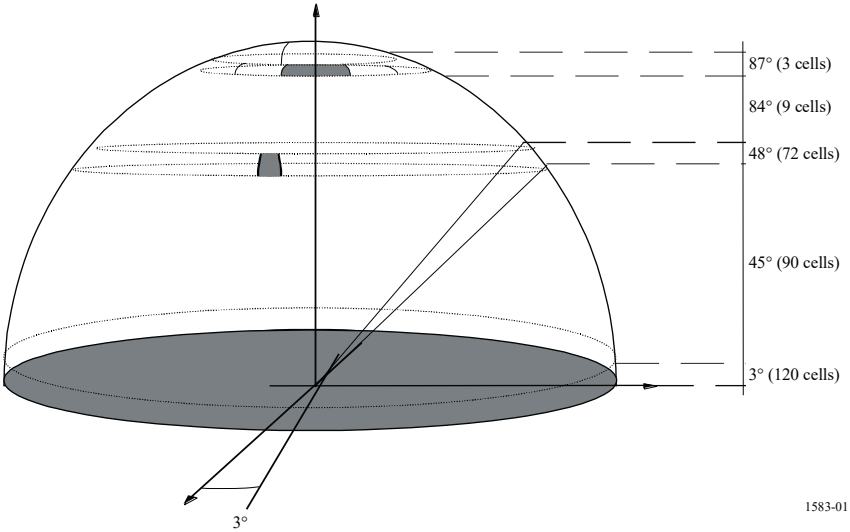
Figure 1 provides an example of division based on a step of 3° width in elevation, this divides the sky into 30 rings of 3° of elevation angle. Then, the azimuth width is approximately equal to:

$$\frac{90/30}{\cos(elevation)} \quad \text{degrees}$$

Elevation is a mean elevation in a given ring.

FIGURE 1

Example of division of the sky in cells of approximately 9 square degrees of solid angle



This leads to a division of the sky into 2 334 cells of approximately 9 square degrees of solid angle each. Table 1 provides the number of cells for each ring corresponding to this example.

TABLE 1

Example of division of the sky into square cells of about 9 square degrees solid angle

Lower elevation of the ring (degrees)	Ring solid angle (square degrees)	Cumulative solid angle (square degrees)	Azimuth step (degrees)	Number of cells in the ring	Cell solid angle (square degrees)	Cumulative number of cells	Percentage of solid angle (%)	Cumulative solid angle (%)
0	1 079.51	1 079.51	3	120	9.00	120	5.23	5.23
3	1 076.55	2 156.05	3	120	8.97	240	5.22	10.45
6	1 070.64	3 226.69	3	120	8.92	360	5.19	15.64
9	1 061.79	4 288.49	3	120	8.85	480	5.15	20.79
12	1 050.04	5 338.53	3	120	8.75	600	5.09	25.88
15	1 035.41	6 373.93	3	120	8.63	720	5.02	30.90
18	1 017.94	7 391.87	3	120	8.48	840	4.94	35.84
21	997.68	8 389.55	3	120	8.31	960	4.84	40.67
24	974.68	9 364.23	3	120	8.12	1 080	4.73	45.40
27	949.01	10 313.24	3	120	7.91	1 200	4.60	50.00
30	920.75	11 233.99	4	90	10.23	1 290	4.46	54.46
33	889.95	12 123.94	4	90	9.89	1 380	4.31	58.78

TABLE 1 (*end*)

Lower elevation of the ring (degrees)	Ring solid angle (square degrees)	Cumulative solid angle (square degrees)	Azimuth step (degrees)	Number of cells in the ring	Cell solid angle (square degrees)	Cumulative number of cells	Percentage of solid angle (%)	Cumulative solid angle (%)
36	856.72	12 980.66	4	90	9.52	1 470	4.15	62.93
39	821.14	13 801.81	4	90	9.12	1 560	3.98	66.91
42	783.31	14 585.12	4	90	8.70	1 650	3.80	70.71
45	743.34	15 328.46	4	90	8.26	1 740	3.60	74.31
48	701.32	16 029.79	5	72	9.74	1 812	3.40	77.71
51	657.39	16 687.17	5	72	9.13	1 884	3.19	80.90
54	611.65	17 298.82	5	72	8.50	1 956	2.97	83.87
57	564.23	17 863.06	6	60	9.40	2 016	2.74	86.60
60	515.27	18 378.33	6	60	8.59	2 076	2.50	89.10
63	464.90	18 843.23	6	60	7.75	2 136	2.25	91.35
66	413.25	19 256.48	8	45	9.18	2 181	2.00	93.36
69	360.47	19 616.95	9	40	9.01	2 221	1.75	95.11
72	306.70	19 923.65	10	36	8.52	2 257	1.49	96.59
75	252.09	20 175.74	12	30	8.40	2 287	1.22	97.81
78	196.79	20 372.53	18	20	9.84	2 307	0.95	98.77
81	140.95	20 513.49	24	15	9.40	2 322	0.68	99.45
84	84.73	20 598.21	40	9	9.41	2 331	0.41	99.86
87	28.27	20 626.48	120	3	9.42	2 334	0.14	100.00

2 epfd distribution for a cell

First, a random choice is made for a pointing direction of the radio astronomy service antenna which will lie within a specific cell on the sky as defined in § 1. Then, the starting time of the constellation is randomly chosen. The epfd is then evaluated for each time sample over a 2 000 s integration time. The average epfd corresponding to this trial is then calculated for the chosen pointing direction and starting time of the constellation.

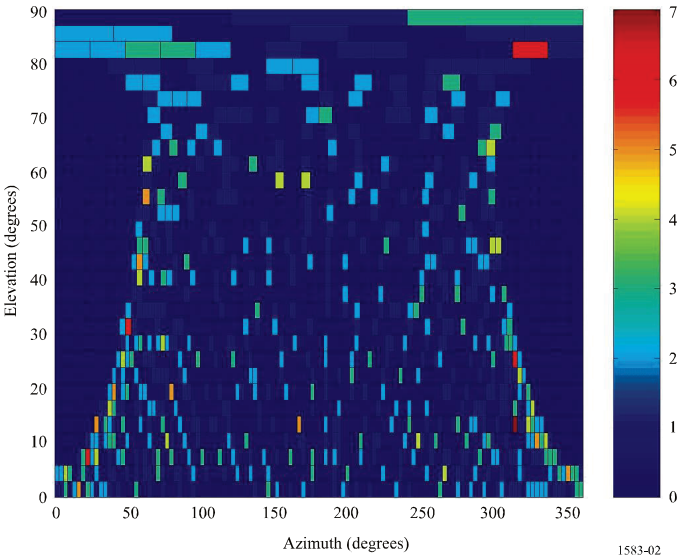
This operation is repeated to obtain a statistical distribution of the epfd in the considered cell. The methodology involves a number of trials, each of which calculates the averaged epfd level over a 2 000 s integration interval. The greater the number of trials, the more accurate this distribution will be. A sufficient number of trials is needed to achieve the required confidence level in the results. In particular, the number of trials multiplied by the 2 000 s integration time should be significantly higher than the period of the constellation. It is also necessary to ensure adequate statistical sampling over the full period of the constellation. Once it is found that no further significant change occurs in the distribution, it can be concluded that a sufficient number of trials has been performed. This check can be done either automatically as an integral part of the simulation, or manually, by stopping the simulation at regular intervals.

3 Output in terms of percentage of data loss

The epfd determination described in § 2 provides a distribution of epfd levels for each cell of the sky which can be compared to the threshold levels used for radio astronomical measurements. When these levels are exceeded, some radio astronomy data will be lost. The percentage of this loss is defined as the sum of these losses in all cells over the number of trials. Figure 2 shows an example of the percentage of data loss per cell over the whole sky for a non-GSO RNSS constellation.

FIGURE 2

Distribution of data loss over the sky



RECOMMENDATION ITU-R S.1586-1

Calculation of unwanted emission levels produced by a non-geostationary fixed-satellite service system at radio astronomy sites

(Question ITU-R 236/4)

(2002-2007)

Scope

This Recommendation describes a method that could be used to calculate the unwanted emission levels produced by a non-GSO fixed-satellite service system on radio astronomy sites. It also contains a procedure for the calculation of the percentage of time during which a given equivalent power flux-density (epfd) is exceeded when the receiving antenna gain is assumed to be 0 dBi in the direction of the incoming interference, and a given integration time is considered.

The ITU Radiocommunication Assembly,

considering

a) that, in some cases, the radio astronomy service and space services (space-to-Earth) have been allocated to adjacent or nearby frequency bands;

b) that the radio astronomy service is based on the reception of emissions at much lower power levels than are generally used in other radio services;

c) that, due to these low received power levels, the radio astronomy service is generally more susceptible to interference from unwanted emissions than other services;

d) that several footnotes to the Radio Regulations (RR) (such as RR Nos. 5.149, 5.443B and 5.511A) draw attention to the protection of the radio astronomy service, particularly from space-borne transmitters;

e) that due to the characteristics of non-geostationary (non-GSO) satellite systems, and in particular to the time-varying nature of interference, the level of interference from such satellites into radio telescopes cannot be evaluated in the same way as for GSO satellites,

recommends

1 that the calculation of unwanted emission levels produced by a non-GSO fixed-satellite service (FSS) system on radio astronomy sites could be conducted by administrations using the method described in Annex 1;

2 that when performing these calculations, the antenna pattern described in Recommendation ITU-R RA.1631 could be used to model radio astronomy antennas;

3 that the percentage of time during which an equivalent power flux-density (epfd) level (defined assuming a 0 dBi receiving antenna gain in the direction of interference and given an integration time) is exceeded could be calculated according to the method described in Annex 2.

Annex 1

Calculation of unwanted emission levels produced by a non-GSO FSS system at radio astronomy sites

The methodology described here, based on the epfd concept defined in RR Article 22, No. 22.5C, is intended for use in calculating the power flux-density (pfd) levels produced by unwanted emissions of a non-GSO FSS satellite system into radio telescopes, taking into account the characteristics of both the satellite system and the radio telescope antenna. The value of the epfd is the aggregate of the contributions from all satellite emissions expressed as the pfd of a single equivalent source on the boresight (peak of main beam) of the radio telescope.

1 Required parameters

Due to the particular characteristics of non-GSO satellite systems, it is clear that the level of the interference from such satellites into a radio telescope cannot be evaluated in the same way as for GSO satellites. A statistical approach is needed which takes into account the dynamic aspect of non-GSO satellites.

The evaluation of interference resulting from the satellites at the radio telescope during the integration time (2 000 s) should be based on statistical calculations and should take into account the parameters of both the satellites and the radio telescope.

Non-GSO satellite system parameters:

– the number of satellites visible in the sky at the radio astronomy station;

– the pfd at the radio telescope within the radio astronomy band considered, estimated using a dBsd or dBc mask;

– the distances between the satellites and the radio astronomy station;

– the detailed orbital characteristics of the satellites.

Radio telescope parameters:

– the antenna location;

– the antenna pattern and antenna gain;

– the practical range of pointing directions;

– the boresight pointing direction;

– the off-axis angles between the boresight of the antenna of the radio astronomy station and the directions of the transmitting satellites;

– the integration time (2 000 s).

2 Calculation of epfd levels at radio astronomy sites

The receiving gain of a radio telescope in the direction of a non-GSO satellite (as opposed to a GSO satellite) varies with time chiefly because of the movement of the satellite and the fine angular structure of the radio telescope's side-lobe pattern. There will be times when the telescope gain in the direction of a satellite is much higher than 0 dBi, and other times when it is less. In addition, in the case of multiple satellites of a non-GSO system, all their contributions must be included and properly taken into account.

This may be done using the concept of epfd originally defined to assess possible sharing conditions between GSO and non-GSO systems. In the section below the concept is developed for the case of a radio astronomy station subject to interference from non-GSO satellites. The definition is based upon RR No. 22.5C as adopted at the World Radiocommunication Conference (Istanbul, 2000) (WRC-2000).

2.1 Definition of epfd

When an antenna receives power, within its reference bandwidth, simultaneously from transmitters at various distances, in various directions and at various levels of incident pfd, the epfd is that pfd which, if received from a single transmitter in the far field of the antenna in the direction of maximum gain, would produce the same power at the input of the receiver as is actually received from the aggregate of the various transmitters.

The instantaneous epfd, expressed in dB(W/m^2), is calculated using the following formula:

$$epfd = 10 \log_{10} \left(\sum_{i=1}^{N_a} 10^{\frac{P_i}{10}} \cdot \frac{G_t(\theta_i)}{4\pi\, d_i^2} \cdot \frac{G_r(\varphi_i)}{G_{r,max}} \right) \tag{1}$$

where:

N_a: number of non-GSO space stations that are visible from the radio telescope

i: index of the non-GSO space station considered

P_i: RF power of the unwanted emission at the input of the antenna (or RF radiated power in the case of an active antenna) of the transmitting space station considered in the non-GSO system in the reference bandwidth (dBW)

θ_i: off-axis angle between the boresight of the transmitting space station considered in the non-GSO system and the direction of the radio telescope

$G_t(\theta_i)$: transmit antenna gain (as a ratio) of the space station considered in the non-GSO system in the direction of the radio telescope

d_i: distance (m) between the transmitting station considered in the non-GSO system and the radio telescope

φ_i: off-axis angle between the pointing direction of the radio telescope and the direction of the transmitting space station considered in the non-GSO system

$G_r(\varphi_i)$: receive antenna gain (as a ratio) of the radio telescope, in the direction of the transmitting space station considered in the non-GSO system (see Recommendation ITU-R RA.1631)

$G_{r,max}$: maximum gain (as a ratio) of the radio telescope

epfd: instantaneous epfd in the reference bandwidth at the radio telescope (dB(W/m^2)).

The epfd calculation in equation (1) assumes that the pfd due to all interfering sources is directed at the boresight of the receiving antenna, where the antenna gain is maximum. However, radio astronomy protection criteria are based on a 0 dBi contour of the radio astronomy antenna. The pfd due to all interfering sources directed at the 0 dBi gain of the receiving antenna, can be determined as follows:

– From equation (1), the instantaneous epfd directed at the 0 dBi gain of the receiving antenna, expressed in (W/m^2), is given by

$$epfd_{G_r = 0\,\text{dBi}} = \left(\sum_{i=1}^{N_a} 10^{\frac{P_i}{10}} \cdot \frac{G_t(\theta_i)}{4\pi d_i^2} \cdot G_r(\varphi_i) \right) \tag{2}$$

– The instantaneous $epfd_{G_r = 0\text{ dBi}}$ values resulting from equation (2), averaged over a 2 000 s integration time, can be compared with pfd levels, also expressed in (W/m^2) (defined assuming a 0 dBi receiving antenna gain in the direction of interference and given this integration time).

NOTE 1 – It is assumed that each transmitter is located in the far field of the radio telescope (that is, at a distance greater than $2D^2/\lambda$, where D is the effective diameter of the radio telescope and λ is the observing wavelength). Though this may not always be satisfied, it is considered to be an adequate approximation.

NOTE 2 – For some telescopes, the direction of maximum gain (boresight direction) may not always coincide with the geometrical axis of the radio telescope.

NOTE 3 – In the case of active antennas, P_i should be taken as the radiated RF power rather than the power at the input to the antenna.

NOTE 4 – The antenna gain of the transmitting station, $G_t(\theta_i)$, is taken at the frequency of the radio astronomy band considered. This may differ from the gain at the frequencies of the intended transmissions.

Annex 2

Distribution of epfd levels

This Annex describes a way to derive epfd statistics over the whole sky.

1 Division of the sky into cells of approximately equal solid angle

The first step of this approach is to divide the sky into M rings parallel to the horizon and equally spaced in terms of elevation angle, from 0° to 90°. The width of each ring is 90°/M. The next step is to divide these rings into cells whose azimuth width is chosen to provide an integer number of cells per ring and is approximately equal to:

$$\frac{90/M}{\cos\,(\text{elevation})} \qquad \text{degrees}$$

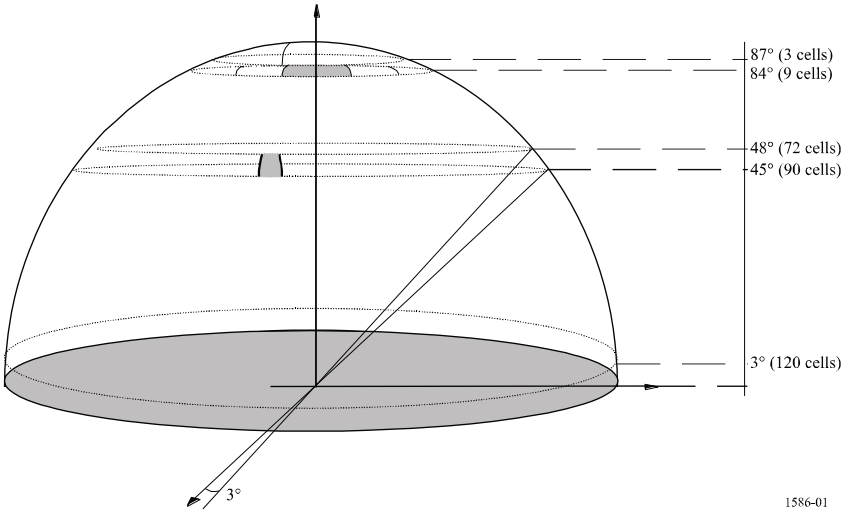
Figure 1 provides an example of division based on a step of 3° width in elevation, this divides the sky into 30 rings of 3° of elevation angle. Then, the azimuth width is approximately equal to:

$$\frac{90/30}{\cos\,(\text{elevation})} \qquad \text{degrees}$$

Elevation is a mean elevation in a given ring.

FIGURE 1

Example of division of the sky in cells of approximately 9 square degrees of solid angle



This leads to a division of the sky into 2 334 cells of approximately 9 square degrees of solid angle each. Table 1 provides the number of cells for each ring corresponding to this example.

TABLE 1

Example of division of the sky into square cells of about 9 square degrees solid angle

Lower elevation of the ring (degrees)	Ring solid angle (square degrees)	Cumulative solid angle (square degrees)	Azimuth step (degrees)	Number of cells in the ring	Cell solid angle (square degrees)	Cumulative number of cells	Percentage of solid angle (%)	Cumulative solid angle (%)
0	1 079.51	1 079.51	3	120	9	120	5.23	5.23
3	1 076.55	2 156.05	3	120	8.97	240	5.22	10.45
6	1 070.64	3 226.69	3	120	8.92	360	5.19	15.64
9	1 061.79	4 288.49	3	120	8.85	480	5.15	20.79
12	1 050.04	5 338.53	3	120	8.75	600	5.09	25.88
15	1 035.41	6 373.93	3	120	8.63	720	5.02	30.90
18	1 017.94	7 391.87	3	120	8.48	840	4.94	35.84
21	997.68	8 389.55	3	120	8.31	960	4.84	40.67
24	974.68	9 364.23	3	120	8.12	1 080	4.73	45.40
27	949.01	10 313.24	3	120	7.91	1 200	4.60	50
30	920.75	11 233.99	4	90	10.23	1 290	4.46	54.46
33	889.95	12 123.94	4	90	9.89	1 380	4.31	58.78
36	856.72	12 980.66	4	90	9.52	1 470	4.15	62.93
39	821.14	13 801.81	4	90	9.12	1 560	3.98	66.91
42	783.31	14 585.12	4	90	8.70	1 650	3.80	70.71
45	743.34	15 328.46	4	90	8.26	1 740	3.60	74.31
48	701.32	16 029.79	5	72	9.74	1 812	3.40	77.71
51	657.39	16 687.17	5	72	9.13	1 884	3.19	80.90
54	611.65	17 298.82	5	72	8.50	1 956	2.97	83.87
57	564.23	17 863.06	6	60	9.40	2 016	2.74	86.60
60	515.27	18 378.33	6	60	8.59	2 076	2.50	89.10
63	464.90	18 843.23	6	60	7.75	2 136	2.25	91.35
66	413.25	19 256.48	8	45	9.18	2 181	2.00	93.36
69	360.47	19 616.95	9	40	9.01	2 221	1.75	95.11
72	306.70	19 923.65	10	36	8.52	2 257	1.49	96.59
75	252.09	20 175.74	12	30	8.40	2 287	1.22	97.81
78	196.79	20 372.53	18	20	9.84	2 307	0.95	98.77
81	140.95	20 513.49	24	15	9.40	2 322	0.68	99.45
84	84.73	20 598.21	40	9	9.41	2 331	0.41	99.86
87	28.27	20 626.48	120	3	9.42	2 334	0.14	100

2 epfd distribution for a cell

First, a random choice is made for a pointing direction of the radio astronomy service antenna which will lie within a specific cell on the sky as defined in the paragraph above. Then, the starting time of the constellation is randomly chosen. The epfd is then evaluated for each time sample over a 2 000 s integration time. The average epfd corresponding to this trial is then calculated for the chosen pointing direction and starting time of the constellation.

This operation is repeated to obtain a statistical distribution of the epfd in the considered cell. The methodology involves a number of trials, each of which calculates the averaged epfd level over a 2 000 s integration interval. The greater the number of trials, the more accurate this distribution will be. A sufficient number of trials is needed to achieve the required confidence level in the results. In particular, the number of trials multiplied by the 2 000 s integration time should be significantly higher than the period of the constellation. It is also necessary to ensure adequate statistical sampling over the full period of the constellation. Once it is found that no further significant change occurs in the distribution, it can be concluded that a sufficient number of trials has been performed. This check can be done either automatically as an integral part of the simulation, or manually, by stopping the simulation at regular intervals.

3 epfd distribution in worst-case pointing directions (to be applied only if the pfd levels from satellites are constant for a given elevation angle of radio astronomy service antenna)

The evaluation of the epfd distributions in cells on the sky may be simplified by first evaluating the epfd distribution in pointing directions corresponding to worst-case pointing directions. These worst-case pointing directions may be taken as those pointing directions where the probability of visibility of satellites is the highest. These pointing directions may be determined according to Recommendation ITU-R S.1257 – Analytical method to calculate short-term visibility and interference statistics for non-geostationary satellite orbit satellites as seen from a point on the Earth's surface (equations (28) and (29)). For a given elevation angle and a given constellation of non-GSO satellites, this Recommendation allows the calculation of the worst-case azimuths (there are usually two worst-case azimuths at a given elevation).

For the cells within which these worst-case pointing directions lie, the epfd distribution may be evaluated for a sufficient number of 2 000 s integration times. Then, this epfd distribution may be compared with a pfd threshold level (defined assuming a 0 dBi receiving antenna gain in the direction of interference and given a 2 000 s integration time).

For a cell, the percentage of time during which a pfd threshold level is exceeded can be calculated as the percentage of 2 000 s integration periods in which the average pfd at the radio telescope exceeds this pfd threshold level.

Considering the 2% criterion in *recommends* 2 of Recommendation ITU-R RA.1513, the comparison of the epfd distribution with the pfd threshold level for cells corresponding to these worst-case pointing directions, can provide the following conclusions:

– If, in all M rings, the time-averaged epfd for the worst-case pointing directions is equal to or less than the threshold of detrimental interference for 98% or more of time (see Fig. 2), then the criteria for avoidance of detrimental interference are met over the whole sky.

– If, in a ring defined for a given elevation angle, the time-averaged epfd for the worst-case pointing directions is equal to or less than the detrimental threshold for 98% or more of time (see Fig. 2), then the criteria for avoidance of detrimental interference are met for the corresponding entire ring.

– If the interference criteria are not met, then further investigation is needed.

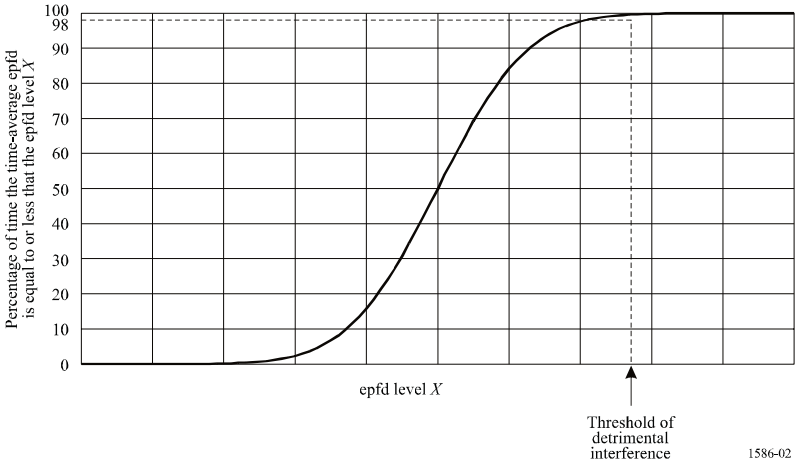
The consideration of these worst-case pointing directions provides information on the location of worst-case cells.

4 Output in terms of epfd distribution

The epfd calculation described in § 2 provides a distribution of epfd levels for each cell of the sky as shown in Fig. 2.

FIGURE 2

Example of a cumulative epfd distribution for a cell



RECOMMENDATION ITU-R F.1613-0*,**

Operational and deployment requirements for fixed wireless access systems in the fixed service in Region 3 to ensure the protection of systems in the Earth exploration-satellite service (active) and the space research service (active) in the band 5 250-5 350 MHz

(Questions ITU-R 113/9 and 218/7)

(2003)

The ITU Radiocommunication Assembly,

considering

a) that the frequency band 5 250-5 350 MHz is allocated to the Earth exploration-satellite service (EESS) (active) and space research service (SRS) (active) for spaceborne active sensors and to the radiolocation service on a primary basis;

b) that the allocations in the frequency band 5 250-5 350 MHz will be reviewed by WRC-03 under agenda item 1.5 with a view to allocating this band to the fixed service in Region 3 on a primary basis;

c) that some administrations in Region 3 have proposed using the band 5 250-5 350 MHz for licence-based fixed wireless access (FWA) systems in the fixed service;

d) that these FWA systems operating outdoors may cause unacceptable interference to the EESS/SRS (active) in the above band;

e) that there is a need to specify operational and deployment requirements for FWA systems in Region 3 in order to protect spaceborne active sensor systems,

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* This Recommendation was developed jointly by Radiocommunication Study Groups 7 and 9, and any future revision will also be undertaken jointly.

** This Recommendation should be brought to the attention of Radiocommunication Study Groups 7 and 8.

noting

a) that the interference from EESS/SRS (active) systems into FWA systems with the characteristics described in Annex 1 is considered to be acceptable,

recognizing

a) that it is difficult for FWA and other types of wireless access systems (including radio local area networks (RLANs)) to operate simultaneously on a co-coverage, co-frequency basis,

recommends

1 that the aggregate interference from FWA systems (sum of the directional e.i.r.p. towards the satellite) should be smaller than –7.6 dB(W/20 MHz) at the Earth's surface within the footprint of the active sensor of the EESS/SRS satellite (see Notes 1, 2 and 3);

2 that the methodology described in Annex 1 should be used to assess the aggregate interference level from FWA systems;

3 that, based on the FWA system characteristics presented in Table 4 for Region 3, a maximum density of 23 FWA base stations per 220 km^2 should be allowed within a satellite active sensor footprint. Variation of the maximum e.i.r.p., antenna pattern and frequency planning would imply a variation in the maximum allowed density of FWA base stations;

4 that the maximum e.i.r.p. of each FWA station should be no more than 3 dB(W/20 MHz) (see Notes 4 and 5);

5 that administrations should control these systems to ensure that the deployment requirements for FWA systems specified in the above *recommends* are satisfied.

NOTE 1 – This aggregate interference level is derived from the interference threshold of –132.35 dB(W/20 MHz) at the satellite receiver specified for the SAR4 in Table 5.

NOTE 2 – The footprint of the active sensor of the EESS/SRS the satellite referred to here has an area of about 220 km^2.

NOTE 3 – The aggregate interference from FWA systems toward the spaceborne active sensor satellite depends on such parameters as transmit power of the FWA systems, the antenna directivity and the number of the FWA base stations using the same RF channel within the satellite active sensor footprint.

NOTE 4 – If the main beam direction is above 10° in elevation, a 6 dB lower e.i.r.p. limit should apply, i.e. a maximum e.i.r.p. of –3 dB(W/20 MHz).

NOTE 5 – The direction of FWA station antennas should be controlled in order to avoid accidental direct illumination to the satellite due to misalignment of antenna direction, for example, a remote station not pointing towards the base station.

NOTE 6 – Additional guidance should be developed in order to facilitate the application of this Recommendation. This matter requires further study.

Annex 1

Frequency sharing between FWA systems and spaceborne active sensor systems in the EESS (active) and the SRS (active) in the band 5 250-5 350 MHz

1 Introduction

The frequency band 5 250-5 350 MHz is considered to be suitable for FWA systems in the fixed service to provide high-speed Internet or other multimedia service applications. Since the frequency band is allocated in the ITU Radio Regulations to the EESS (active) and the SRS (active) on a worldwide basis, sharing feasibilities between FWA systems and systems in the EESS/SRS (active) needs to be determined.

In this frequency band various types of spaceborne synthetic aperture radar (SAR), spaceborne radar altimeter and spaceborne scatterometer systems in the EESS/SRS (active) are operating.

This Annex deals with sharing consideration between FWA systems and these spaceborne active sensors, using typical system parameters that are currently available or being considered in the developmental stage.

2 Technical characteristics of spaceborne active sensors

Technical characteristics of spaceborne active sensors in the 5 250-5 350 MHz are given in Tables 1 to 3.

TABLE 1

5.3 GHz typical spaceborne SAR characteristics

Parameter	Value		
	SAR2	SAR3	SAR4
Orbital altitude (km)	600 (circular)	400 (circular)	
Orbital inclination (degrees)	57		
RF centre frequency (MHz)	5 405	5 305	5 300
Peak radiated power (W)	4 800	1 700	
Polarization	Horizontal and vertical (HH, HV, VH, VV)		
Pulse modulation	Linear FM chirp		
Pulse bandwidth (MHz)	310		40
Pulse duration (μs)	31	33	

TABLE 1 (*end*)

Parameter	Value		
	SAR2	**SAR3**	**SAR4**
Pulse repetition rate (pps)	4 492	1 395	
Duty cycle (%)	13.9	5.9	
Range compression ratio	9 610	10 230	1 320
Antenna type (m)	Planar phased array 1.8 × 3.8	Planar phased array 0.7 × 12.0	
Antenna peak gain (dBi)	42.9	42.7/38 (full focus/beamspoiling)	
Antenna median side-lobe gain (dBi)	–5		
Antenna orientation (degrees)	20-38 from nadir	20-55 from nadir	
Antenna beamwidth	1.7 (El), 0.78 (Az)	4.9/18 (El), 0.25 (Az)	
Antenna polarization	Linear horizontal/vertical		
Receiver noise figure (dB)	4.62		
Receiver front end 1 dB compression point referred to receiver input	–62 dBW input		
Receiver input maximum power handling (dBW)	+7		
Operating time	30% of the orbit		
Minimum time for imaging (s)	15		
Service area	Land masses and coastal areas		
Image swath width (km)	20	16/320	
Footprint (km^2)	159.03	76.5	76.5-220
Receiver bandwidth (MHz)	356.5		46.00
Interference threshold (dB)	$I/N = -6$		

TABLE 2

5.3 GHz typical spaceborne altimeter characteristics

Jason mission characteristics	
Lifetime	5 years
Altitude (km)	1 347 ± 15
Inclination (degrees)	66
Poseidon 2 altimeter characteristics	
Signal type	Pulsed chirp linear frequency modulation
C band PRF (Hz)	300
Pulse duration (μs)	105.6
Carrier frequency (GHz)	5.3
Bandwidth (MHz)	320
Emission RF peak power (W)	17
Emission RF mean power (W)	0.54
Antenna gain (dBi)	32.2
3 dB aperture (degrees)	3.4
Side-lobe level/Maximum (dB)	–20
Back-side-lobe level/Maximum (dB)	–40
Beam footprint at –3 dB (km)	77
Interference threshold (dBW)	–118

TABLE 3

5.3 GHz typical spaceborne scatterometer characteristics

Parameter	**Value**	
System name	Scatterometer 1	Scatterometer 2
Orbital altitude (km)	780	800
Inclination (degrees)	81.5	
Centre frequency (GHz)	5.3	5.255
Pulse width	70 μs (mid) 130 μs (fore/aft)	8 ms (mid) 10.1 ms (fore/aft)
Modulation	Interrupted CW	Linear FM (chirp)
Transmitter bandwidth (kHz)	15	500
PRF (Hz)	115 (mid) 98 (fore/aft)	29.4
Antenna type	Slotted waveguide	

TABLE 3 (*end*)

Parameter	Value			
Antenna gain (dBi)	31 (mid) 32.5 (fore/aft)		28.5 (mid) 29.5 (fore/aft)	
Antenna main beam orientation (degrees)	Incidence angles: 18-47 (mid) 24-57 (fore/aft)		Incidence angles: 25.0-54.5 (mid) 33.7-65.3 (fore/aft)	
Antenna beamwidth (–3 dB) elevation (degrees) Azimuth beamwidth (degrees)	24 (mid) 1.3	26 (fore/aft) 0.8	23.6 (mid) 1.1	23.9 (fore/aft) 0.8
Instrument elevation angle (degrees)	29.3		37.6	
Antenna polarization	Vertical			
Transmitter peak power	4.8 kW		120 W	
Receiver noise figure (dB)	3			
Service area	Oceanic and coastal areas, land masses			
Interference threshold (dB(W/Hz))	–207			

3 Technical features of FWA systems

Technical parameters of FWA systems should be decided to meet both the high-speed Internet service requirements and the sharing criteria with other services.

When FWA systems are to operate in the band 5 250-5 350 MHz, the following points have to be considered:

– FWA systems are composed of a base station and many remote stations within the service coverage, in other words a cell. It is assumed that all the remote stations communicate to the base station only during the assigned time slot (in case of time division multiple access (TDMA)) or accessible timings (in case of carrier sense multiple access (CSMA)). This means that within a cell only one station is transmitting at any instant in time. Therefore, the deployment density (per km^2) of FWA base stations will affect the interference to a spaceborne active sensor satellite station.

– The antenna directivity for high elevation angle is important. If the antenna at the FWA stations has enough upward discrimination, the interference power will be sufficiently suppressed.

– Active ratio of a group of FWA transmitters in a cell may become 100% in the worst case.

– Licence-based measures will be required to control the deployment density of FWA systems.

Considering the aforementioned features, examples of technical parameters for FWA systems are assumed as shown in Table 4 for the purpose of preliminary studies in this Annex.

The characteristics chosen in this analysis are those which would result in the worst-case interference to a narrow-band SAR receiver. For this type of FWA system, if the antenna boresight is pointed approximately along the horizon for a point-to-multipoint connection, the angle from the boresight becomes the elevation angle. At nadir angles of 20° to 55°, FWA station elevation angles directed towards a spaceborne SAR range from 69° to 30°.

TABLE 4

Technical characteristics of FWA system at 5.3 GHz

	Base station	**Remote station**
Frequency band (MHz)	5 250-5 350	
Operational mode	Point-to-multipoint	
Cell radius (km)	1-2	
Maximum transmit e.i.r.p./power (W)	2/0.2	2/0.063
Antenna gain/ characteristics	10 dBi/ Rec. ITU-R F.1336 Omnidirectional pattern (k = 0) (Fig. 1)	15 dBi/ Rec. ITU-R F.1336 Low-cost, low-gain antenna (Fig. 2)
Bandwidth (MHz)	20	
Receiver noise figure (dB)	8	
Interference threshold	I/N = –6 dB or –128.8 dB(W/20 MHz)	
Polarization	Vertical or horizontal	
Active ratio (%)	90	10

FIGURE 1

Base station antenna pattern

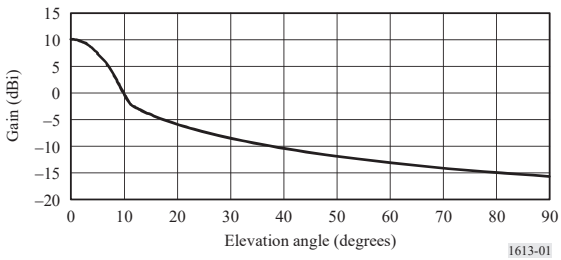
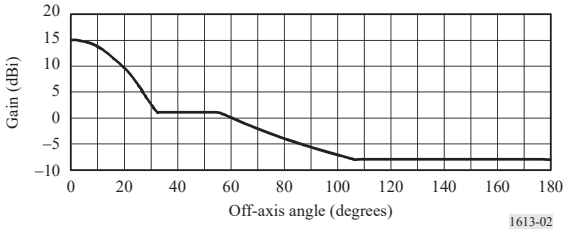


FIGURE 2

Remote station antenna pattern



4 Frequency sharing between spaceborne active sensors and FWA systems

4.1 Sharing between SAR and FWA

4.1.1 Interference from FWA into SAR

Table 5 presents a calculation result of interference from an FWA system with parameters in Table 4 to SAR4 in Table 1. Although SAR2, SAR3 and SAR4 provide the equivalent interference threshold per MHz, the analysis hereafter refers to SAR4 with the most stringent requirement in absolute value. In calculating the interference, the side-lobe effect of the FWA antenna and the scattering effect at the surface/building are considered. With regard to the side-lobe interference from remote stations, the average e.i.r.p. towards the satellite from all remote stations surrounding the base station is calculated (see Appendix 1 to Annex 1). Note that the frequency reuse factor of 4 is assumed in Table 5.

The surface scattered contribution or eventual scattering from nearby buildings will be possible sources of interference. This is dependent on the area where these systems are deployed and on which altitude they will be placed (top or side of buildings), etc. It can be envisaged that FWA systems are present in high-density urban areas where by definition scattering from a wide range of objects will occur, so besides surface scattering these other cases will have to be taken into account. One could especially envisage modern office buildings, which are constructed out of metal where the possibility of a high reflectivity into the direction of the sensor cannot be excluded. As the worst-case approach, a scattering coefficient is taken as –18 dB. This assumption may need to be reviewed.

The above analysis is based on the hypothesis of having only FWA transmitters not using sector antennas. The presence of sector antennas would deteriorate the sharing scenario related to scattering.

The result indicates that 23 FWA cells can be operated in the SAR4 footprint within an area of 220 km^2 while the interference to the SAR satellite receiver is smaller than the acceptable level. If the parameters of FWA systems are different from those listed in Table 4, including the case where sector antennas are employed at the base stations, the number of cells allowed within the satellite footprint would be different. Table 5 should be recalculated with the actual parameters.

TABLE 5

Interference from an FWA system to SAR4

Parameter			20° from nadir		55° from nadir	
			Value	dB	Value	dB
Interfering e.i.r.p. due to FWA antenna side lobe	From base station	Transmitted peak power (W)	0.2	–7.00	0.2	–7.00
		Transmit antenna gain (dBi)		–14.20		–8.80
		Active ratio	90%	–0.46	90%	–0.46
		e.i.r.p. (dBW)		–21.66		–16.26
	From remote station	Transmitted peak power (W)	0.063	–12.00	0.063	–12.00
		Average transmit antenna gain (dBi)		–4.96		–2.34
		Active ratio	10%	–10.00	10%	–10.00
		e.i.r.p. (dBW)		–26.96		–24.34
	Total e.i.r.p. due to side lobe (dBW)			–20.54		–15.63
Interfering power due to scattering at the surface	From base station	Transmitted peak power (W)	0.2	–7.00	0.2	–7.00
		Active ratio	90%	–0.46	90%	–0.46
		Transmitted power (dBW)		–7.46		–7.46
	From remote stations	Transmitted peak power (W)	0.063	–12.00	0.063	–12.00
		Active ratio	10%	–10.00	10%	–10.00
		Transmitted power (dBW)		–22.00		–22.00
	Total transmitted power (dBW)			–7.31		–7.31
	Scattering coefficient (dB)			–18.00		–18.00
	Total scattered e.i.r.p. (dBW)			–25.31		–25.31
Total interfering e.i.r.p. from a cell (dBW)				–19.29		–15.19
Interference power received at SAR	Receive antenna gain (dBi)			42.70		42.70
	Polarization loss (dB)			–3.00		–3.00
	Free space loss (dB)		(427 km)	–159.55	(749 km)	–164.43
	Power received (dBW)			–139.14		–139.92
SAR receiver sensitivity	Noise figure (dB)			4.62		4.62
	kT		4.0×10^{-21}	–203.98	4.0×10^{-21}	–203.98
	Receiver bandwidth (MHz)		20.0	73.01	20.0	73.01
	Noise power (dBW)			–126.35		–126.35
	SAR interference threshold ($I/N = -6$ dB) (dBW)			–132.35		–132.35
Allowable number of FWA cells	Margin (dB)			6.79		7.57
	Maximum number of FWA cells using the same RF channel within the SAR footprint		4.78		5.71	
	Maximum number of FWA cells assuming frequency reuse factor of 4		19.1		22.8	

4.1.2 Interference from SAR into FWA

The first step in analysing the interference potential from spaceborne SARs into FWA systems is to determine the signal power from spaceborne SARs side lobes onto the Earth's surface. For this analysis the median side-lobe gain has been used since these side lobes give a substantially larger footprint than the peak gain and will result in a longer duration interference. Table 6 shows the interference levels caused from SAR4 satellite side lobes into FWA. SAR4 was selected to represent the worst case. This Table shows a positive margin in the order of 20 dB and would result in a positive sharing scenario as far as side lobes are concerned.

TABLE 6

Interference from SAR4 side lobes into FWA

Parameter	20° from nadir		55° from nadir	
	Interference into base station	Interference into remote station	Interference into base station	Interference into remote station
Transmitted power (dBW)	32.3		32.3	
Transmit antenna gain (dBi)	–5.0		–5.0	
Free space loss (dB)	–159.5 (427 km)		–164.4 (749 km)	
Receive antenna gain (dBi)	–14.2	–2.2	–8.8	2.3
FWA feeder loss (dB)	–5.0	–10.0	–5.0	–10.0
Power received (dBW)	–151.4	–144.4	–150.9	–144.8
Bandwidth reduction (dB)	–3.0		–3.0	
Power received (dB(W/20 MHz))	–154.4	–147.4	–153.9	–147.8
FWA interference threshold (dB(W/20 MHz))	–128.8		–128.8	
Margin (dB)	25.6	18.6	25.1	19.0

However, the peak antenna gain is 43-47.7 dB higher than the average side-lobe gain of –5 dBi. Therefore, for the duration of the flyover the interference levels at the surface would be above the FWA interference threshold. Although the threshold is exceeded, the frequency and duration of this excess interference are estimated once per 8-10 days and 0.5-1 s per event, respectively.

4.1.3 Summary

It is demonstrated that frequency sharing between the SAR system and an FWA system is feasible in the band 5 250-5 350 MHz under certain operational and deployment requirements for the FWA system. FWA systems may experience short periods of high interference from SAR systems during their flyover periods. This interference is considered to be acceptable, given the assumed small joint probability of SAR interference and fading by the FWA systems. However, further studies may be required on the detailed interference effects on FWA systems.

4.2 Sharing between spaceborne altimeter and FWA

4.2.1 Interference from FWA into spaceborne altimeter

Table 7 shows the interference calculation from FWA into the spaceborne altimeter. The result shows an ample margin of 42.6 dB with respect to a –118 dBW threshold, and thus it can be concluded that FWA systems will not cause unacceptable interference to the spaceborne altimeter operation.

TABLE 7

Interference from FWA into spaceborne altimeter

Parameter			From nadir	
			Value	dB
Interfering e.i.r.p. due to FWA antenna side lobe	From base station	Transmitted peak power (W)	0.2	–7.00
		Transmit antenna gain (dBi)		–15.84
		Active ratio	90%	–0.46
		e.i.r.p. (dBW)		–23.30
	From remote station	Transmitted peak power (W)	0.063	–12.00
		Average transmit antenna gain (dBi)		–5.71
		Active ratio	10%	–10.00
		e.i.r.p. (dBW)		–27.71
	Total e.i.r.p. due to side lobe (dBW)			–21.96
Interfering power due to scattering at the surface	From base station	Transmitted peak power (W)	0.2	–7.00
		Active ratio	90%	–0.46
		Transmitted power (dBW)		–7.46
	From remote stations	Transmitted peak power (W)	0.063	–12.00
		Active ratio	10%	–10.00
		Transmitted power (dBW)		–22.00
	Total transmitted power (dBW)			–7.31
	Scattering coefficient (dB)			–18.00
	Total scattered e.i.r.p. (dBW)			–25.31
Total interfering e.i.r.p. from a cell (dBW)				–20.31
Interference power received at altimeter receiver	Receive antenna gain (dBi)			32.20
	Polarization loss (dB)			–3.00
	Free space loss (dB)		(1 347 km)	–169.53
	Power received (dBW)			–160.64
Altimeter interference threshold (dBW)				–118.00
Margin (dB)				42.64

4.2.2 Interference from spaceborne altimeter into FWA

Table 8 shows interference levels from the spaceborne altimeter main beam into a base station and a remote station. There are sufficient margins in both cases.

TABLE 8

Interference from spaceborne altimeter into FWA

Parameter	To nadir	
	Interference into base station	Interference into remote station
Transmitted power (dBW)	12.3	
Transmit antenna gain (dBi)	32.2	
Free space loss (dB)	–169.5 (1 347 km)	
Receive antenna gain (dBi)	–15.8	–5.7
FWA feeder loss (dB)	–5.0	–10.0
Power received (dBW)	–145.8	–140.7
Bandwidth reduction (20 MHz/320 MHz) (dB)	–12.0	
Power received (dB(W/20 MHz))	–157.8	–152.7
FWA interference threshold (dB(W/20 MHz))	–128.8	
Margin (dB)	29.0	23.9

4.2.3 Summary

It has been demonstrated that frequency sharing between spaceborne altimeter system and FWA systems is feasible in the band 5 250-5 350 MHz.

4.3 Sharing between scatterometer and FWA

4.3.1 Interference from FWA into scatterometer

Table 9 shows an interference analysis from FWA into Scatterometer 1. Scatterometer 1 is selected to represent the worst case. Table 9 shows that the interference from FWA does not cause unacceptable interference.

4.3.2 Interference from scatterometer into FWA

Table 10 shows an analysis of interference from the scatterometer into FWA. The negative margins mean that FWA systems may experience short periods of high interference during the flyover of the scatterometer system.

TABLE 9

Interference from FWA into Scatterometer 1

Parameter			18° from nadir (El: 69.7°)		57° from nadir (El: 19.7°)	
			Value	dB	Value	dB
Interfering e.i.r.p. due to FWA antenna side lobe	From base station	Transmitted peak power (W)	0.2	–7.00	0.2	–7.00
		Transmit antenna gain (dBi)		–14.20		–5.94
		Active ratio	90%	–0.46	90%	–0.46
		e.i.r.p. (dBW)		–21.66		–13.40
	From remote station	Transmitted peak power (W)	0.063	–12.00	0.063	–12.00
		Average transmit antenna gain (dBi)		–4.93		0.64
		Active ratio	10%	–10.00	10%	–10.00
		e.i.r.p. (dBW)		–26.96		–21.36
	Total e.i.r.p. due to side lobe (dBW)			–20.54		–12.76
Interfering power due to scattering at the surface	From base station	Transmitted peak power (W)	0.2	–7.00	0.2	–7.00
		Active ratio	90%	–0.46	90%	–0.46
		Transmitted power (dBW)		–7.46		–7.46
	From remote stations	Transmitted peak power (W)	0.063	–12.00	0.063	–12.00
		Active ratio	10%	–10.00	10%	–10.00
		Transmitted power (dBW)		–22.00		–22.00
	Total transmitted power (dBW)			–7.31		–7.31
	Scattering coefficient (dB)			–18.00		–18.00
	Total scattered e.i.r.p. (dBW)			–25.31		–25.31
Total interfering e.i.r.p. from a cell (dBW)				–19.29		–12.53
Interference power received at SAR	Receive antenna gain (dBi)			31.00		32.50
	Polarization loss (dB)			–3.00		–3.00
	Free space loss (dB)		(825 km)	–165.27	(1 745 km)	–171.78
	Power received (dBW)			–156.56		–154.81
	Power received (dB(W/Hz))			–229.57		–227.82
Scatterometer interference threshold (dB(W/Hz))				–207.00		–207.00
Margin (dB)				22.57		20.82

TABLE 10

Interference from Scatterometer 1 into FWA

Parameters	18° from nadir (El: 69.7°)		57° from nadir (El: 19.7°)	
	Interference into a base station	Interference into a remote station	Interference into a base station	Interference into a remote stations
Transmitted power (dBW)	36.8		36.8	
Transmit antenna gain (dBi)	31.0		32.5	
Free space loss (dB)	–165.3 (825 km)		–171.8 (1 745 km)	
Receive antenna gain (dBi)	–14.2	–4.9	–5.9	0.6
FWA feeder loss (dB)	–5.0	–10.0	–5.0	–10.0
Power received (dBW)	–116.7	–112.4	–113.4	–111.9
FWA interference threshold (dBW)	–128.8		–128.8	
Margin (dB)	–12.1	–16.4	–15.4	–16.9

4.3.3 Summary

It has been demonstrated that frequency sharing between scatterometer systems and FWA systems is feasible. FWA systems may experience short periods of high interference from Scatterometer systems during their flyover periods. This interference is considered to be acceptable, given the assumed small joint probability of scatterometer interference and fading by FWA systems. However, further studies may be required on the detailed interference effects on FWA systems.

5 Conclusion

Frequency sharing between EESS/SRS (active) and FWA is possible under the condition that deployment of FWA systems is controlled so that the total interference e.i.r.p. from FWA to the EESS/SRS satellite does not exceed –7.6 dB(W/20 MHz) within the footprint of the active sensor of the satellite. FWA systems may experience short periods of interference from active sensor systems of EESS/SRS satellites during their flyover periods. This interference is considered to be acceptable for this band, given the assumed small joint probability of the active sensor interference and fading by FWA systems.

It is noted that these conclusions apply only to sharing between FWA and EESS/SRS (active), and do not address the possible increased aggregate interference to EESS/SRS (active) from the effects of mobile devices which may also operate in the EESS/SRS (active) footprint. However, studies have indicated that it is difficult for FWA and other types of wireless access systems (including RLANs) to operate simultaneously on a co-coverage, co-frequency basis. This matter is under further study and it is assumed not to impact on the conclusions of this Recommendation.

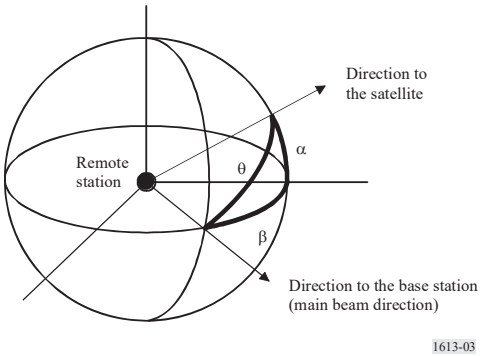
Appendix 1
to Annex 1

Interference into the spaceborne active sensor caused by side lobes of FWA remote stations

In an FWA cell, remote stations are scattered around the base station. It is assumed that remote stations surround the base station uniformly in terms of azimuth angles observed from the remote station. Since the main beam of remote stations are directed to the base station, the angle from the main beam of remote station is larger than the elevation angle towards the EESS/SRS satellite due to the azimuth separation as shown in Fig. 3.

FIGURE 3

Off-beam angle: θ towards the EESS/SRS satellite at the remote station



The off-beam angle: θ towards the satellite at the remote station is calculated by the following relation, assuming that the elevation of remote station antenna is 0°:

$$\cos\theta = \cos\alpha \cdot \cos\beta$$

where:

α: elevation angle towards the satellite

β: azimuth separation angle between the satellite and the base station directions.

Assuming β to be uniformly distributed over 0° to 360°, the average gain towards the satellite is calculated as shown in Table 11.

TABLE 11

Average antenna gain of remote stations towards the satellite

Satellite elevation (degrees)	70	30
Average gain (dBi)	–4.96	–2.34

Appendix 2
to Annex 1

List of abbreviations

Az	Azimuth
BW	Bandwidth
CSMA	Carrier sense multiple access
CW	Continuous wave
EESS	Earth exploration-satellite service
El	Elevation
FM	Frequency modulation
FWA	Fixed wireless access
PRF	Pulse repetition frequency
RF	Radio frequency
RLAN	Radio local area network
SAR	Synthetic aperture radar
SRS	Space research service
TDMA	Time division multiple access

RECOMMENDATION ITU-R RA.1631-0

Reference radio astronomy antenna pattern to be used for compatibility analyses between non-GSO systems and radio astronomy service stations based on the epfd concept

(Question ITU-R 146/7)

(2003)

The ITU Radiocommunication Assembly,

considering

a) that there is a need to determine the levels of interference which may occur at typical observatory sites, due to various sources of interference;

b) that, to determine these levels of interference, a reference antenna pattern needs to be defined;

c) that Recommendation ITU-R SA.509 gives a reference antenna pattern which represents the side-lobe gain levels that are not expected to be exceeded at most off-axis angles in the majority of antennas used in the service;

d) that the antenna pattern given in Recommendation ITU-R SA.509 is appropriate in some compatibility or sharing analyses;

e) that, if the peak envelope radiation pattern such as given in Recommendation ITU-R SA.509 is used in the assessment of the aggregate interference consisting of many interference entries, the predicted interference will result in values that are greater than values that would be experienced in practice;

f) that Recommendation ITU-R S.1586 and Recommendation ITU-R M.1583 provide a methodology based on the epfd concept as defined in No. 22.5C of the Radio Regulations to calculate the level of unwanted emission levels produced by a non-geostationary-satellite system at radio astronomy stations;

g) that it is necessary to use an antenna radiation pattern representing average side-lobe levels to predict interference to a radio astronomy station from one or more fast moving stations seen under continuously variable angle such as non-GSO systems;

h) that, a simple mathematical formula is preferable to the radiation pattern representing average side-lobe levels;

j) that, to derive the epfd resulting from unwanted emission levels produced by a non-geostationary-satellite system at radio astronomy stations, it is necessary to use the typical maximum antenna gain of radio astronomy service (RAS) stations,

recommends

1 that, in the absence of particular information concerning the radiation pattern of the radio astronomy antenna involved, the mathematical model of the average radiation pattern as stated below should be used for compatibility analyses between non-GSO systems and RAS stations for frequencies above 150 MHz:

$G(\varphi) = G_{max} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda}\varphi\right)^2$	dBi	for	$0 < \varphi < \varphi_m$
$G(\varphi) = G_1$		for	$\varphi_m \leq \varphi < \varphi_r$
$G(\varphi) = 29 - 25 \log \varphi$	dBi	for	$\varphi_r \leq \varphi < 10°$
$G(\varphi) = 34 - 30 \log \varphi$	dBi	for	$10° \leq \varphi < 34.1°$
$G(\varphi) = -12$	dBi	for	$34.1° \leq \varphi < 80°$
$G(\varphi) = -7$	dBi	for	$80° \leq \varphi < 120°$
$G(\varphi) = -12$	dBi	for	$120° \leq \varphi \leq 180°$

where:

$$G_{max} = 20 \log\left(\frac{D}{\lambda}\right) + 20 \log \pi \qquad \text{dBi}$$

$$G_1 = -1 + 15 \log \frac{D}{\lambda} \qquad \text{dBi}$$

$$\varphi_m = \frac{20\lambda}{D}\sqrt{G_{max} - G_1} \qquad \text{degrees}$$

$$\varphi_r = 15.85 \left(\frac{D}{\lambda}\right)^{-0.6} \qquad \text{degrees}$$

D: diameter of the telescope (m)

λ: wavelength (m);

2 that the following mathematical model of the radiation pattern may be adopted for a more accurate representation of the main beam radiation pattern for frequencies above 150 MHz:

$$G(\varphi) = G_{max}\left[\frac{J_1(2\pi x)}{\pi x}\right]^2 \qquad \text{(expressed as a ratio not in dB)}$$

where:

$J_1(x)$: first order Bessel function

$G_{max} = \left[\frac{4\pi A_{eff}}{\lambda^2}\right]$: maximum gain (expressed as a ratio not in dB)

$A_{eff} = \pi(D/2)^2$: area of the aperture of the telescope (m^2)

D: diameter of the telescope (m)

λ: wavelength (m)

and where:

$$x = \frac{\pi \cdot D \cdot \varphi}{360 \cdot \lambda}$$ with φ, off-boresight angle (degrees) ($0 \le \varphi < \varphi_0$)

φ_0: first null in this antenna pattern at $69.88/(D/\lambda)$ (degrees) off-boresight

and that the following mathematical model of the radiation pattern may be adopted for a more accurate representation of the radiation pattern of near side lobes up to 1° from the boresight for frequencies above 150 MHz:

$$G(\varphi) = B\left[\frac{\cos(2\pi x - 3\pi/4 + 0.0953)}{\pi x}\right]^2$$ (expressed as a ratio not in dB)

where:

$$x = \frac{\pi \cdot D \cdot \varphi}{360 \cdot \lambda}$$ with φ, off-boresight angle (degrees) ($\varphi_0 \le \varphi \le 1°$)

D: diameter of the telescope

λ: wavelength

and:

$$B = 10^{3.2}\, \pi^2\, ((\pi D/2)/(180 \cdot \lambda))^2$$

This main beam model corresponds to the ideal case of 100% aperture efficiency;

3 that the following typical maximum RAS antenna gain be used in compatibility analysis between non-GSO systems and RAS antenna stations.

RAS allocated band (MHz)	**Typical maximum antenna gain**
150.05-153	44
322-328.6	51
406.1-410	53
608-614	56
1 400-1 427	63
1 610.6-1 613.8	64
1 660-1 670	65
2 690-2 700	69
4 990-5 000	74

RAS allocated band (GHz)	Typical maximum antenna gain
10.6-10.7	81
14.47-14.5	84
15.35-15.4	84
22.21-22.5	87
23.6-24	88
31.3-31.7	90
42.5-43.5	93

The corresponding antenna diameter may be derived using the following equations (see *recommends* 2):

$$G_{max} = \left[\frac{4\pi A_{eff}}{\lambda^2} \right] \qquad \text{maximum gain (expressed as a ratio)}$$

where:

$A_{eff} = \pi(D/2)^2$: area of the aperture of the telescope (m^2)

D: diameter of the telescope (m)

λ: wavelength (m).

RECOMMENDATION ITU-R M.1642-2

Methodology for assessing the maximum aggregate equivalent power flux-density at an aeronautical radionavigation service station from all radionavigation-satellite service systems operating in the 1 164-1 215 MHz band

(2003-2005-2007)

Scope

This Recommendation gives a methodology and the reference antenna characteristics for assessing the maximum aggregate equivalent power flux-density (epfd) level produced at the input of a station of the aeronautical radionavigation service (ARNS) by all radionavigation-satellite service (RNSS) systems operating in any portion of the 1 164-1 215 MHz band.

The ITU Radiocommunication Assembly,

considering

a) that in accordance with the Radio Regulations (RR), the band 960-1 215 MHz is allocated on a primary basis to the aeronautical radionavigation service (ARNS) in all the ITU Regions;

b) that analyses show that RNSS signals in the 1 164-1 215 MHz band can be designed not to cause interference to the DME/TACAN ARNS receivers operating in this band;

c) that a protection criterion for the ARNS has been developed and is expressed in terms of equivalent power flux-density (epfd), which is set out in Recommendation ITU-R M.1639,

recognizing

a) that WRC-2000 introduced a co-primary allocation for the RNSS in the frequency band 1 164-1 215 MHz, subject to conditions that require the RNSS to protect the ARNS from harmful interference;

b) that WRC-03 determined that protection of the ARNS from RNSS can be achieved if the value of the epfd produced by all the space stations of all RNSS (space-to-Earth) systems in the band 1 164-1 215 MHz does not exceed the level of –121.5 dB(W/m^2) in any 1 MHz band, and adopted Resolution 609 (WRC-03) in order to ensure that this level is not exceeded;

c) that the ARNS is a safety service in accordance with RR No. 1.59 and special measures need to be taken by Administrations to protect these services in accordance with provision RR No. 4.10,

recommends

1 that the methodology in Annex 1 and the reference ARNS characteristics in Annex 2 should be used to calculate the maximum aggregate epfd produced by emissions from all RNSS systems at any aeronautical radionavigation station.

Annex 1

Methodology for assessing the maximum aggregate epfd at an ARNS station from all RNSS systems operating in the 1 164-1 215 MHz band

Summary of the method

With the method described in this Annex it is possible to calculate the maximum aggregate epfd level of all RNSS systems in the band 1 164-1 215 MHz.

This method allows different systems to be combined easily, so that the effect of changes such as including or excluding one or various systems or the effect of changing the characteristics of specific systems can be examined during a consultation meeting.

The method accommodates both non-GSO systems, with constellations of satellites in any orbits of any inclination, and GSO systems.

The method is based on a two-step process:

Step 1: Calculation of the epfd of each individual RNSS system. This step may be performed by each operator independently prior to the consultation meeting, provided that results are submitted in a compatible format (see § 1.3, for non-GSO systems, and § 1.4, for GSO systems).

Step 2: Combination of the maximum epfd of the individual systems, by superposition of the maps, if necessary at different frequencies, to obtain the maximum aggregate epfd (see § 2) in the band 1 164-1 215 MHz.

Description of the method

1 Method for calculating the maximum epfd from satellites of one RNSS system

1.1 Definition of epfd

The definition of equivalent power flux-density (epfd) is based upon RR No. 22.5C.1 as adopted at WRC-2000.

When an antenna receives power, within its reference bandwidth, simultaneously from transmitters at various distances, in various directions and at various levels of incident pfd, the epfd is that pfd which, if received from a single transmitter in the far field of the antenna in the direction of maximum gain, would produce the same power at the input of the receiver as is actually received from the aggregate of the various transmitters.

The instantaneous epfd is calculated using the following formula:

$$epfd = 10 \log_{10} \left[\sum_{i=1}^{N_a} 10^{\frac{P_i}{10}} \cdot \frac{G_t(\theta_i)}{4\pi d_i^2} \cdot \frac{G_r(\varphi_i)}{G_{r,\,max}} \right]$$

where:

N_a: number of space stations that are visible from the receiver

i: index of the space station considered

P_i: RF power (in the reference bandwidth) at the input of the antenna (or RF radiated power in the case of an active antenna) of the transmitting space station (dB(W/MHz))

θ_i: off-axis angle (degrees) between the boresight of the transmitting space station and the direction of the receiver

$G_t(\theta_i)$: transmit antenna gain (as a ratio) of the space station in the direction of the receiver

d_i: distance (m) between the transmitting station and the receiver

φ_i: off-axis angle (degrees) between the pointing direction of the receiver and the direction of the transmitting space station

$G_r(\varphi_i)$: receive antenna gain (as a ratio) of the receiver, in the direction of the transmitting space station (see Annex 2)

$G_{r,\,max}$: maximum gain (as a ratio) of the receiver

epfd: instantaneous equivalent power flux-density (dB(W/(m^2 · MHz))) at the receiver.

NOTE 1 – It is assumed that each transmitter is located in the far field of the receiver (that is, at a distance greater than $2D^2/\lambda$, where D is the effective diameter of the receiver antenna and λ is the observing wavelength in the same unit). In the case under consideration this will always be satisfied.

1.2 General consideration

In the first step of the method, the maximum epfd for each constellation of RNSS satellites is calculated at each latitude and longitude over the whole surface of the Earth for each 1 MHz of spectrum occupied by the system.

As the victim ARNS receiver may be mounted on an aircraft flying at an altitude up to 40 000 ft (12 192 m) (see § 2 of Annex 2), the calculation should include all satellites with elevation angles from 90° down to –3.54°.

Calculation of the epfd distribution of each system is only necessary at a single reference frequency, preferably the frequency at which signal power is maximum. The RNSS signal spectral shape should be supplied to a consultation meeting, so that results of the calculation can then be multiplied by the appropriate spectral shaping factors to obtain the results at any other frequency.

1.3 Method for calculating the maximum epfd for a non-GSO RNSS system

The simulation methodology given in Appendix 1 to Annex 1, which is based entirely on Recommendation ITU-R S.1325, may be used to accomplish this.

The methodology, given in Appendix 2 to Annex 1, is based entirely on an analytical technique. The method could be used for obtaining prompt estimates but it does not yield an exact upper bound result.

1.4 Method for calculating the maximum epfd for a GSO RNSS system

The maximum epfd for each GSO satellite is required to be calculated at each latitude and longitude over the whole surface of the Earth for each 1 MHz of spectrum occupied by the system.

In this case the epfd will not be dependent on time, so a single table of results can be calculated directly.

2 Method for calculating the maximum aggregate epfd from all RNSS systems

2.1 Data required for each system

Each non-GSO RNSS system not having a geosynchronous period will, having followed the methodology of § 1.3, provide a consultation meeting with a list of maximum epfd versus latitude (applicable at all longitudes) and a signal spectral shape.

Each non-GSO RNSS system having a geosynchronous period will, having followed the methodology of § 1.3, provide a consultation meeting with a list of maximum epfd versus latitude and longitude, and a signal spectral shape.

Each GSO RNSS system will, having followed the methodology of § 1.4, provide a consultation meeting with a table of maximum epfd versus latitude and longitude and a signal spectral shape.

2.2 Combination of epfds of systems with similar signal characteristics

The determination of aggregate epfd of RNSS systems with the same frequency of signal spectral maximum may be achieved using three steps:

Step 1a: point-by-point summation of maximum epfd's in the 1 MHz of the band where the signal has maximum power at each latitude of all the non-GSO (not having a geosynchronous period) lists to obtain the list of non-GSO (not having a geosynchronous period) aggregate epfd versus latitude;

Step 1b: point-by-point summation of maximum epfds in the 1 MHz of the band where the signal has maximum power at each latitude and longitude of all the non-GSO (having a geosynchronous period) lists to obtain the list of non-GSO (having a geosynchronous period) aggregate epfd versus latitude and longitude;

Step 2: point-by-point summation of maximum epfd's in the 1 MHz of the band where the signal has maximum power at each point of latitude and longitude of all the GSO tables to obtain the table of GSO aggregate epfd versus latitude and longitude;

Step 3: point-by-point summation of the list of non-GSO (not having a geosynchronous period) aggregate epfd versus latitude, and the list of non-GSO (having a geosynchronous period) aggregate epfd versus latitude and longitude to each longitude column of the table of GSO aggregate epfd versus latitude and longitude to obtain the overall the table of aggregate epfd versus latitude and longitude.

Examination of the highest epfd in this table will reveal whether the protection criterion in Recommendation ITU-R M.1639 in any 1 MHz of the band is respected.

2.3 Combination of epfd's of systems with different signal characteristics

It should be noted that the maximum aggregate epfd will be frequency dependent. If the spectra of all the RNSS systems under consideration have their maxima at the same frequency, a single analysis will suffice. However, if different systems have different maxima, either because they use different centre frequencies with overlapping spectra or because they use different modulation techniques, then analysis of the maximum aggregate epfd will require frequency to be taken into account.

The determination of maximum aggregate epfd of RNSS systems with different centre frequencies will require, as a minimum, the above three steps to be performed at each frequency for which any one system has its signal spectral maximum, and may also require analysis at intermediate frequencies.

For each frequency, each list or table will be factored by the appropriate spectral shaping factor before summation with other lists and tables.

Examination of the highest epfd in all of the resultant tables will reveal whether protection criterion in Recommendation ITU-R M.1639 in any 1 MHz of the band is respected.

2.4 Check of results

Following determination of the maximum aggregate epfd, a single simultaneous simulation of all RNSS systems at the ARNS station location where the absolute maximum aggregate epfd was determined may be considered to confirm results obtained using Appendix 1 or 2 to Annex 1.

Appendix 1
to Annex 1

A simulation methodology for determining the maximum epfd for a non-GSO RNSS system

1 Method and simulation approach description

The framework for this methodology based on Recommendation ITU-R S.1325 is to model all the satellites of one RNSS system at a specific reference frequency (typically the 1 MHz portion of the 1 164-1 215 MHz band with the maximum RNSS signal spectral density). A simulation of the constellation is sampled over a period of time at a relatively fine rate. At each sample the epfd is computed for all latitude and longitude points. The maximum sample should be recorded for each latitude and longitude point. Other samples may be discarded. The result is a table, which can be shown as a map, as illustrated in Figs. 5 and 6. Following this, the maximum epfd, for each latitude should be determined, which will eliminate approximations due to limited simulation time.

2 Simulation assumptions

2.1 Orbit model

The orbit models to simulate the space stations in their orbits are for circular and elliptical orbits only accounting for precession of the line of nodes in the equatorial plane due to asphericity of the Earth.

The orbit model represents satellite motion in a geocentric inertial coordinate frame shown in Fig. 1. The origin of this inertial frame is at the centre of the Earth. The x-axis points to the first point in the constellation Aries (i.e. vernal equinox), the z-axis is the mean rotation axis of the Earth, and the y-axis is determined as the cross product of the unit vectors in the z and x direction, i.e. $\vec{y} = \vec{z} \times \vec{x}$.

The orbital models are based on Newton's equation of motion for a satellite orbiting a perfectly spherical Earth in a circle and in an ellipse. For the non-GSO system using circular orbit, the characteristics of this motion that make it easy to model is that the satellite orbital radius and velocity are constant.

2.1.1 Earth-related constants

For the Earth, the general constants are:

R_e: Earth radius (6 378.137 km)

O: Earth centre

μ: Earth attraction constant (3.986005×10^5 km^3/s^2)

J_2: second harmonic Earth potential constant ($1\,082.63 \times 10^{-6}$)

T_e: Earth rotation period (23 h 56′ 4.0989" = 86 164.0989 s)

Ω_e: Earth rotation angular velocity = $2\pi/T_e \cong 7.2921151467 \times 10^{-5}$ rad/s

t: elapsed time since the simulated epoch (s).

2.1.2 Non-GSO satellite system space station related constants

For the non-GSO satellite system space stations using circular orbits (see Fig. 1), the constants are as follows:

N: number of space stations of the non-GSO system

i: index for each of the non-GSO satellites ($0 \le i < N$)

h_{sat}: satellite altitude above the Earth (km)

r: radius of the satellite orbit (km) = $h_{sat} + R_e$

I: inclination angle of the orbital plane above the Equator (rad)

RAAN: right ascension of the ascending node

$\Omega_{i,0}$: RAAN of the i-th non-GSO satellite at the time t (rad)

$u_{i,0}$: argument of latitude of the i-th non-GSO satellite at the time t (rad)

T: satellite orbit period (s) = $2\pi\,(r^3/\mu)^{1/2}$

n: mean motion of a satellite (rad/s) = $2\pi/T$

$u_{i,t}$: argument of latitude of the i-th satellite at the time t (rad) = $u_{i,0} + n_t$

Ω_r: nodal regression of the ascending node (rad/s)

$$= -\frac{3}{2} J_2 \cos(I)\, R_e^2 \frac{\sqrt{r\mu}}{r^4}$$

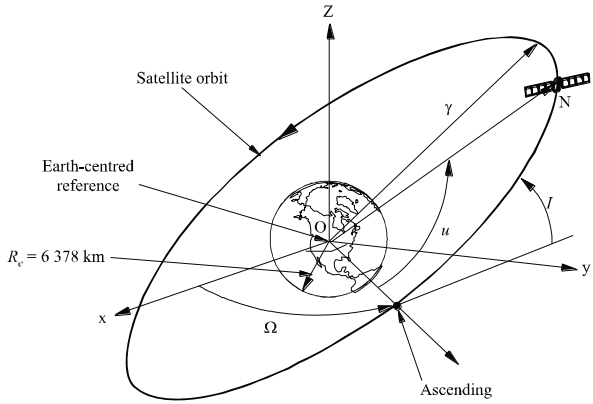
$\Omega_{i,t}$: RAAN of the i-th satellite at the time t (rad) = $\Omega_{i,0} + \Omega_r t$

$\overrightarrow{ON_i}$: coordinate vector (inertial coordinate system) of a non-GSO satellite in the Earth-centred fixed coordinate frame:

$$\overrightarrow{ON_i} = \begin{bmatrix} x_i \\ y_i \\ z_i \end{bmatrix} = r \begin{bmatrix} \cos(u_{i,t}) \cdot \cos(\Omega_{i,t}) - \cos(I) \cdot \sin(u_{i,t}) \cdot \sin(\Omega_{i,t}) \\ \cos(u_{i,t}) \cdot \sin(\Omega_{i,t}) + \cos(I) \cdot \sin(u_{i,t}) \cdot \cos(\Omega_{i,t}) \\ \sin(u_{i,t}) \cdot \sin(I) \end{bmatrix}$$

FIGURE 1

Circular orbit geometry



γ : semi-major axis
u: argument of satellite latitude
I: inclination angle
Ω: RAAN

1642-01

For the non-GSO satellite system space stations using elliptical orbits (see Figs. 2 and 3), the constants are as follows:

N: number of space stations of the non-GSO system

i: index for each of the non-GSO satellites ($0 \le i < N$)

a_i: semi-major axis of the i-th satellite (km)

e_i: eccentricity of the i-th satellite

$M_{i,0}$: mean anomaly of the i-th non-GSO satellite at the initial time (rad)

T_i: satellite orbit period of the i-th satellite (s) $= 2\pi(a_i^3/\mu)^{1/2}$

n_i: mean motion of the i-th satellite (rad/s) $= 2\pi/T_i$

$\nu_{i,t}$: true anomaly of the i-th satellite at time $t = 2\cdot\tan^{-1}\left[\sqrt{\frac{1+e_i}{1-e_i}}\tan\frac{E_{i,t}}{2}\right]$

$E_{i,t}$: eccentric anomaly of the i-th satellite at time $t = 2\cdot\tan^{-1}\left[\sqrt{\frac{1-e_i}{1+e_i}}\tan\left(\frac{\nu_{i,t}}{2}\right)\right]$

$M_{i,t}$: mean anomaly of the i-th satellite at time $t = M_{i,0} + n_i\cdot t = E_{i,t} - e_i\cdot\sin E_{i,t}$ *

* Once $M_{i,t}$ is given, $E_{i,t}$ is determined by iteration. Usually, for short time-steps, the last value of $E_{i,t}$ can be used as an initial estimate.

I_i: inclination angle of the orbital plane above the Equator of the i-th satellite (rad)

RAAN: right ascension of the ascending node

$\Omega_{i,0}$: RAAN of each of the i-th non-GSO satellites at the initial time (rad)

$\omega_{i,0}$: argument of perigee of each of the i-th non-GSO satellites at the initial time (rad)

$u_{i,t}$: argument of latitude of the i-th satellite at the time t (rad) = $\omega_{i,0} + \nu_{i,t}$

Ω_{ri}: nodal regression of the ascending node of the i-th satellite (rad/s)

$$= -\frac{3}{2} J_2 \cos(I_i) R_e^2 \frac{\sqrt{a_i \mu}}{a_i^4 (1-e_i^2)^2}$$

$\Omega_{i,t}$: RAAN of the i-th satellite at the time t (rad) = $\Omega_{i,0} + \Omega_{ri} t$

$\overrightarrow{ON}_{i,t}$: coordinate vector (inertial coordinate system) of the i-th non-GSO satellite in the Earth-centred fixed coordinate frame at the time t:

$$\overrightarrow{ON}_{i,t} = rot3(-\Omega_{i,t}) \cdot rot1(-I_i) \cdot rot3(-\omega_{i,0}) \cdot \vec{r}_{i,t}$$

$rot1(\alpha)$: rotation about the x-axis

$$rot1(\alpha) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\alpha & \sin\alpha \\ 0 & -\sin\alpha & \cos\alpha \end{bmatrix}$$

$rot3(\alpha)$: rotation about the z-axis

$$rot3(\alpha) = \begin{bmatrix} \cos\alpha & \sin\alpha & 0 \\ -\sin\alpha & \cos\alpha & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\vec{r}_{i,t} : \vec{r}_{i,t} = r_{i,t} \begin{bmatrix} \cos\nu_{i,t} \\ \sin\nu_{i,t} \\ 0 \end{bmatrix} = \frac{a(1-e^2)}{1+e_i \cdot \cos\nu_{i,t}} \cdot \begin{bmatrix} \cos\nu_{i,t} \\ \sin\nu_{i,t} \\ 0 \end{bmatrix}$$

FIGURE 2

Elliptical orbit geometry in focal plane

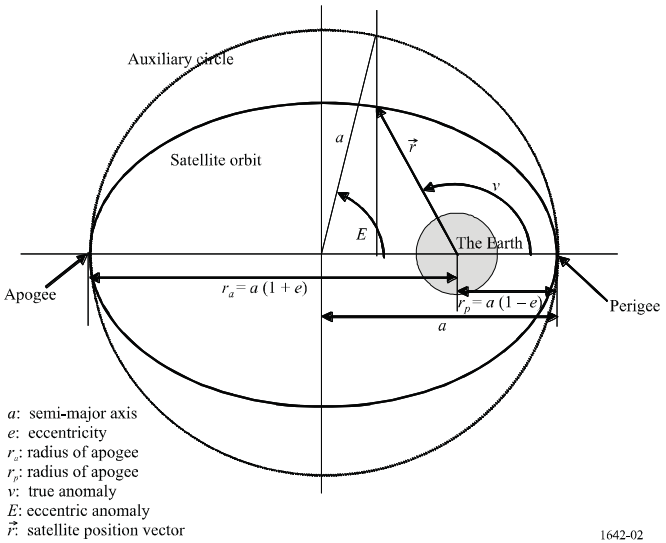
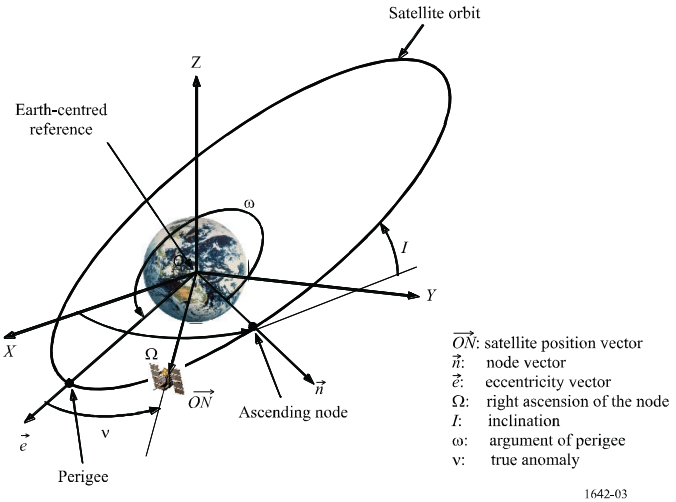


FIGURE 3

Elliptical orbit geometry in ECI coordination



The non-GSO perturbation can be considered in calculating the non-GSO constellation related constants, as the position of the satellites may vary when taking perturbation into account.

2.1.3 ARNS station related constants

Lat: latitude of ARNS station (rad)

Lon: longitude of ARNS station (rad)

h_{ARNS}: altitude of ARNS station (km)

$\overrightarrow{OM}$: ARNS station coordinates in the Earth-centred, inertial coordinate system

$$\overrightarrow{OM} = \begin{cases} X = (R_e + h_{ARNS}) \cos(\text{Lat}) \cos\left(\text{Lon} + \Omega_e\, t\right) \\ Y = (R_e + h_{ARNS}) \cos(\text{Lat}) \sin\left(\text{Lon} + \Omega_e\, t\right) \\ Z = (R_e + h_{ARNS}) \sin(\text{Lat}) \end{cases}$$

2.2 Antenna parameters

2.2.1 ARNS station antenna parameters

The antenna pattern for the ARNS station is an input parameter to the simulation (see Annex 2).

2.2.2 Non-GSO space station antenna parameters

In order to perform interference analysis, non-GSO satellite antennas should be modelled using either of the following patterns, subject to availability:

– measured antenna patterns;

– proposed reference antenna patterns;

– an analytical function which models the radiation pattern of the non-GSO satellite antenna.

2.3 Calculation of the simulation time

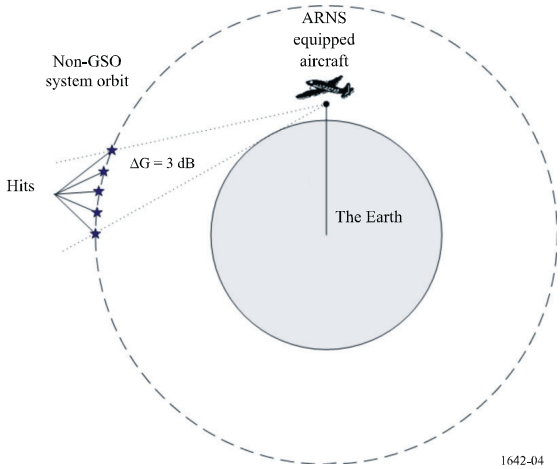
2.3.1 Simulation time increment

For obtaining accurate results the simulation time increment, t_{inc}, should be as short as possible, but on the other hand the total simulation time should be reasonable. To attain the accuracy required it is necessary to ensure a sufficient number of epfd measurements (N_{hits}) when non-GSO RNSS spacecraft falls into the ARNS antenna pattern of maximum gain visible to a space station. $N_{hits} = 5$ is thought to be sufficient.

The maximum gain visible to a space station occurs at –3.54° to +3° elevation angle (Annex 2) for an aircraft at 40 000 ft (12 192 m). It is important to have 5 N_{hits} within this range, implying that simulation increments of 1° of constellation movement is sufficient.

FIGURE 4

Simulation time increment consideration



2.3.2 Total simulation time

A satellite of a non-GSO constellation on any orbit traces out a path on the Earth's surface. After a time, which is specific to the system, the satellite or another satellite of the constellation returns to the same or practically to the same point. The time between these two cases is the repeat period of the constellation. The repeat periods of different constellations are from a few days to several months. Typical results of the epfd calculation of a RNSS system over one constellation repeat period is illustrated in Fig. 5.

The exact longitude precession rate of the satellites in a non-GSO constellation will be affected by drifts due to longitudinal station keeping errors. This effect can be modelled and integrated in the simulations.

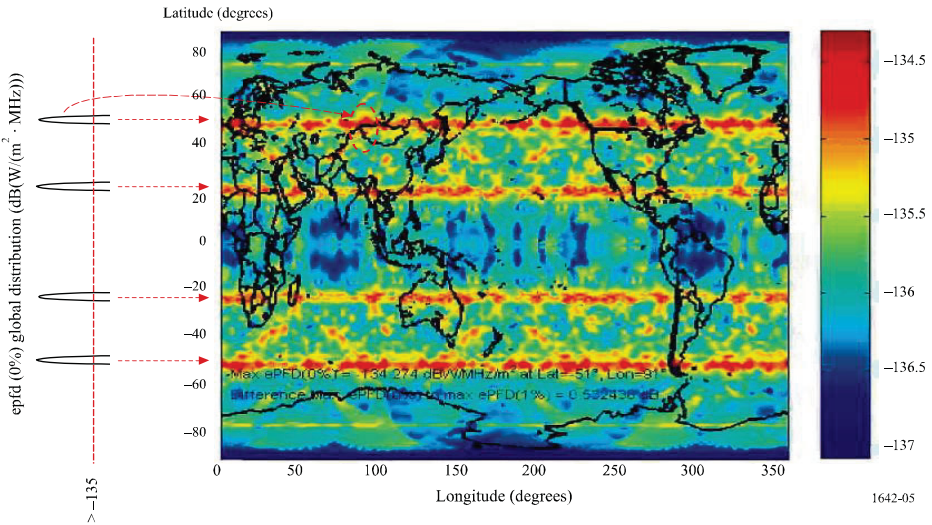
For the non-GSO system not having a geosynchronous period, the aforementioned effect of this will result in the maximum epfd at any longitude becoming, in fact, the maximum epfd at all longitudes. (In other words, if the simulation were to be extended to cover all possible states of the constellation, the "high spots" of maximum epfd on the map in Fig. 5 would spread horizontally to become uniform horizontal stripes.) It is therefore considered more correct to take, for each latitude, the maximum epfd at any longitude and use it for all longitudes. This converts the table of maximum epfd versus latitude and longitude into a simple list of maximum epfd versus latitude.

If this is done, then the simulation time could be reduced to a single orbital period for the non-GSO system not having a geosynchronous period. The "map" produced by such a limited simulation would show only a few "high spots" but, at each latitude, the value of the "high spots", representing the maximum epfd at any longitude, would be the same.

As a by-product, the amount of information which must be presented to the consultation meeting would be considerably reduced.

FIGURE 5

Example of maximum epfd global distribution

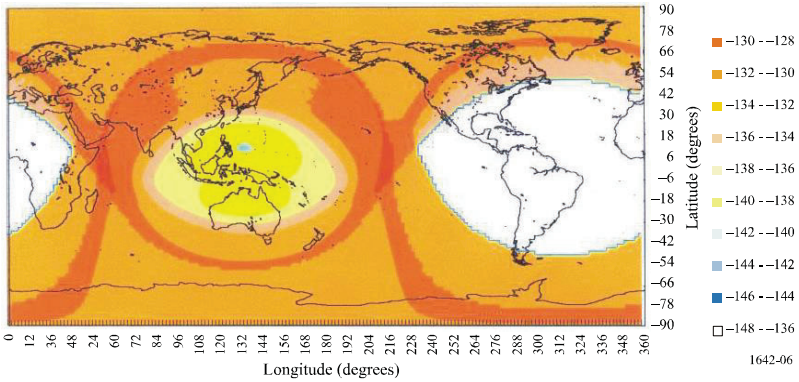


On the other hand, non-GSO systems having a geosynchronous period produce ground tracks that are confined to a limited longitude range on the Earth's surface. This will result in the "high spots" of maximum epfd appearing only within a limited area of the Earth's surface. (In other words, the "high spots" of maximum epfd on the Earth's surface would not spread horizontally.) Therefore, the aggregate epfd, caused by the non-GSO systems having a geosynchronous period, shall be computed for the latitude and longitude points within the visible range from the non-GSO.

For this case of a non-GSO system having a geosynchronous period, the computation could be accomplished considering a single orbital period. Typical results of the epfd calculation for a non-GSO system having a geosynchronous period are shown in Fig. 6.

FIGURE 6

Example of maximum epfd global distribution for a non-GSO system having a geosynchronous period



Appendix 2
to Annex 1

Analytical methodology for assessing the maximum epfd of a single RNSS system operating in the band 1 164-1 215 MHz

1 Introduction

The intent of this methodology is to show how the maximum epfd of a single RNSS system can be evaluated.

The definition of epfd is given in § 1.1 of Annex 1.

2 Description of the methodology

If one assumes that the non-GSO RNSS-system constellations consist of a number of orbital planes, then it is most likely that, in any one particular plane, a maximum of one satellite per plane will be within the –3.54° to +3° elevation angle of the ARNS antenna pattern (see Annex 2). In addition, for non-GSO systems, it is likely that, when a satellite is within the ARNS antenna pattern of maximum gain visible to a space station, other satellites in the plane will have a relatively insignificant epfd contribution. Hence, the number of satellites with a significant contribution to an RNSS system's aggregate epfd is likely to be less than or equal to the number of the system's using these assumptions, one can formulate the non-GSO RNSS constellation maximum epfd ($epfd_{max}$) as:

$$epfd_{max} = 10 \log N_p + epfd_{i,\,max} \qquad \text{dB(W/(m}^2 \cdot \text{MHz))}$$

where:

N_p: the maximum number of satellites in the main beam of the ARNS receiving antenna (typically, the number of orbital planes in the constellation)

$epfd_{i,max}$: maximum single-satellite epfd contribution (dB(W/(m^2 · MHz))).

3 Non-GSO examples

For a single-satellite maximum epfd contribution of –136.9 dB(W/(m^2 · MHz)) within a non-GSO RNSS constellation of six planes using the equation in § 2 the $epfd_{max}$ is:

$$epfd_{max} = (-136.9) + 10 \log 6 = -129.12 \qquad \text{dB(W/(m}^2 \cdot \text{MHz))}$$

A similar calculation, with a single-satellite maximum epfd contribution of –130.24 dB(W/(m^2 · MHz)), within a non-GSO RNSS constellation of three planes, using the equation in § 2 gives a maximum epfd of –125.47 dB(W/(m^2 · MHz)).

These values are in very good agreement with the simulation method in Appendix 1 to Annex 1, with only 1.2 dB difference.

Annex 2

ARNS reference station characteristics to be used in epfd calculation

1 ARNS antenna characteristics

Table 1 provides the antenna gain for elevation values between –90° and 90°. For elevation values between two values of Table 1 a linear interpolation should be used. The $G_{r,\,max}$ value is 3.4 dBi as specified in Recommendation ITU-R M.1639, including 2 dB of circular-to-linear polarization mismatch. It is assumed that the elevation and gain pattern is the same for all azimuth angles.

TABLE 1

Elevation angle (degrees)	Antenna gain including circular-to-linear polarization mismatch $G_r/G_{r,\,max}$ (dB)	Elevation angle (degrees)	Antenna gain including circular-to-linear polarization mismatch $G_r/G_{r,\,max}$ (dB)	Elevation angle (degrees)	Antenna gain including circular-to-linear polarization mismatch $G_r/G_{r,\,max}$ (dB)
–90	–17.22	22	–10.72	57	–15.28
–80	–14.04	23	–10.81	58	–15.49
–70	–10.51	24	–10.90	59	–15.67
–60	–8.84	25	–10.98	60	–15.82
–50	–5.40	26	–11.06	61	–16.29
–40	–3.13	27	–11.14	62	–16.74
–30	–0.57	28	–11.22	63	–17.19
–20	–1.08	29	–11.29	64	–17.63
–10	0.00	30	–11.36	65	–18.06
–5	–1.21	31	–11.45	66	–18.48
–3	–1.71	32	–11.53	67	–18.89
–2	–1.95	33	–11.60	68	–19.29
–1	–2.19	34	–11.66	69	–19.69

TABLE 1 (*end*)

Elevation angle (degrees)	Antenna gain including circular-to-linear polarization mismatch $G_r/G_{r,\,max}$ (dB)	Elevation angle (degrees)	Antenna gain including circular-to-linear polarization mismatch $G_r/G_{r,\,max}$ (dB)	Elevation angle (degrees)	Antenna gain including circular-to-linear polarization mismatch $G_r/G_{r,\,max}$ (dB)
0	–2.43	35	–11.71	70	–20.08
1	–2.85	36	–11.75	71	–20.55
2	–3.26	37	–11.78	72	–20.99
3	–3.66	38	–11.79	73	–21.41
4	–4.18	39	–11.80	74	–21.80
5	–4.69	40	–11.79	75	–22.15
6	–5.20	41	–12.01	76	–22.48
7	–5.71	42	–12.21	77	–22.78
8	–6.21	43	–12.39	78	–23.06
9	–6.72	44	–12.55	79	–23.30
10	–7.22	45	–12.70	80	–23.53
11	–7.58	46	–12.83	81	–23.44
12	–7.94	47	–12.95	82	–23.35
13	–8.29	48	–13.05	83	–23.24
14	–8.63	49	–13.14	84	–23.13
15	–8.97	50	–13.21	85	–23.01
16	–9.29	51	–13.56	86	–22.88
17	–9.61	52	–13.90	87	–22.73
18	–9.93	53	–14.22	88	–22.57
19	–10.23	54	–14.51	89	–22.40
20	–10.52	55	–14.79	90	–22.21
21	–10.62	56	–15.05		

2 ARNS station location

The ARNS station altitude should be taken at worst case (12 192 m)[1], which gives maximum visibility of potentially interfering satellites from the ARNS receiving antenna.

[1] Equivalent to 40 000 ft.

RECOMMENDATION ITU-R M.1643-0*

Technical and operational requirements for aircraft earth stations of aeronautical mobile-satellite service including those using fixed-satellite service network transponders in the band 14-14.5 GHz (Earth-to-space)

(2003)

Summary

This Recommendation provides the technical and operational requirements for aircraft earth stations (AES) of aeronautical mobile-satellite service (AMSS), including those using FSS network transponders operating in the band 14-14.5 GHz (Earth-to-space), that should be used by administrations as a technical guideline for establishing conformance requirements for AES and facilitating their licensing, for worldwide use.

The ITU Radiocommunication Assembly,

considering

a) that various technically and operationally different aeronautical mobile-satellite service (AMSS) networks have been designed to commence operation in the near future;

b) that these planned AMSS networks may provide access to a variety of broadband communication applications (Internet, email, internal corporate networks) to and from aircraft on a global basis;

c) that the aircraft earth station (AES) will operate on national and international airlines around the world;

d) that circulation of AES is usually a subject of a number of national and international rules and regulations including satisfactory conformance to a mutually agreed technical standard and operational requirements;

e) that there is a need for identifying the technical and operational requirements for the conformance testing of AES;

* NOTE – The Arab Group represented at RA-03 reserves its position on this Recommendation and is not ready to accept any repercussions with respect to WRC-03 Agenda item 1.11.

f) that the identification of technical and operational requirements for AES would provide a common technical basis for facilitating conformance testing of AES by various national and international authorities and the development of mutual recognition arrangements for conformance of AES;

g) that the technical and operational requirements need to achieve an acceptable balance between radio equipment complexity and the need for effective use of the radio-frequency spectrum,

considering also

a) that in the frequency band 14-14.5 GHz there are allocations to the FSS (Earth-to-space), radionavigation, fixed and mobile (except aeronautical mobile) services on a primary basis; that secondary services allocated in the band 14-14.5 GHz or in parts of the band include mobile-satellite (except aeronautical mobile-satellite) service (Earth-to-space), space research service (SRS), radio astronomy service (RAS), and radionavigation-satellite service;

b) that there is a requirement to fully protect all primary services and pre-existing systems of secondary services in the band 14-14.5 GHz;

c) that results of the studies conducted in accordance with Resolution 216 (Rev.WRC-2000) showed the feasibility of using the band 14-14.5 GHz by AMSS (Earth-to-space) on a secondary basis under certain conditions and arrangements[1];

d) that the identification by ITU-R of technical and operational requirements for AES operating in the band 14-14.5 GHz could assist administrations to prevent harmful and/or unacceptable interference to other services;

e) that technical and operational characteristics should be continuously and accurately measurable and controllable,

recommends

1 that the technical and operational requirements[1] for aircraft earth stations of AMSS networks operating in the band 14-14.5 GHz given in Annexes 1 and 2 be used by administrations as a guideline for:

– establishing conformance requirements for AES;

– facilitating AES operations.

[1] The characteristics of the typical aircraft earth stations need to fulfil the requirements described in this Recommendation and, further, need to be within the envelope of those initially published in the International Frequency Information Circular (BR IFIC) relating to the corresponding FSS network. In the case that the characteristics are outside of the envelope of those in the initial publication, the required coordination of such an aircraft earth station needs to be effected in accordance with the current provisions of the Radio Regulations (RR) and a modified Rule of Procedure as contained in § 2 of the Rules of Procedure relating to RR No. 11.32, as appropriate.

Annex 1

Technical and operational requirements for AES of AMSS networks in the band 14-14.5 GHz (Earth-to-space)

Part A

Essential requirements related to the protection of FSS networks

1 AMSS networks should be coordinated and operated in such a manner that the aggregate off-axis e.i.r.p. levels produced by all co-frequency AES within AMSS networks are no greater than the interference levels that have been published and coordinated for the specific and/or typical earth station(s) pertaining to FSS networks where FSS transponders are used.

2 The design, coordination and operation of an AES should, at least, account for the following factors which could vary the aggregate off-axis e.i.r.p. levels generated by the AES:

2.1 mispointing of AES antennas. Where applicable, this includes, at least, effects caused by bias and latency of their pointing systems, tracking error of closed loop tracking systems, misalignment between transmit and receive apertures for systems that use separate apertures, and misalignment between transmit and receive feeds for systems that use combined apertures;

2.2 variations in the antenna pattern of AES. Where applicable, this includes, at least, effects caused by manufacturing tolerances, ageing of the antenna and environmental effects. AMSS networks using certain types of AES antennas, such as phased arrays, should account for variation in antenna pattern with scan angles (elevation and azimuth). Networks using phased arrays should also account for element phase error, amplitude error and failure rate;

2.3 variations in the transmit e.i.r.p. from AES. Where applicable, this includes, at least, effects caused by measurement error, control error and latency for closed loop power control systems. Network control and monitoring centres (NCMCs) that calculate the e.i.r.p. of AES based on the received signal need to take into account error sources and latency in this calculation. NCMCs that calculate the e.i.r.p. of AES based on input power must account for measurement error and reporting latency.

3 AES that use closed loop tracking of the satellite signal need to employ an algorithm that is resistant to capturing and tracking adjacent satellite signals. AES must immediately inhibit transmission when they detect that unintended satellite tracking has happened or is about to happen.

4 AES should be subject to the monitoring and control by an NCMC or equivalent facility. AES must be able to receive at least “enable transmission” and “disable transmission” commands from the NCMC. AES must automatically cease transmissions immediately on receiving any

"parameter change" command, which may cause harmful interference during the change, until it receives an "enable transmission" command from its NCMC. In addition, it should be possible for the NCMC to monitor the operation of an AES to determine if it is malfunctioning.

5 AES need also to be self-monitoring and, should a fault which can cause harmful interference to FSS networks be detected, the AES must automatically mute its transmissions.

Part B

Essential requirements related to the protection of the fixed service

In the 14-14.5 GHz frequency band as used by fixed service networks, within line-of-sight of the territory of an administration where fixed service networks are operating in this band, the maximum pfd produced at the surface of the Earth by emissions from a single AES, of an AMSS network should not exceed:

$-132 + 0.5 \cdot \theta$	dB(W/(m^2 · MHz))	for $\theta \leq 40°$
-112	dB(W/(m^2 · MHz))	for $40 < \theta \leq 90°$

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizontal).

NOTE 1 – The aforementioned limits relate to the pfd and angles of arrival that would be obtained under free-space propagation conditions.

NOTE 2 – An e.i.r.p. mask can be derived from the aforementioned pfd mask by applying the method given in Annex 2 of this Recommendation. Simplification of the resulting e.i.r.p. mask could also be considered.

Part C

Essential requirements related to sharing with the RAS

In order to protect the radio astronomy in the band 14.47-14.5 GHz, AMSS earth stations should comply with both following measures:

AMSS channels in the 14.47-14.5 GHz band

– AMSS stations do not transmit in the 14.47-14.5 GHz band within line-of-sight of radio astronomy stations operating within this band;

or,

– if an AMSS operator intends to operate co-frequency within the visibility of the radio astronomy station, a specific agreement with the radio astronomy station will be needed to ensure that AMSS AES will meet the requirements of Recommendations ITU-R RA.769 and ITU-R RA.1513 within the 14.47-14.5 GHz band during observations. Where practicable, this may include advance information to AMSS operators regarding observation schedules.

AMSS channels in the 14-14.47 GHz band

All AES transmitters on channels in the 14-14.47 GHz band within line-of-sight of radio astronomy stations during radio astronomy observations have emissions in the band 14.47-14.5 GHz such that they meet the levels and percentage of data loss given in

Recommendations ITU-R RA.769 and ITU-R RA.1513. Results from studies show that the following AES pfd levels (dB(W/(m^2 · 150 kHz))) in the band 14.47-14.5 GHz are sufficient, with some margin, to meet the radio astronomy pfd levels in Recommendation ITU-R RA.769 and the percentage of data loss given in Recommendation ITU-R RA.1513, i.e.:

$-190 + 0.5 \cdot \theta$	dB(W/(m^2 · 150 kHz))	for	$\theta \leq 10°$
-185	dB(W/(m^2 · 150 kHz))	for	$10° < \theta \leq 90°$

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizontal).

Such AES pfd levels in the band 14.47-14.5 GHz may be achieved by the AMSS operators through a combination of reduced AES signal power, sharp filtering, maintaining adequate frequency separation, or better AES antenna performance.

Part D

Essential requirements related to sharing with the space research service

Coordination agreements should be developed between AMSS and space research systems based on controlling the emissions levels of the AES in the frequency band used by the SRS systems, and, in severe cases, may require cessation of AES emissions on frequencies used by the SRS system when operating in the vicinity of the space research earth station. Specifics of the agreements will vary based on the characteristics of the individual SRS sites and the AMSS networks.

Annex 2

Derivation of a lower hemisphere e.i.r.p. mask from a pfd mask

In testing AMSS equipment to determine if it meets a given pfd mask, such as the one in Annex 1, Part B, it may be useful to determine an equivalent e.i.r.p. mask that can be used for testing purposes.

The pfd mask, pfd(θ) where θ is the angle of arrival (elevation angle) at the Earth's surface, can be used to mathematically determine an e.i.r.p. mask, e.i.r.p.(γ, *H*) where γ is the angle below the local horizontal plane and *H* is the altitude of the aircraft. This conversion proceeds in two steps. First, γ is converted to an equivalent angle of arrival, θ. Then the length of the propagation path for angle of arrival θ is determined and used to calculate the spreading loss for the path and the resulting e.i.r.p.

Step 1: Calculation of an angle of arrival in degrees, θ, from γ and *H*:

$$\theta = \arccos((R_e + H)\cos(\gamma)/R_e)$$

where:

θ: angle of arrival

R_e: earth radius (6 378 km)

H: altitude of the aircraft (km)

γ: angle below horizontal.

NOTE 1 – If the argument of the arccos function is greater than 1, the propagation path in the direction of the angle γ does not intersect the Earth. In this case, which occurs for values of γ of about 3.5° or less, a value for θ does not exist and so there is no defined value for the pfd mask.

Step 2: Calculation of the e.i.r.p. value from the defined pfd(θ):

$$d = (R_e^2 + (R_e + H)^2 - 2\,R_e(R_e + H)\cos(\gamma - \theta))^{1/2}$$

$$\text{e.i.r.p.}(\gamma, H) = \text{pfd}(\theta) + 10\log_{10}(4\,\pi\,d^2) + 60$$

where:

d: distance between the AES and the considered point on the Earth's surface (km)

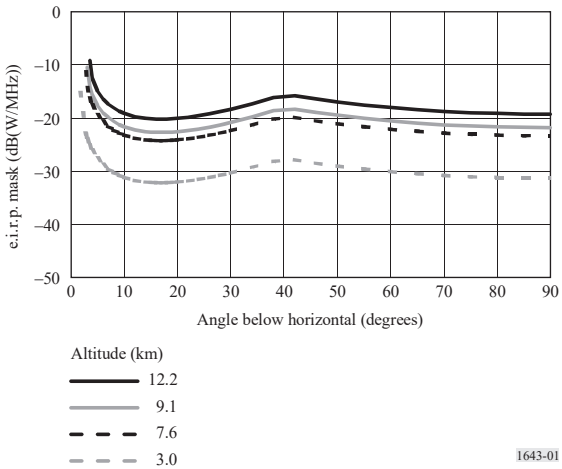
pfd(θ): (dB(W/(m^2 · MHz)))

e.i.r.p.: (dB(W/MHz)).

The graph in Fig. 1 shows this function for various aircraft altitudes based on the pfd mask provided in Annex 1, Part B of this Recommendation.

FIGURE 1

e.i.r.p. mask derived from pfd mask



RECOMMENDATION ITU-R M.1652-1

Dynamic frequency selection* in wireless access systems including radio local area networks for the purpose of protecting the radiodetermination service in the 5 GHz band

(Questions ITU-R 212/5)

(2003-2011)

Scope

This Recommendation provides requirements of dynamic frequency selection (DFS) as a mitigation technique to be implemented in wireless access systems (WAS) including radio local area networks (RLANs) for the purpose of facilitating sharing with the radiodetermination service in the 5 GHz band. Annex 1 specifies the detection, operational and response requirements. Other Annexes address the methodologies and provide information which can be used by administrations when conducting sharing studies between radars and WAS including RLANs.

The ITU Radiocommunication Assembly,

considering

a) that harmonized frequencies in the bands 5 150-5 350 MHz and 5 470-5 725 MHz for the mobile service would facilitate the introduction of wireless access systems (WAS) including radio local area networks (RLANs);

b) that there is a need to protect the radars in the radiodetermination service operating in the bands 5 250-5 350 and 5 470-5 725 MHz;

c) that in many administrations, the ground-based meteorological radars are extensively deployed and support critical weather services;

d) that procedures and methodologies to analyse compatibility between radars and systems in other services are provided in Recommendation ITU-R M.1461;

e) that representative technical and operational characteristics of radiolocation, radionavigation and meteorological radars are provided in Recommendation ITU-R M.1638, including maritime radionavigation radars in, *inter alia*, the band 5 470-5 650 MHz;

f) that WAS including RLANs as described in Recommendation ITU-R M.1450 are capable of operating both indoor and outdoor;

g) Report ITU-R M.2034 which addresses the impact of certain detection requirements of the DFS on the performance of WAS,

* Dynamic frequency selection is a general term used in this Recommendation to describe mitigation techniques that allow, amongst others, detection and avoidance of co-channel interference with respect to radar systems.

recognizing

a) that the band 5 250-5 350 MHz is allocated to the radiolocation service on a primary basis; that the band 5 250-5 350 MHz is also allocated to the Earth exploration-satellite service (EESS) (active) on a primary basis;

b) that the band 5 470-5 650 MHz is allocated to the maritime radionavigation service on a primary basis;

c) that the band 5 350-5 650 MHz is allocated to the radiolocation service on a secondary basis;

d) that ground-based radars used for meteorological purposes are authorized to operate in the band 5 600-5 650 MHz on a basis of equality with stations in the maritime radionavigation service;

e) that the band 5 650-5 725 MHz is allocated to the radiolocation service on a primary basis;

f) that administrations may take account of detailed information on actual radar deployment when developing guidance for the use of DFS in WAS in consultation with potentially affected administrations,

noting

a) that the high RF power level and the receiver sensitivity of radars in the radiodetermination service in conjunction with the expected high density of WAS including RLANs would, in general, not enable compatible operation of WAS including RLANs and radars on a co-channel basis in the absence of mitigation techniques;

b) that WAS including RLANs could be deployed in these bands as licence-exempt devices, consequently making control of their deployment density more difficult;

c) that there are various standards for RLAN specifications;

d) that administrations may consider procedures to confirm the ability of interference avoidance mechanisms to function correctly in the presence of the radar systems deployed in this band,

recommends

1 that, in order to facilitate sharing with radars, mitigation techniques as described in Annex 1 be implemented by WAS, including RLANs in the bands used by radars at 5 GHz;

2 that the mitigation techniques comply with the detection, operational and response requirements as given in § 2 of Annex 1;

3 that the methodologies given in Annexes 4, 5, 6 and 7 can be used by administrations when conducting sharing studies between radars and WAS including RLANs.

NOTE 1 – Further information on the results of studies on the requirements stated in *recommends* 2 is given in Report ITU-R M.2115, which provides information on the procedures in place in various administrations and/or regional groups to test compliance with DFS requirements.

Annex 1

The use of DFS in WAS including RLANs for the purpose of protecting the radiodetermination service in the 5 GHz band

1 Introduction

1.1 DFS

In relation to studies on the feasibility of sharing between the mobile service for WAS[1] and the radiodetermination service in the frequency bands 5 250-5 350 and 5 470-5 725 MHz, link budget calculations have shown that interference mitigation techniques are required to enable sharing of WAS with other services such as radar systems. This Annex describes the interference mitigation technique(s) DFS[2] as specified in the 5 GHz RLAN standards, with performance calculations based on typical implementations.

WAS and radars operating in the 5 GHz band will interfere when operating at the same frequencies and within range of each other.

DFS has then been envisaged to:

– ensure a spread of the loading across the available spectrum of the WAS under the field of view of a satellite to reduce the aggregate emission levels at the satellites of the FSS (feeder links) and EESS (active) from WAS;

– avoid co-channel operation with other systems, notably radar systems.

Extension of the use of DFS as described herein allows WAS to avoid interfering with the radiodetermination service. The general principle applied is that WAS should detect interference and identify radar interferers and shall not use those frequencies used by the radar.

1.2 Objective of the use of DFS with respect to radars

The objective of using DFS in WAS is to provide adequate protection to radars in the 5 GHz band. This is achieved by avoiding the use of, or vacating, a channel identified as being occupied by radar equipment based on detection of radar signals.

For the purpose of this Annex, a discussion of radiodetermination systems in the 5 GHz range utilized in determining DFS characteristics can be found in Annex 3.

The implementation of radar detection mechanisms and procedures used by WAS are outside the scope of this Annex. The main reasons for this are that:

– WAS design affects implementation;

– practical experience may lead to innovative and more efficient means than can be formulated today;

– different manufacturers may make different implementation choices to achieve the lowest cost for a given level of performance; therefore only performance criteria rather than specifications for a particular mechanism should be given in regulatory documents.

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[1] Throughout this Recommendation the term “WAS” denotes “wireless access systems including RLANs”.

[2] The DFS feature was specified in the 5 GHz RLAN standards initially in order to mitigate interference among uncoordinated RLAN clusters, and to provide optimized spectral efficiency for high-capacity, high bit-rate data transmission.

2 DFS performance requirements

The DFS performance requirement is stated in terms of response to detection of an interference signal.

5 GHz WAS should meet the following detection and response requirements.

Procedures for compliance verification should be incorporated in relevant industry standards for RLANs.

2.1 Detection requirements

The DFS mechanism should be able to detect interference signals above a minimum DFS detection threshold of –62 dBm for devices with a maximum e.i.r.p. of < 200 mW and –64 dBm for devices with a maximum e.i.r.p. of 200 mW to 1 W[3] averaged over 1 μs.

This is defined as the received signal strength (RSS) (dBm), normalized to the output of a 0 dBi receive antenna, that is required to be detected within the WAS channel bandwidth.

2.2 Operational requirements

The WAS should be able to perform channel availability check: A check during which the WAS listens on a particular radio channel for 60 s to identify whether there is a radar operating on that radio channel.

The WAS should be able to perform in-service monitoring: Monitoring of the operating channel to check that a co-channel radar has not moved or started operation within range of the WAS. During in-service monitoring the radar detection function continuously searches for radar signals in-between normal WAS transmissions. This requires the use of quiet spaces between successive WAS transmissions (see Annex 4).

If the WAS has not previously been in operation or has not continuously monitored the channel with in-service monitoring, it should not start transmission in any channel before completion of a channel availability check.

2.3 Response requirements

A channel that has been flagged as containing a radar signal, either by a channel availability check or in-service monitoring, is subject to a 30 min period (non-occupancy period) where it cannot be used by the WAS device in order to protect scanning radars. The non-occupancy period should start at the time when the radar signal is detected.

Additionally, in the band 5 600-5 650 MHz, if a channel has been flagged as containing a radar, a 10 min continuous monitoring of the flagged channel is required prior to use of that channel. Otherwise, other appropriate methods such as channel exclusion would be required.

Channel move time is defined as the period of 10 s needed by a WAS to cease all transmissions on the operating channel upon detection of an interfering signal above the DFS detection threshold. Transmissions during this period will consist of normal traffic for typically less than 100 ms and a maximum of 200 ms after detection of the radar signal. In addition, intermittent management and control signals can be sent during the remaining time to facilitate vacating the operating channel.

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[3] In practice, it may not be necessary for each device to implement full DFS functionality, provided that such devices are only able to transmit under the control of a device that ensures that all DFS requirements are fulfilled.

The aggregate time of the intermittent management and control signals are typically less than 20 ms.

2.4 Summary of the requirements

Table 1 provides a summary of the requirements described above. An example of the operating procedures is given in Annex 2.

TABLE 1

Parameter	Value
DFS detection threshold	–62 dBm for devices with a maximum e.i.r.p. of < 200 mW and –64 dBm for devices with a maximum e.i.r.p. of 200 mW to 1 W averaged over 1 μs
Channel availability check time	60 s
Non-occupancy period	30 min
Channel move time	≤ 10 s

Annex 2

Radar detection and example of associated DFS procedures

An example of how a DFS mechanism could be described is given in this Annex.

1 Definitions

The following definitions are given for use within this Annex:

Available channel: A radio channel on which a channel availability check has not identified the presence of a radar.

Received radar signal: A signal as characterized below:

– an RSS equal to or greater than the DFS detection threshold level of T_{DFS} (dBm) within the WAS channel bandwidth;

– pulse repetition rates in the range 200-4 000 pulses/s;

– nominal pulse widths in the range 1-20 μs.

Operating channel: Once a WAS starts to operate on an available channel then that channel becomes the operating channel.

2 Procedures

2.1 Finding an initial available channel

Before a WAS transmits, and if no available channel has yet been identified, it shall undertake a channel availability check on a radio channel before it is used for transmission. Consequently, when a network is installed and first powered on, channel availability check(s) should be undertaken, so as to identify at least one available channel. Having identified an available channel, the WAS can start operation on that channel; the checking of other radio channels to identify other available channels is optional.

2.2 Starting operation

Once a WAS starts to operate on an available channel then that channel becomes the operating channel.

2.3 Monitoring the operating channel

In-service monitoring is performed by the WAS to re-check the operating channel for co-channel radar signals that may have come within range of the WAS or started operation on the operating channel.

3 Implementation aspects

3.1 Radar signal detection

Radar signals may occur at any time and they may occur in the presence of co-channel WAS signals.

While finding an initial available channel, the WAS will not be operational and this will assure rapid and reliable detection of any radar signal with the possible exception of very slowly rotating radars. However, these will be detected by the in-service monitoring.

During in-service monitoring the radar detection function continuously searches for radar signal patterns – during or in between normal WAS transmissions. For weakly received radar signals, this may increase the time needed for radar signal detection. This is reflected in the requirements contained in Annex 1.

3.1.1 Detection of frequency hopping radars

Frequency hopping radars operate over a large frequency range, with a rapid change of the operating frequency.

The time required by a WAS for reliable detection varies with the pulse characteristics of the radar. In the case of frequency hopping radars, the time for which the radar occupies the WAS channel (dwell time) also influences the detection probability.

The results will be one of the following:

– if the dwell time is long enough, DFS detects the radar signal (see Annex 4) and WAS transmissions will cease on the current channel;

– if the dwell time is very short, the probability of detection of the radar by a WAS on the operating channel may be affected, depending on the number of pulses during the dwell time.

3.1.2 Threshold and antenna gain

The detection threshold is defined in terms of dBm normalized to the output of a 0 dBi receive antenna. If the WAS uses higher antenna gains, the T_{DFS} level should be increased, by adding the antenna gain.

3.1.3 Spurious emissions

Further study is required to determine the impact on the interaction between WAS and radars spurious emissions.

3.2 Channel move time

Upon detection of a signal above the detection threshold, the DFS procedures require the broadcasting of commands to cease all operational transmission and to effect a move to (one of) the available channels identified by the channel availability check. This broadcast will be repeated a number of times to assure reception by all member devices. Part of the WAS population may be in so-called "Sleep Mode" in which the devices re-awaken at intervals of typically hundreds of milliseconds but extremes of up to 60 s are possible. Disregarding the latter, the broadcast has to be repeated a number of times during the channel move time to ensure that, for all practical purposes, all of the WAS devices will have left the channel.

Annex 3

Use of characteristics of radiolocation, maritime radionavigation and meteorological radars

The technical characteristics of some meteorological, radiolocation and maritime radionavigation radars operating in the bands between 5 250-5 350 MHz and 5 470-5 725 MHz can be found in Recommendation ITU-R M.1638. This information is used for the determination of the technical requirements of the DFS mechanism to be implemented in the WAS, which is identified as necessary to enable the introduction of WAS in the mobile service in these frequency bands used by radars. Specifically radars A through S provided in Recommendation ITU-R M.1638 are considered in development of DFS characteristics.

Table 1 of Recommendation ITU-R M.1638 shows the allocations within the 5 GHz range to the radiodetermination service.

Annex 4

Parameters and methodology to calculate the probability of detection of radiodetermination systems by WAS including RLAN devices using DFS in the 5 GHz band during in-service monitoring

The following methodology considers the probability that a WAS device operating in the 5 GHz band using DFS will successfully detect during in-service monitoring a 5 GHz radar operating in the radiodetermination service.

Step 1: Determine the amount of time that an individual device will be in the main beam of the radar antenna (i.e., 3 dB beamwidth/antenna scan rate). Table 2 identifies the radar parameters to be used as a baseline in the study. Analysis time is the period during which the WAS is exposed to the main beam of the radar in one sweep based on the radar antenna pattern and scanned rate.

TABLE 2

Radar	C	K	P	S
3 dB beamwidth (degrees)	0.95	2.5	2.6	2
Scan rate (degrees/s)	36	Not applicable	72	20
Analysis time (ms)	26	100	36	100

Step 2: Radars C, K, P and S represent the more stringent cases and can be utilized to define sharing with all the radars shown in the radar characteristics document. Radar K does not utilize a 360º scan type of function.

Step 3: Based on a distribution of WAS devices using data rate and packet length distributions as shown in Table 3, create a waveform to represent WAS transmit time, and listening periods in length $(x) \cdot 9 + 50$ ms, where x is a random integer between 2 and 32 (i.e., 31 discrete possible durations, uniformly distributed).

TABLE 3

Weighting of RLAN transmit time

Packet size (bytes)	**Weight**
64	0.6
538	0.2
1 500	0.2

Data rate (Mbit/s)	**Weight**
6	0.1
12	0.1
18	0.1
24	0.3
36	0.3
54	0.1

The WAS transmit waveform for each instance of a WAS packet transmission is created by randomly choosing a packet transmission, using weights shown in Table 3 for the packet size and transmission data rate, then calculating the transmission time as "Packet size"/(Data rate · 8). Each packet is followed by a quiet period that is required by the WAS network to facilitate sharing of the access medium (i.e., the WAS channel) by the multiple devices using the network. This quiet period is available for in-service monitoring. The quiet period is chosen as defined above. Another random chosen packet is then created in the same manner as the first, with another quiet period following. This is repeated until the waveform has the same duration as that of a WAS device in the main beam of the antenna, as calculated in Step 1.

Step 4: Create a waveform based on the pulse repetition rate (PRR) and pulse width of the radar being analysed. The values to be used for the baseline are shown in Table 4. The waveform should be of the same duration as calculated in Step 1.

TABLE 4

Baseline radar values for determining probability of detection

Radar	C	K	P	S
Pulse width (μs)	0.95	1	20	1
PRR (pps)	200	3 000	500	200

Step 5: Determine if a detection event occurs by determining if radar pulses in the simulated radar waveform align with the listen periods in the simulated WAS network waveform.

Step 6: Repeat the simulation multiple times, recording the occurrence, or lack of occurrence of detection events, using this data to calculate the probability of detection (i.e., percentage of simulations during which the radar pulse is considered to be detected).

Step 7: Probability of detection in n rotations:

p: probability of detection in one rotation

p_n: probability of detection in n rotations

$$p_n = 1 - (1 - p)n.$$

Annex 5

Interference assessment using link budget calculations involving a single WAS device and radiodetermination systems in the 5 GHz band

1 Background

This Annex addresses the case of interference from a single WAS. The values derived from the calculations in this Annex were used as starting values in the aggregate modelling (see Annex 6) for determination of a detection threshold.

2 Methodology

The calculations presented in this Annex are based on link budget analysis. The threshold is determined from a link budget analysis, assuming that this threshold must be reached when the radar can be interfered with by emissions of a single WAS device (i.e., when the WAS signal at the radar receiver exceeds the radar tolerable interference level). This is based on the assumption of a symmetrical propagation path between the path and the radar.

This method based on link budget is considered appropriate to study static cases which involve one WAS and one radar. It is based on Recommendations ITU-R SM.337 and ITU-R M.1461 and applied in the specific case of DFS.

3 Calculation based on link budget with radars from Recommendation ITU-R M.1638

The determination of the maximum tolerable interference level from emissions of a single WAS device at the radar receiver is based on Recommendation ITU-R M.1461, where it is said that this level should be lower than $N + (I/N)$ where N is the radar receiver inherent noise level and I/N the interference to noise ratio (taken as –6 dB as given in Recommendations ITU-R M.1461 and ITU-R M.1638).

A calculation table is given in Appendix 1 to this Annex. From that Table, if we ignore radar J, under these conditions, the necessary detection threshold is equal to –52 dBm to protect radars from a single WAS.

4 Calculation based on link budget for some new radars

In addition to the radars described in Recommendation ITU-R M.1638, two new ground radars have been recently deployed by some administrations in Region 1. Some parameters have been made available to perform link budget calculations. These are given in Appendix 2 to this Annex.

From the calculations, it appears that the necessary detection threshold is equal to –62 dBm to ensure non-interference to the considered radars from a single 1 W WAS device.

5 Possibility of a variable detection threshold

In this Annex, the calculations assume a single outdoor WAS with 1 W e.i.r.p., which constitutes a worst-case single interferer analysis. It has been expressed that 1 W e.i.r.p. WAS will not represent the majority of the deployed WAS.

Consequently, the idea of a variable detection threshold value which will vary with the WAS e.i.r.p. level may be introduced. According to the methodology used in this Annex, the detection threshold is proportional to the WAS e.i.r.p.

According to the methodology used in this Annex for scenarios related to a single WAS device, the detection threshold is proportional to the WAS e.i.r.p.

Under these conditions, for example, if a 1 W WAS must detect radar above $-N$ dBm, for a 200 mW WAS, the corresponding threshold can be set up at $-(N - 7)$ dBm.

6 Influence of the WAS architecture on the detection threshold

In the case of a centralized WAS architecture, it may be expected that the DFS will be controlled by one specific device within a network or a cell. There might be circumstances where significant propagation path loss differences occur between a radar and the devices within a network or a cell and the assumption of a symmetrical propagation path between the radar and the detection device is not valid.

Measures should be considered by administrations to ensure that each WAS device within a single network will not interfere with radars.

Appendix 1
to Annex 5

Calculation of detection threshold based on link budget for the radars of Recommendation ITU-R M.1638

	Characteristics	A	C	E	F	G	H 1	H 2	I1	I1	J	K	L	M	N	O	P	Q
RADAR	Function	Meteo	Meteo	Meteo	Meteo	Meteo	Meteo	Meteo	Meteo	Meteo	Meteo	Instrumen-tation	Instrumen-tation	Instrumen-tation	Instrumen-tation	Instrumen-tation	Surface and air search	Surface and air search
	Platform type	Ground/ship	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ship	Ship
	Tx power into antenna peak (kW)	250	250	250	250	250	250	250	250	250	2.25	250	2 800	1 200	1 000	165	360	285
	Receiver $IF_{3\ dB}$ bandwidth (MHz)	0.5	20	0.91	0.6	0.5	0.7	4	0.1	3	10	1	4.8	4	8	8	1.5	10
	Antenna polarization	V	H	H	H	H	H	H	H	H	H	V/left-hand circular	V/left-hand circular	V/left-hand circular	V/left-hand circular	V/left-hand circular	H	H
	Antenna main beam gain (dBi)	39	44	50	40	40	50	50	50	50	35	38.3	54	47	45.9	42	28	30
	Antenna height (m)	30	10	30	30	30	30	30	30	30	10							
	e.i.r.p. radar (dBm)	123.0	128.0	134.0	124.0	124.0	134.0	134.0	134.0	134.0	98.5	122.3	148.5	137.8	135.9	124.2	113.6	114.5
	Receiver noise figure (dB)	7	4	2.3	3	3	3.5	3.5	1.5	1.5	3	6	5	5	11	5	5	10
	$N = k\,T\,B\,F$ (dBm)	–110.0	–97.0	–112.1	–113.2	–114.0	–112.0	–104.5	–122.5	–107.7	–101.0	–108.0	–102.2	–103.0	–93.9	–99.9	–107.2	–94.0
	N – 6 dB	–116.0	–103.0	–118.1	–119.2	–120.0	–118.0	–110.5	–128.5	–113.7	–107.0	–114.0	–108.2	–109.0	–99.9	–105.9	–113.2	–100.0
WAS	e.i.r.p. (dBm) outdoor	30																
	TPC (dB)	0																
	Bandwidth (MHz)	18																
	Antenna gain (omni) (dBi)	0																
	10 log (Brad/BWAS)	–15.6	0.5	–13.0	–14.8	–15.6	–14.1	–6.5	–22.6	–7.8	–2.6	–12.6	–5.7	–6.5	–3.5	–3.5	–10.8	–2.6
		185.0	177.0	198.1	189.2	190.0	198.0	190.5	208.5	193.7	172.0	182.3	192.2	186.0	175.8	177.9	171.2	160.0
	Link budget for WAS signal received at radar receiver N – 6 dB	169.4	177.0	185.1	174.4	174.4	183.9	183.9	185.9	185.9	169.4	169.7	186.4	179.4	172.3	174.4	160.4	157.4
	Necessary detection threshold	–46.4	–49.0	–51.1	–50.4	–50.4	–49.9	–49.9	–51.9	–51.9	–70.9	–47.4	–38.0	–41.6	–36.4	–50.2	–46.9	–42.9

Appendix 2
to Annex 5

Calculation of detection threshold based on link budget for new radar deployed by some administrations in Region 1

RADAR	Function	Air search
	Platform type	Ground/vehicle
	Tx power into antenna peak (kW)	15
	Receiver $IF_{3\ dB}$ bandwidth (MHz)	4
	Antenna polarization	V
	Antenna main beam gain (dBi)	35
	Antenna height (m)	10
	e.i.r.p. (dBm)	106.8
	Receiver noise figure (dB)	5
	$N = k\ T\ B\ F$ (dBm)	–103
	N – 6 dB	–109
WAS	e.i.r.p. (dBm) outdoor	30
	TPC (dB)	0
	Bandwidth (MHz)	18
	Antenna gain (omni) (dBi)	0

10 log (Brad/BWAS)	–6.5
Propagation loss for WAS signal received at the radar receiver N – 6 dB (dB)	175.0
	168.4
Necessary detection threshold (dBm)	–61.7

It is noted that this Table assumes a single 1 W e.i.r.p. WAS, which may be the highest power value in a statistical distribution of the e.i.r.p. in a deployment of WAS (e.g., as described in Table 6 of Annex 6). For example, consideration of a lower e.i.r.p. (< 100 mW) will lead to a corresponding increase by 10 dB of T_{DFS}.

Annex 6

Parameters and methodology for conducting aggregate interference studies involving WAS including RLANs and radiodetermination systems in the 5 GHz band

The following considerations should be utilized to define the baseline scenario for studies to be conducted in determining DFS parameters:

– Recommendation ITU-R M.1461 was utilized in interference calculations.

– The radar antenna pattern contained in Appendix 1 to this Annex was utilized.

– The WAS antenna pattern contained in Appendix 2 to this Annex was utilized.

– The probability of detection (see Annex 4) was utilized in the sharing studies to determine the aggregate interference into radars. This probability was set for each step interval.

– A step interval of 1° was utilized.

– Three concentric rings were utilized to define the WAS deployment as shown in Table 5. Uniform distribution of devices in each zone should be utilized throughout each volumetric zone including height.

TABLE 5

WAS user distribution

	Urban zone	**Suburban zone**	**Rural zone**
Radius from the centre (km)	0-4	4-12	12-25
WAS user (%)	60	30	10
Building height (m)	30	6	6

– A total of 2 753 WAS devices operating on a co-channel basis with a radiodetermination system at a given moment was utilized.

– WAS power distribution in Table 6 was utilized.

TABLE 6

WAS power distribution

Power level	1 W	200 mW	100 mW	50 mW
WAS users (%)	5	25	40	30

– Tracking radars were modelled starting with random placement and a random start angle and then moving directly overhead to the opposite horizon.

– Maritime radars were modelled starting at the horizon of the rural area and tracked into the centre of the urban zone.

– Airborne radars were modelled starting at the horizon of the rural area and tracked over the centre of the urban zone.

– The studies focused on the following radars:

C, I, K, P and S as defined in Recommendation ITU-R M.1638.

– For ground-based radars a random propagation factor was utilized in determining the propagation path loss to each WAS device. A value from 20 to 35 log *D* was used. In addition a random building/terrain propagation attenuation was used. A value from 0 to 20 dB was used. A uniform distribution was applied in determining these values.

– For airborne radars, free space loss +17 dB was used.

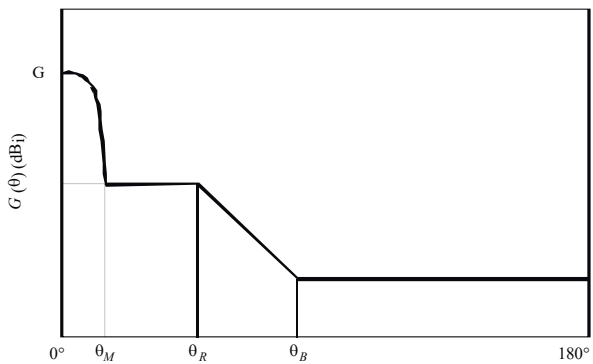
– For maritime radars, free space loss +0 to 20 dB was used.

– A smooth Earth line-of-sight calculation was utilized. Any WAS devices beyond the line-of-sight were discounted.

Appendix 1
to Annex 6

There are no existing radar antenna reference patterns currently in ITU, therefore the following is provided as a baseline. A statistical gain antenna model is used to determine the radar antenna gain in the azimuth and elevation orientations. The model gives the antenna gain as a function of off-axis angle (θ) for a given main beam antenna gain (*G*). The model includes separate algorithms for very high-gain, high-gain, and medium-gain antennas, corresponding to antennas with gains greater than 48 dBi, gains between 22 and 48 dBi, and gains between 10 and 22 dBi, respectively. Figure 1 illustrates the general form of the antenna gain distribution. The equations for the angles θ_M (first side-lobe shelf), θ_R (near side-lobe region), and θ_B (far side-lobe region) are given in Table 7. The antenna gains as a function of off-axis angle, are given in Table 8 for very high-gain antennas, in Table 9 for high-gain antennas, and in Table 10 for medium-gain antennas. The angle θ is in degrees and all gain values are given in terms of decibels relative to an isotropic antenna (dBi).

FIGURE 1



M.1652-01

TABLE 7

Angle definitions

Very high-gain (G > 48 dBi)	**High-gain (22 < G < 48 dBi)**	**Medium-gain (10 < G < 22 dBi)**
$\theta_M = 50\ (0.25\ G + 7)^{0.5}/10^{G/20}$ $\theta_R = 27.466\ 10^{-0.3G/10}$ $\theta_B = 48$	$\theta_M = 50\ (0.25\ G + 7)^{0.5}/10^{G/20}$ $\theta_R = 250/10^{G/20}$ $\theta_B = 48$	$\theta_M = 50\ (0.25\ G + 7)^{0.5}/10^{G/20}$ $\theta_R = 250/10^{G/20}$ $\theta_B = 131.8257\ 10^{-G/50}$

TABLE 8

Equations for very high-gain antennas (G > 48 dBi)

Angular interval (degrees)	**Gain (dBi)**
0 to θ_M	$G - 4 \times 10^{-4}\ (10^{G/10})\ \theta^2$
θ_M to θ_R	$0.75\ G - 7$
θ_R to θ_B	$29 - 25 \log (\theta)$
θ_B to 180	–13

TABLE 9

Equations for high-gain antennas (22 < G < 48 dBi)

Angular interval (degrees)	**Gain (dBi)**
0 to θ_M	$G - 4 \times 10^{-4}\ (10^{G/10})\ \theta^2$
θ_M to θ_R	$0.75\ G - 7$
θ_R to θ_B	$53 - (G/2) - 25 \log (\theta)$
θ_B to 180	$11 - G/2$

TABLE 10

Equations for medium-gain antennas (10 < G < 22 dBi)

Angular interval (degrees)	**Gain (dBi)**
0 to θ_M	$G - 4 \times 10^{-4}\ (10^{G/10})\ \theta^2$
θ_M to θ_R	$0.75\ G - 7$
θ_R to θ_B	$53 - (G/2) - 25 \log (\theta)$
θ_B to 180	0

Appendix 2
to Annex 6

WAS antenna patterns

The WAS antenna pattern in the azimuth orientations is omnidirectional. The WAS antenna pattern in elevation orientations was determined by examination of WAS antenna patterns. The pattern used is described in Table 11. Note that use of directional WAS antennas, given the same e.i.r.p., may result in less interference to the radiodetermination receiver, but could result in significantly higher interference levels to the WAS receiver if main beam-to-main beam coupling were to occur.

TABLE 11

WAS elevation antenna pattern

Elevation angle, φ (degrees)	**Gain (dBi)**
$45 < \varphi \leq 90$	–4
$35 < \varphi \leq 45$	–3
$0 < \varphi \leq 35$	0
$-15 < \varphi \leq 0$	–1
$-30 < \varphi \leq -15$	–4
$-60 < \varphi \leq -30$	–6
$-90 < \varphi \leq -60$	–5

In order for most devices to radiate with 1 W e.i.r.p. an antenna gain of 6 dBi will typically be required. For this pattern the following description is given in accordance with Recommendation ITU-R F.1336:

$$G(\theta) = \max\left[G_1(\theta), G_2(\theta)\right]$$

$$G_1(\theta) = G_0 - 12\left(\frac{\theta}{\theta_3}\right)^2$$

$$G_2(\theta) = G_0 - 12 + 10\log\left[\left(\max\left\{\frac{|\theta|}{\theta_3}, 1\right\}\right)^{-1.5} + k\right]$$

$$\theta_3 = 107.6 \times 10^{-0.1G_0}$$

where:

$G(\theta)$: antenna gain (dBi)

θ: elevation angle (degrees)

k = 0.5

G_0 = 6 dBi.

Annex 7

Interference assessment results analysis and recommendation on DFS threshold values

A summary of the results of simulations using the methodologies detailed in Annexes 5 and 6, for simulating respectively static interference from one WAS device and aggregate interference from a deployment of WAS into a victim radar receiver, is presented for the relevant 5 GHz radars.

Table 12 shows the values derived from the calculations in Annex 5 for the case of interference from a single WAS.

TABLE 12

Values derived from the calculations in Annex 5

Radar per Annex 5	Link budget analysis per Annex 5	–62 dBm for 1 W device
		–55 dBm for 0.2 W device
		–52 dBm for 0.1 W device

Table 13 shows a summary of required protection threshold levels resulting from the aggregate interference modelling calculations.

TABLE 13

Required protection threshold levels

Radar type	**Simulation scenario**	**DFS threshold for protection (T_{DFS}) (Note 1)**
Rotating radars A, C, E, F, G, H, I, J Radars P and Q	Standard per Annex 6	–52 dBm and operational considerations utilized by radar systems
Radar I	Annex 6 but radar antenna height between 500 and 1 000 m	–62 dBm
Radar S	Standard per Annex 6	See Note 2
Radar K	Standard per Annex 6	–67 dBm
	Annex 6 but half population density	–64 dBm
	Annex 6 but all devices 50 mW	–62 dBm

NOTE 1 – Assuming a receive antenna gain normalized to 0 dBi for WAS.

NOTE 2 – The sharing situation between this radar and WAS is extremely difficult. Initial calculations based on the baseline results show that a required DFS detection threshold of values below the operating noise floor of WAS devices would be required. Based on discussions, it was found that these systems were limited to military aircraft only. It was agreed to not consider this case when developing a detection threshold requirement.

Notes on parameters and methodologies used

The impact of the parameters and methodology variations can be summarized as follows:

a) A reduction in active device density by half results in a 3 dB increase in T_{DFS}. Similarly, doubling the active device density results in a 3 dB decrease in T_{DFS}.

b) The transmit power of a single interferer in the link budget calculation has a direct dB for dB impact on the required protection threshold. In the aggregate analysis, the impact depends on the distribution of power levels used in the simulation.

c) In most cases the interaction of variables in the aggregate modelling is not intuitive and therefore simple conclusions cannot be drawn from changes in a single variable.

RECOMMENDATION ITU-R M.1827-1

Guideline on technical and operational requirements for stations of the aeronautical mobile (R) service limited to surface application at airports in the frequency band 5 091-5 150 MHz

(2007-2015)

Scope

This Recommendation provides technical and operational requirements for stations of the aeronautical mobile (route) service (AM(R)S) limited to surface applications at airports in the frequency band 5 091-5 150 MHz that should be used by administrations as a technical guideline for establishing conformance requirements for stations for worldwide use.

Keywords

AM(R)S, FSS, airport, conformance.

Abbreviations/Glossary

AM(R)S	Aeronautical mobile (route) service
ARNS	Aeronautical radionavigation service
FSS	Fixed satellite service

The ITU Radiocommunication Assembly,

considering

a) that the aeronautical stations will operate on a national, regional and international basis around the world;

b) that circulation of aeronautical stations is usually a subject of a number of national and international rules and regulations including satisfactory conformance to a mutually agreed technical standard and operational requirements of the International Civil Aviation Organisation;

c) that there is a need for identifying the technical and operational requirements for the conformance testing of the aeronautical stations;

d) that the identification of technical and operational requirements for aeronautical stations would provide a common technical basis for facilitating conformance testing of aeronautical stations by various national, regional and international authorities and the development of mutual recognition arrangements for conformance of aeronautical stations;

e) that the technical and operational requirements need to achieve an acceptable balance between radiocommunication equipment complexity and the need for effective use of the radio-frequency spectrum,

considering also

a) that there is a requirement to fully protect all primary services in the band 5 091-5 150 MHz;

b) that results of the studies conducted in accordance with Resolution **414 (Rev.WRC-03)** showed the feasibility of using the frequency band 5 091-5 150 MHz by the AM(R)S limited to surface application at airports on a primary basis under certain conditions;

c) that the identification by ITU-R of technical and operational requirements for aeronautical stations operating in the frequency band 5 091-5 150 MHz should prevent unacceptable interference to other services;

d) that technical and operational characteristics should be continuously and accurately measurable and controllable,

recognizing

a) that the frequency band 5 000-5 250 MHz is allocated to the aeronautical radionavigation service (ARNS) on a primary basis;

b) that the frequency band 5 030-5 150 MHz is to be used for the operation of the international standard microwave landing system for precision approach and landing. The frequency band 5 091-5 150 MHz is also used in the FSS for feeder links for non-geostationary mobile-satellite service systems. The requirements of the international standard microwave landing system shall take precedence over other uses of the band 5 030-5 091 MHz in accordance with No. **5.444** of the Radio Regulations,

recommends

1 that the technical and operational requirements for stations of AM(R)S limited to surface application at airports in the frequency band 5 091-5 150 MHz given in Annex 1 should be used by administrations as a guideline for ensuring compatibility with the fixed satellite service (FSS).

2 the following Note is considered as part of this Recommendation.

NOTE – Due to the fact that other limits may also be acceptable and that all essential requirements are not covered by this Recommendation, further study is required, in particular with respect to the flexible apportionment of $\Delta T_s/T_s$ approach used in this Recommendation

Annex 1

Essential requirements related to compatibility with fixed satellite service networks in the frequency band 5 091-5 150 MHz

For the analyses that follow, Table 1 summarizes the assumed FSS receiver characteristics.

TABLE 1

Parameter values used in satellite interference calculations

Parameter	Units	HIBLEO-4 FL
Satellite receiver noise temperature T	K	550
Antenna effective area at 5 120 MHz	dB(m^2)	–35.6
Polarization discrimination L_p	dB	1
Feed loss L_{feed}	dB	2.9
Satellite receiver bandwidth B	MHz	1.23
Satellite receive antenna gain G_r	dBi	4

NOTE – The compliance with the pfds defined below would be obtained under free-space propagation conditions.

Requirements on the aeronautical mobile (route) service

The requirements that follow represent technical guidelines to be used by administrations for establishing conformance requirements for stations for worldwide use. Other limits may also be acceptable, however further study is required.

The pfd defined in this section is based on ensuring that the increase in noise temperature of the FSS satellite due to operation in the frequency band 5 091-5 150 MHz of the AM(R)S (i.e. $(\Delta T_s/T_s)_{AM(R)S}$) does not exceed the greater of the following two values:

1) 2%

2) $5\% - (\Delta T_s/T_s)_{ARNS}$

where:

$(\Delta T_s/T_s)_{ARNS}$: is the increase in noise temperature due to the ARNS in the same band.

Three examples of this calculation are provided below. The first assumes that the $(\Delta T_s/T_s)_{ARNS}$ is 3%. The second assumes that no ARNS is present in the band. The third assumes that $(\Delta T_s/T_s)_{ARNS}$ is >3%. The methodology assumes 250[2] co-channel AM(R)S transmitters operating concurrently within the field of view of the FSS satellite.

Example 1: $(\Delta T_s/T_s)_{ARNS} = 3\%$

In this case, $5\% - (\Delta T_s/T_s)_{ARNS}$ equals 2%, hence, $(\Delta T_s/T_s)_{AM(R)\,S} = 2\%$, i.e. –17 dB.

Assuming the Table 1 characteristics for the FSS, the maximum aggregate interference level tolerable at the receiver input is $I_{Agg\text{-}Rec}$:

$$I_{Agg-Rec} = KTB - 17\text{ dB} = -157.3\text{ dB(W/1.23 MHz)}$$

where:

K: Boltzmann's constant (1.38×10^{-23} J/K)

T: receiver noise temperature (K)

B: receiver bandwidth (Hz).

Therefore at the satellite receiver antenna input the maximum pfd level produced by one AM(R)S transmitter is:

$$\begin{aligned} pfd_{Max} &= I_{Agg-Rec} - Gr + L_{Feed} + L_P - 10\log_{10}(250) + 10\log\left(\frac{4\pi}{\lambda^2}\right) \\ &= -157.3 - 4 + 2.9 + 1 - 23.97 + 35.6 \\ &= -145.77\text{ dBW}/(\text{m}^2 \times 1.23\text{ MHz}) \end{aligned}$$

where:

Gr: FSS receiver antenna gain

250: maximum number of AM(R)S stations emitting simultaneously in the FSS receiver bandwidth.

Example 2: $(\Delta T_s/T_s)_{ARNS} = 0$

In this case, $5\% - (\Delta T_s/T_s)_{ARNS}$ equals 5%, which is greater than 2%, Hence, $(\Delta T_s/T_s)_{AM(R)S} = 5\%$, i.e. –13 dB.

Hence:

$$I_{Agg-Rec} = KTB - 13 \text{ dB} = -153.3 \text{ dB(W/1.23 MHz)}$$

Therefore at the satellite receiver antenna input the maximum pfd level produced by one AMRS transmitter is:

$$pfd_{Max} = I_{Agg-Rec} - Gr + L_{Feed} + L_P - 10 \log_{10}(250) + 10 \log\left(\frac{4\pi}{\lambda^2}\right)$$

$$= -153.3 - 4 + 2.9 + 1 - 23.97 + 35.6$$

$$= -141.77 \text{ dBW/(m}^2 \times 1.23 \text{ MHz)}$$

Example 3: $(\Delta T_s/T_s)_{ARNS} > 3\%$

In this case, 5% – $(\Delta T_s/T_s)_{ARNS}$ is smaller than 2%, Hence, $(\Delta T_s/T_s)_{AM(R)S}$ = 2%, i.e. –17 dB, as in Example 1, and the same pfd_{Max} value is obtained as in Example 1.

RECOMMENDATION ITU-R M.2013-0

Technical characteristics of, and protection criteria for non-ICAO aeronautical radionavigation systems, operating around 1 GHz

(2012)

Scope

This Recommendation describes the technical characteristics of, and protection criteria for, non-International Civil Aviation Organisation (ICAO) aeronautical radionavigation service (ARNS) systems operating around 1 GHz for use in compatibility studies. It concerns with non-ICAO ARNS systems operating in countries referred to in RR No. **5.312** and TACAN systems.

The ITU Radiocommunication Assembly,

considering

a) that the tactical air navigation system (TACAN) is an aeronautical radionavigation system used on a national basis and operates in the frequency band 960-1 215 MHz;

b) that the TACAN system is used by both civil and state aircraft;

c) that when used by civil aviation, TACAN functionally is equivalent to the ICAO standardized distance measuring equipment (DME);

d) that the TACAN system provides additional functionality to that of DME, i.e. obtaining bearing information;

e) that this additional functionality results in technical characteristics that differ from those of DME and may require additional consideration in future compatibility studies,

f) that the use of TACAN also includes shipborne and air-to-air applications,

noting

a) that according to Resolution 417 (WRC-07) precedence must be given to the ARNS operating in the frequency band 960-1 164 MHz;

b) that ITU-R studies have shown that following the introduction of aeronautical mobile (route) service (AM(R)S) in the frequency band 960-1 164 MHz, more detailed site-specific compatibility studies between TACAN and AM(R)S systems need to be performed,

recommends

that for compatibility studies the characteristics and protection criteria in the annexes should be used.

Annex 1

Tactical air navigation system

TACAN is an aeronautical radionavigation system used on a national basis operating between 960 and 1 215 MHz. A TACAN system consists of an interrogator on-board an aircraft and a beacon which gives the replies. In most cases the TACAN beacons are fixed ground based installations but there are maritime mobile and aeronautical mobile beacons in use as well. Depending on the generated e.i.r.p. and design of the interrogator slant ranges up to 400 nm (740 km) can be achieved but in practice the range is limited to the maximum radio line-of-sight (RLOS). The aircraft unit transmits regular pulse pairs, so-called interrogation pulses which are received by ground based installations (beacons). The TACAN pulses have a pulse width of 3.5 μs at the 50% amplitude points. The spacing between the pulses of an interrogation pulse pair is 12 μs (X channel) or 36 μs (Y channel). After receiving an interrogator pulse pair a ground station will test the pulse shape and spacing. If these fall within the acceptance limits, it will respond by transmitting a reply after a fixed delay with a ±63 MHz frequency offset from the interrogation frequency depending on selected channel on pulse code. The beacon has a spacing between the reply pulses of 12 μs (X channel) and 30 μs (Y channel). After receipt of the reply, the interrogator will calculate the momentary slant range distance to the beacon from the time elapsed between transmitting interrogation and receiving reply pulse pairs.

The beacon will receive interrogations from many aircraft and therefore will send out many replies. Each interrogator creates a unique pattern by varying, within certain limits, the time between the pulse pairs to avoid generation of synchronic replies. By this principle each platform is able to recognize among all pulse pairs the replies that are initiated by its own interrogator.

For identification purposes, a TACAN beacon transmits a Morse ID code. The ID tone is used at the airborne interrogators to verify if the range readouts are provided by the correct beacon. Besides the pulse responses, proper reception of the ID tone is also an important condition for TACAN interrogators to properly function.

In addition to the range measurements TACAN also offers azimuth bearing information. The bearing information is provided by applying a modulation in the amplitude of the pulses transmitted by the ground beacon. This pulse amplitude modulation (PAM) is created using either a mechanically or electronically scanning beacon antenna. The variation in the azimuth pattern in the form of 15 Hz and 135 Hz antenna lobes at the maximum allowable modulation index of 55% will reduce the signal level of the reply pulses by up to 10.7 dB below the maximum e.i.r.p. level of pulses without PAM. In order for the interrogator to decode the orientation of the antenna pattern in reference to north from the PAM, an additional 900 pulse pairs, consisting of a north-reference-pulse-group (NRPG) and additional fine reference pulse groups (RPG) are transmitted by the beacon. In order to obtain accurate bearing information and be able to reply to at least 100 aircraft with 70% reply efficiency a constant number of at least 3 600 pulse pairs have to be transmitted.

The TACAN system is used for aeronautical navigation for both state aircraft as well as civil aviation. When used by civil aviation, the TACAN equipment is functionally equivalent to the ICAO standardized DME. TACAN characteristics are given in Table 1.

TABLE 1

Typical characteristics of TACAN stations

Purpose	**Units**	**Radio systems for air navigation (960-1 215 MHz)**				
Radio transmission direction		Earth-aircraft	Aircraft-Earth	Earth-aircraft maritime	Aircraft-Earth maritime	Aircraft –aircraft
Operating frequency range	(MHz)	962-1 213	1 025-1 150	962-977	1 025-1 088	1 025-1 151
Operation range (limited to RLOS)	(km)	up to 600	up to 600	up to 600	up to 600	up to 740
Transmitted information		Range and bearing response signals, Identification information	Range and bearing request signal	Range and bearing response signals, Identification	Range and bearing request signal	Range and bearing response signals, Identification
Transmitter characteristics						
Station name		Beacon	Interrogator	Beacon	Interrogator	Beacon
Height above the ground	(m)	3 (10 ft)	up to 18 288 (60 000 ft)	3 (10 ft)	up to 18 288 (60 000 ft)	up to 18 288 (60 000 ft)
Signal type		Pulsed	Pulsed	Pulsed	Pulsed	Pulsed
Channel spacing	(MHz)	1	1	1	1	1
Type of modulation		Pulse form and pulse pair spacing	Pulse form and pulse pair spacing	Pulse form and pulse pair spacing	Pulse form and pulse pair spacing	Pulse form and pulse pair spacing
Transmitter power (pulsed)	(dBW)	39 (max)	33 (max.)	39 (max)	33 (max)	33 (max)
Pulse length	(μs)	3.5 ± 0.5 (50% amplitude)	3.5 ± 0.5 (50% amplitude)	3.5 ± 0.5 (50% amplitude)	3.5 ± 0.5 (50% amplitude)	3.5 ± 0.5 (50% amplitude)
Typical duty factor	(%)	2.52	0.105	2.52	0.105	0.735
Antenna type		Circular array	Omnidirectional	Circular array	Omnidirectional	Circular array
Typical antenna gain	dBi	6	0	6	0	6

TABLE 1 *(end)*

Purpose	Units	Radio systems for air navigation (960-1 215 MHz)				
Receiver characteristics						
Receiving station		Aircraft station	Airport and en-route ground station	Aircraft stations	Maritime station	Aircraft station
Operating frequency range	(MHz)	962-1 213	1 025-1 150	962-977	1 025-1 088	1 025-1 151
Height above the ground	(m)	up to 20 880 (60 000 ft)	3 (10 ft)	up to 20 880 (60 000 ft)	3 (10 ft)	up to 20 880 (60 000 ft)
Receiver 3 dB bandwidth	(MHz)	2	2-4.5	2	2-4.5	2-4.5
Max/min antenna gain	(dBi)	5.4/0	9.1/4.1	5.4/0	9.1/4.1	5.4/0
Polarization		Vertical	Vertical	Vertical	Vertical	Vertical
Receiver sensitivity	(dBW)	−122	−122	−122	−122	−122
Maximum acceptable interference level based on received power	(dBW)	−129	−130	−129	−130	−129

NOTE – The protection ratios shown in Table 1 were obtained for non-pulsed signals. In case of pulsed signals it is required to carry out additional studies. In this respect signals with a pulse length of more than 50 µs are considered non-pulsed or continuous signals.

NOTE – The airborne antenna gain is taken from Recommendation ITU-R M.1642-1.

NOTE – Measurements on some TACAN devices showed that the TACAN sensitivity for the distance and angular measurements only differ by 3 dB for the TACAN interrogator receiver (−90 dBm for distance and −87 dBm for angular measurement).

There is a large installed base of TACAN equipment, both ground stations (beacons) as well as aircraft stations (interrogators), in various administrations. The actual technical characteristics of the various types of equipment vary. One important factor, that determines the interference effect, is the receiver selectivity curve. Figure 1 shows the receiver selectivity curves of five types of TACAN interrogator equipment. It can be seen that there is a great spread in the selectivity of the different TACAN type receivers. In the compatibility studies all TACAN type interrogators should be taken into account in order to guarantee sufficient protection of this aeronautical radionavigation service (ARNS) application including both range and azimuth determination functionality.

Figure 2 shows a receiver selectivity curve for a typical TACAN beacon. The TACAN beacon selectivity is worse than those of the TACAN interrogator receivers.

FIGURE 1

Airborne station (interrogator) receiver RF-selectivity curves

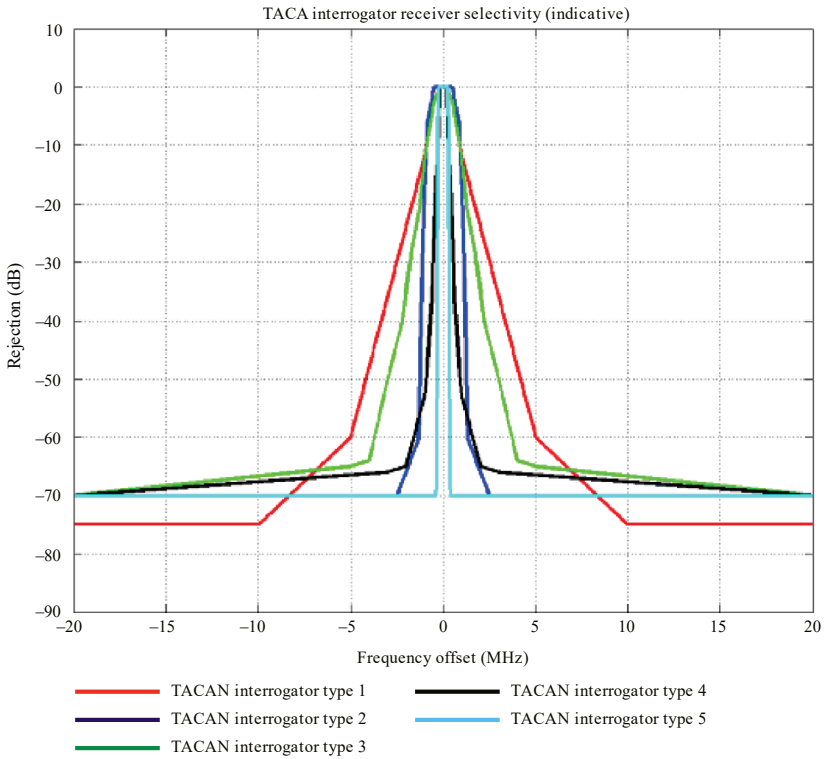


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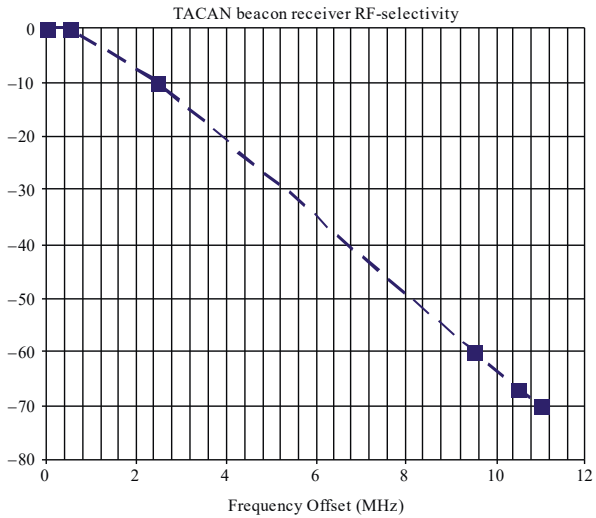
FIGURE 2

Ground station (beacon) receiver RF selectivity curves



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Annex 2

Non-ICAO aeronautical radionavigation ystems operating in countries referred to in RR No. 5.312

Specifically the countries referred to in RR No. **5.312** of the Radio Regulations operate the aeronautical radionavigation systems of the following three types:

– Type 1: the ARNS systems of the first type refer to direction-finding and ranging systems. The systems are designed for finding an azimuth and a slant range of an aircraft as well as for area surveillance and inter-aircraft navigation. They are composed of airborne and ground-based stations. The airborne stations generate requesting signals transmitted via omnidirectional antennae and received at ARNS ground stations which also operate in an omnidirectional mode. The ground stations generate and transmit response signals containing azimuth/ranging information. Those signals are received and decoded at the ARNS airborne stations. The first type stations transmit the signals requesting the azimuth/ranging data outside the 960-1 164 MHz frequency band. After receiving a requesting signal the ARNS ground stations use the 960-1 164 MHz frequency band only for transmitting the ranging data to be received at the ARNS airborne stations. Thus the ARNS systems of the first type use the 960-1 164 MHz frequency band only for transmitting the signals in the surface-to-air direction. The maximum operation range for

the first type ARNS systems is 400 km. It is expected that in some of the countries mentioned in RR No. 5.312 the usage of Type 1 of ARNS mentioned above may be discontinued.

– Type 2: the ARNS direction-finding and ranging systems of the second type are designed for the same missions as the first type ARNS systems. The primary difference of the second type stations refers to the fact that requesting signals are transmitted by the airborne stations in the same frequency band as responding signals transmitted from the ground stations. Moreover, the ground-based ARNS stations of the second type can operate in both directional and omnidirectional modes. Directional mode provides increased number of operational channels at the ARNS stations. The maximum operation range for the first type ARNS systems is 400 km. It is planned to use the overall frequency band 960-1 164 MHz allocated to the ARNS in order to increase flexibility of operation of the second type ARNS systems. Application of the wideband tuning filter on the ARNS receiver front end is the design peculiarity of the second type ARNS systems which is stipulated by the necessity to receive signals on several channels simultaneously. The 3 dB bandwidth of this filter is 22 MHz and it allows receiving simultaneously up to five channels among 30 overlapping channels of 4.3 MHz each. The simultaneous usage of wideband filter and correlator allows increase in the accuracy of aircraft position data measurement and *C*/*N* ratio at the receiver front end as well. Type 2 of the ARNS system can operate in a limited number of countries mentioned in RR No. 5.312.

– Type 3: the ARNS systems of the third type are designed for operating at the approach and landing stages of flight. The system provides control functions of heading, range and glide path at aircraft approach and landing. The ARNS ground stations of the third type operate in both directional and omnidirectional modes. Operation range of the third type ARNS systems does not exceed 60 km. The 960-1 164 MHz frequency band is used for operation of the channels designed for control of the glide path and range between airborne and ground ARNS stations. Type 3 of the ARNS system can operate in a limited number of countries mentioned in RR No. 5.312.

Table 2 provides a brief technical description of the ARNS stations.

Thus the stations of the non-ICAO systems operate using the air-to-surface and surface-to-air links are made up of ground and airborne receivers and transmitters.

TABLE 2

Typical characteristics of the ARNS stations operating in the countries referred to in RR No. 5.312

ARNS system characteristics	**Type 1**	**Type 2**		**Type 3**	
Purpose	**Radio systems of short-range navigation**	**Radio systems of short-range navigation**		**Radio systems of approach and landing**	
Operating frequency range	960-1 000.5	960-1 164			
Radioline direction (MHz)	"Earth-aircraft"	"Earth-aircraft"	"aircraft-Earth"	"Earth-aircraft"	"aircraft-Earth"
Operation range	up to 400	up to 400	up to 400	up to 45	up to 45
Transmitted information (km)	Transmission of azimuthal signals, range response signals and request to indication	Transmission of azimuthal signals, range response signals and request to indication	Transmission of range request signal and indication response signal	Transmission of signals in glide path and course channels and range response signals	Transmission of range request
Transmitter characteristics					
Station name	Airport and en-route path ground stations	Airport and en-route path ground stations	Aircraft station	Airport ground station	Aircraft station
Class of emission	700KPXX	4M30P1N	4M30P1D	700KP0X; 4M30P1N	700KP0X; 4M30P1N
Channel spacing (MHz)	0.7	0.7	0.7	0.7	2
Type of modulation	pulsed	pulsed	pulsed	pulsed	pulsed
Transmitter power (pulsed) (dBW)	20-45	29-39	27-33	3-30	5-33
Duty factor (%)	0.018; 0.066	0.064 - 0.3	0.00765	0.04; 0.025	0.009
Mean output Power (min/max) (dBW)	7.6/13.2	7.1/13.8	−8.2	−4/−6	−7.5
Pulse length (μs)	1.5; 5.5	1.25; 1.5; 5.5	1.5	1.7	1.7
Antenna type	Omnidirectional	array antenna	omnidirectional	array antenna	omnidirectional
Max/min antenna gain (dBi)	6/0	15.6	3/−10	10/0	1.5/−3
Height above the ground (m)	10	10	up to 12 000	10	up to 12 000

TABLE 2 *(end)*

ARNS system characteristics	**Type 1**	**Type 2**		**Type 3**	
Purpose	**Radio systems of short-range navigation**	**Radio systems of short-range navigation**		**Radio systems of approach and landing**	
Receiver characteristics					
Receiving station	Aircraft station	Aircraft station	Airport and en-route path ground stations	Aircraft station	Airport ground station
Height above the ground (m)	up to 12 000	up to 12 000	10	up to 12 000	10
Receiver 3 dB bandwidth (MHz)	1.5	22	22	7	7
Receiver noise temperature, K (K)	400	1 060	550	400	400
Max/min antenna gain (dBi)	1.5/−3	3/−10	14	1.5/−3	10/0
Polarization	horizontal	horizontal	horizontal	horizontal	horizontal
Receiver sensitivity (dBW)	−120	−118	−125	−110…−120	−113
Protection ratio *C*/*I* (dB)	25	17	20	25	25

NOTE – The protection ratios shown in Table 2 were obtained for non-pulsed signals. In case of pulsed signals it is required to carry out additional studies. In this respect signals with a pulse length of more than 50 μs are considered non-pulsed or continuous signals.

RECOMMENDATION ITU-R RS.2065-0

Protection of space research service space-to-Earth links in the 8 400-8 450 MHz and 8 450-8 500 MHz bands from unwanted emissions of synthetic aperture radars operating in the Earth exploration-satellite service (active) around 9 600 MHz

(2014)

Scope

This Recommendation provides mitigation techniques that can reduce the unwanted emissions of Earth exploration-satellite service (EESS) (active) systems in the space research service (SRS) band and recommends that EESS (active) systems fully protect the operations of SRS (deep space) missions during their critical events and prevent damages to the SRS earth station receivers at all times.

Keywords

Critical events, damages, deep space, earth stations, EESS (active), interference, mitigation, protection, criterion, receiver, SAR, saturation, space-to-Earth, space research service, SRS, synthetic aperture radar, unwanted emissions

Abbreviations/Glossary

EESS	Earth exploration satellite service
LFM	Linear FM (frequency modulation)
SAR	Synthetic aperture radar
SRS	Space research service
TR	Transmit and receive

Related ITU Recommendations, Reports

Recommendation ITU-R RS.2043	Characteristics of synthetic aperture radars operating in the Earth exploration-satellite service (active) around 9 600 MHz
Recommendation ITU-R SA.609	Protection criteria for radiocommunication links for manned and unmanned near-Earth research satellites
Recommendation ITU-R SA.1014	Telecommunication requirements for manned and unmanned deep-space research
Recommendation ITU-R SA.1157	Protection criteria for deep-space research
Recommendation ITU-R SM.1541	Unwanted emissions in the out-of-band domain
Report ITU-R RS.2308	Radio frequency compatibility of unwanted emissions from 9 GHz EESS synthetic aperture radars with the Earth exploration-satellite service (passive), space research service (passive), space research service and radio astronomy service operating in the frequency bands 8 400-8 500 MHz and 10.6-10.7 GHz, respectively

The ITU Radiocommunication Assembly,

considering

a) that the frequency band 9 300-9 800 MHz is allocated to EESS (active) on primary basis;

b) that the frequency band 9 800-9 900 MHz is allocated to EESS (active) on secondary basis;

c) that the frequency band 8 400-8 450 MHz is allocated to SRS (deep space) space-to-Earth links on primary basis;

d) that the frequency band 8 450-8 500 MHz is allocated to SRS on primary basis for space-to-Earth links;

e) that systems operating active radars in the frequency band 9 300-9 900 MHz use high power emissions in the space-to-Earth direction;

f) that SRS (deep space) earth stations operating in the frequency band 8 400-8 450 MHz as described in Recommendation ITU-R SA.1014, use extremely sensitive receivers;

g) that these SRS earth stations also support SRS missions such as Lagrange and lunar missions in the frequency band 8 450-8 500 MHz;

h) that protection criteria of the SRS (deep space) missions in the frequency band 8 400-8 450 MHz is given in Recommendation ITU-R SA.1157 and the protection criteria of the SRS missions in the 8 450-8 500 MHz band is given in Recommendation ITU-R SA.609;

i) that the unwanted emissions of EESS (active) operating in the frequency band 9 300-9 900 MHz may exceed the SRS (deep space) protection criterion in the 8 400-8 450 MHz band;

j) that the frequency band 8 400-8 450 MHz is used by nearly all SRS (deep space) missions for support of their routine and critical events and the frequency band 8 450-8 500 MHz is used by nearly all SRS Lagrange and lunar missions;

k) that SRS (deep space) critical events such as launch, orbit insertion, planetary fly-by, and entry-descend-landing, including sample return, often determine the success of deep space missions;

l) that interference during the SRS (deep space) missions' critical events can lead to the loss of critical data, or may even jeopardize the health and safety of a spacecraft;

m) that, during routine operations of the SRS (deep space) missions, unwanted emissions of EESS (active) exceeding the protection criterion of SRS (deep space) with a very small probability may be acceptable;

n) that unwanted emissions of EESS (active) may exceed the saturation levels and the damage levels of SRS earth station receivers described in Annex 1,

recommends

1 that EESS SAR systems should use the methods described in Annex 2 to reduce their unwanted emissions in the frequency band 8 400-8 500 MHz in order to:

a) avoid damaging the SRS earth station receivers at all times;

b) reduce the probability of saturating SRS earth station receivers;

c) avoid causing interference exceeding the protection criteria of the SRS (deep space) earth stations during critical events;

2 that, as a last resort, if *recommends* **1** cannot be satisfied fully by the application of the methods described in Annex 2, operators of EESS SAR systems should predict any remaining potential interference events and mitigate them by coordinating their operations with the operators of SRS missions at least seven days before an event for EESS SAR routine operations and at least 24 hours for EESS SAR acquisition of images in cases of emergency such as disaster management;

3 that in order to facilitate the use of some of the mitigation techniques as well as operational coordination, operators of EESS SAR and SRS systems should share the orbital and telecom characteristics of their respective operations, including the up-to-date trajectory of their missions, antenna pointing, and schedule of critical events;

4 that when applying *recommends* **1**, **2** and **3**, the damage and saturation levels of Table 1 of Annex 1 should apply;

5 that *recommends* **1**, **2**, **3** and **4** should only apply to the SRS earth stations listed in Recommendation ITU-R SA.1014.

Annex 1

Damage and saturation to front end of the SRS deep-space earth station receivers

The locations and characteristics of SRS deep-space receivers are described in Recommendation ITU-R SA.1014. The United States of America's civil space agency, the National Aeronautics and Space Administration (NASA), and the European Space Agency (ESA) have provided characteristics of saturation and potential damage levels to their deep-space earth station receivers. These levels are summarized in the Table A1-1 below.

TABLE A1-1

Saturation and damage levels of SRS (deep space) earth station receivers

Parameter	Unit	NASA	ESA
Frequency band	MHz	8 200-8 700	8 400-8 500
Saturation level	dBW	–115	–117
Damage level	dBW	–105	–107

These saturation and damage levels are measured directly at the input terminal of the receiver front ends. NASA's SRS deep-space earth station receivers are designed to also support NASA's solar system radar operating in the 8 500-8 700 MHz band, which is allocated to the radiolocation service.

SRS earth stations as described in Recommendation ITU-R SA.1014 are designed to also support SRS missions such as Lagrange missions and lunar missions in the 8 450-8 500 MHz band. These damage levels should not be exceeded at any time. The unwanted emission from the EESS (active) should be below the saturation level during the critical events of SRS deep-space missions. SRS earth stations that are not described in Recommendation ITU-R SA.1014 typically use different RF front-end technologies. They are typically less susceptible to saturation and damages from the unwanted emissions of EESS (active).

Annex 2

Mitigation techniques for reducing unwanted emissions in the SRS in the frequency bands 8 400-8 450 MHz and 8 450-8 500 MHz from the EESS (active) systems operating around 9 600 MHz

This Annex presents the computations of the theoretical unwanted emissions of EESS (active) systems around 9 600 MHz using the parameters for SAR-1, SAR-2 and SAR-3 from Recommendation ITU-R RS.2043. Several mitigation techniques to reduce the unwanted emissions of EESS (active) system in the 8 400-8 450 MHz SRS deep space band and in the 8 450-8 500 MHz SRS band are discussed.

1 Protection of SRS space-to-Earth links

Recommendation ITU-R SA.1157 gives the protection criterion of deep-space research earth stations as –221 dB(W/Hz) for the SRS frequency band 8 400-8 450 MHz. The calculation of non-line-of-sight interference due to trans-horizon propagation should be based on weather statistics that apply for 0.001% of the time. Recommendation ITU-R SA.1157 provides the protection criterion for receiver systems in SRS deep-space systems. Compliance to the protection criterion for these assets determines the mission success of SRS deep-space missions. Harmful interference during mission critical events, e.g. orbit insertions, planetary fly-bys, and entry-decent-and-landing (EDL) phases, can cause potential loss of a spacecraft or the loss of irreplaceable data. There are also critical events such as one-time scientific observations where a spacecraft penetrates the atmosphere of a planet or a moon, or it impacts a moon, a planet, an asteroid, or a comet. The spacecraft may be destroyed in the process. The data transmitted during the approach or the moments before and during the impacts define the success of the missions. Therefore, the protection of SRS deep space spacecraft and earth stations during mission critical events, to the extent demanded by Recommendation ITU-R SA.1157, is crucial for the success of SRS deep-space missions.

In addition, spacecraft emergencies for deep space systems should be considered as critical events.

Additionally, Recommendation ITU-R SA.609 gives the protection criterion of space research earth stations as –216 dB (W/Hz) for the SRS frequency band 8 450-8 500 MHz. The calculation of interference that may result from atmospheric and precipitation effects should be based on weather statistics for 0.1% of the time for unmanned missions such as Lagrange and lunar missions.

2 Characteristics of EESS (active) systems around 9 600 MHz

The 9 300-9 900 MHz band, typically identified by as the 9 600 MHz EESS (active) band, is used by SAR systems. Recommendation ITU-R RS.2043 provides the characteristics of three SAR systems operating in band.

TABLE A2-1

Characteristics of SAR-1, SAR-2 and SAR-3 systems

Parameter	SAR-1	SAR-2	SAR-3
Orbital altitude (km)	400	619	506
Orbital inclination (degrees)	57	98	98
RF centre frequency (GHz)	9.6	9.6	9.6
Peak radiated power (W)	1 500	5 000	25 000
Pulse modulation	Linear FM chirp	Linear FM chirp	Linear FM chirp
Chirp bandwidth (MHz)	10	400	450
Pulse duration (μs)	33.8	10-80	1-10
Pulse repetition rate (pps)	1 736	2 000-4 500	410-515
Duty cycle (%)	5.9	2.0-28.0	0.04-0.5
Range compression ratio	338	< 12 000	450-4 500
Antenna type	Slotted waveguide	Planar array	Planar phased array
Antenna peak gain (dBi)	44.0	44.0-46.0	39.5-42.5
e.i.r.p. (dBW)	75.8	83.0	83.5-88.5
Antenna orientation from Nadir	20° to 55°	34°	20° to 44°
Antenna beamwidth	5.5° (El) 0.14° (Az)	1.6-2.3° (El) 0.3° (Az)	1.1-2.3° (El) 1.15° (Az)
Antenna polarization	Linear vertical	Linear HH or VV	Linear horizontal/vertical
System noise temperature (K)	551	500	600

3 Unwanted emission of EESS (active) systems in the frequency range 8 400-8 500 MHz

The theoretical unwanted emission levels of the three SAR systems described in Table A2-1 in the frequency band 8 400-8 450 MHz are shown in Table A2-2. The linear FM (LFM) SAR systems are assumed to have 10-ns rise-time and 10-ns fall-time with trapezoidal waveforms. The pulse durations for SAR-2 and SAR-3 systems are 10 μs and 1 μs, respectively. The SRS deep space earth station antenna gain is 74 dBi.

TABLE A2-2

Unwanted emissions from SAR-1, SAR-2, and SAR-3 in the 8 400-8 450 MHz band

Parameter	SAR-1	SAR-2	SAR-3
e.i.r.p. (dBW)	76	83	86
Bandwidth (MHz)	10	400	450
Minimum slant range (km)	424	654	536
Space loss (dB)	–164	–167	–166
Rx antenna peak gain (dBi)	74	74	74
Polarization loss (dB)	–3	–3	–3
Spectral roll-off (dB)	–109	–86	–78
Rx interference PSD (dB(W/Hz))	–196	–185	–174
Deep-space protection criterion (dB(W/Hz))	–221	–221	–221
Exceedance of protection criterion (dB)	25	36	47

Table A2-2 shows that the unwanted emissions of SAR-1, SAR-2, and SAR-3 systems exceed the deep space protection criterion by 25-47 dB. The unwanted emissions from the SAR systems are computed based on theoretical roll-off of SAR signals. Higher unwanted emissions are possible if EESS (active) systems include components such as high-efficiency power amplifiers operating in saturation modes. Computation of unwanted emissions of the SAR systems using Annex 8 of Recommendation ITU-R SM.1541 results in higher wanted emissions, and hence, higher interference to the deep-space space-to-Earth links in the frequency band 8 400-8 450 MHz. To compute the attenuation levels needed to protect SRS (deep space) operations and to protect the SRS receivers from damages, the unwanted emissions of EESS (active) hardware, rather than theoretical values, should be used.

The level of unwanted emissions falling in the frequency band 8 450-8 500 MHz would even be higher due to the reduced frequency separation. Although studies show that there would not be any harmful interference issue for this band, there may be a risk of saturation and damage of the earth station receivers in case of direct illumination, which requires specific mitigation techniques to also apply in this band.

4 Mitigation techniques

Several interference mitigating techniques are described in this section. Potential interference from the unwanted emissions of EESS (active) systems can be reduced using one or a combination of some of the techniques described. Generally, the first three techniques, pulse shaping, antenna pointing, and filtering, can significantly reduce the unwanted emissions of EESS (active) systems.

4.1 Pulse shaping

Pulse shaping changes the envelope of the LFM chirp pulses to reduce the unwanted emissions of the radar. Compared to a LFM system with 10-ns rise-time and 10-ns fall-time, pulse shaping with trapezoid waveforms and raised-cosine waveforms with 100-ns rise time and 100-ns fall-time can theoretically reduce the unwanted emissions of LFM radars by about 17 dB to 26 dB. Table A2-3 shows that the 100-ns rise-time and 100-ns fall-time trapezoid waveform can reduce the unwanted emission of SAR-1 system to be below the protection level of SRS deep space, although the unwanted emissions of SAR-2 and SAR-3 still exceed the protection level. With the raised-cosine pulse shaping, the unwanted emissions of all three SAR systems are below the protection criterion.

It should be noted that imperfections and nonlinearities of various components in the EESS (active) transmit chain will likely increase the unwanted emissions.

TABLE A2-3

Unwanted emissions of EESS (active) with 100-ns rise-time and fall-time trapezoid waveform in the 8 400-8 450 MHz band

Parameter	SAR-1	SAR-2	SAR-3
e.i.r.p. (dBW)	76	83	86
Bandwidth (MHz)	10	400	450
Minimum slant range (km)	424	654	536
Space loss (dB)	–164	–167	–166
Rx antenna peak gain (dBi)	74	74	74
Polarization loss (dB)	–3	–3	–3
Spectral roll-off (dB)	–135	–106	–95
Rx interference PSD (dB(W/Hz))	–222	–205	–191
Deep-space protection criterion (dB(W/Hz))	–221	–221	–221
Exceedance of protection criterion (dB)	–1	16	30

TABLE A2-4

Unwanted emissions of EESS (active) with 100-ns rise-time and fall-time raised-cosine waveform in the 8 400-8 450 MHz band

Parameter	SAR-1	SAR-2	SAR-3
e.i.r.p. (dBW)	76	83	86
Bandwidth (MHz)	10	400	450
Minimum slant range (km)	424	654	536
Space loss (dB)	–164	–167	–166
Rx antenna peak gain (dBi)	74	74	74
Polarization loss (dB)	-3	–3	–3
Spectral roll-off (dB)	–168	–147	–137
Rx interference PSD (dB(W/Hz))	–255	–246	–233
Deep-space protection criterion (dB(W/Hz))	–221	–221	–221
Exceedance of protection criterion (dB)	–34	–25	–12

4.2 Antenna pointing

All three SAR systems in Report ITU-R RS.2094 have highly directional antennas. For example, the antenna peak gain of SAR-2 system is between 43 dBi and 46 dBi. The antenna pattern rolls-off quickly in horizontal (or azimuth) direction to –3 dBi. If SAR-2 can point the antenna away from the SRS earth stations such that the antenna gain is –3 dBi towards the SRS earth stations, the unwanted emission of SAR-2 system can be reduced by 46 to 49 dB. Similar technique will also work for SAR-1 and SAR-3 systems.

4.3 Filtering

Depending on the implementations of EESS (active) systems, transmit filters and waveguides with steep cut-off below the EESS (active) band can be implemented to limit the unwanted emissions of the systems. Filtering techniques have been successfully implemented by EESS space-to-Earth links in the frequency band 8 025-8 400 MHz to reduce the unwanted emissions of EESS space-to-Earth links by 40 dB and more in the frequency band 8 400-8 450 MHz.

SAR systems may use phased array antennas which are composed of several hundreds of transmission and receive (TR) modules including high-power amplifiers. Any output filtering would have to be applied to the high power stages of these modules and, thus, increases the system complexity, costs, and performance losses of the radar.

However, if needed, an appropriate notch filter may be added in the transmission chain in order to attenuate to the best possible extend the unwanted emissions of the SAR, in a limited bandwidth.

4.4 Selection of sweep range and pulse width

The spectral roll-off of the unwanted emission for LFM radar is a function of both the frequency sweep range and the pulse width of the LFM chirp signal. The unwanted emission increases as the chirp sweep range increases. It also increases as the pulse width of the chirp signal decreases. It may be possible for an EESS (active) operator to vary the radar sweep range and pulse duration to reduce the unwanted emission, especially when the EESS (active) antenna is pointing near as SRS deep-space earth station. The effectiveness of these techniques is limited. They may reduce the unwanted emission of an EESS (active) system by just a few decibels.

4.5 Geographic separation

It is also possible to reduce the interference from EESS (active) systems through geographic separation. EESS (active) systems may keep a minimum slant range from an SRS earth station using the information in Recommendation ITU-R SA.1014 to maintain a minimum free space loss resulting in an exclusion zone. Taken to extreme, EESS (active) systems may refrain from transmission whenever there is line-of-sight between the EESS (active) systems and one of these SRS earth stations.

RECOMMENDATION ITU-R RS.2066-0

Protection of the radio astronomy service in the frequency band 10.6-10.7 GHz from unwanted emissions of synthetic aperture radars operating in the Earth exploration-satellite service (active) around 9 600 MHz

(2014)

Scope

This Recommendation provides an operational procedure to avoid main-beam to main-beam coupling between Earth exploration-satellite service (EESS) (active) SAR-4 systems when transmitting near 9 600 MHz and radio astronomy service (RAS) stations performing observations in the band 10.6-10.7 GHz in order to avoid damage to the sensitive RAS low noise amplifier.

Keywords

EESS (active), RAS, mitigation

Abbreviations/Glossary

SAR Synthetic Aperture Radar

Related ITU Recommendations/Reports

Recommendation ITU-R RS.2043	Characteristics of synthetic aperture radars operating in the Earth exploration-satellite service (active) around 9 600 MHz
Report ITU-R RA.2188	Power flux-density and e.i.r.p. levels potentially damaging to radio astronomy receivers
Report ITU-R RS.2274	Spectrum requirements for spaceborne synthetic aperture radar applications planned in an extended allocation to the Earth exploration-satellite service around 9 600 MHz
Report ITU-R RS.2308	Radio frequency compatibility of unwanted emissions from 9 GHz EESS synthetic aperture radars with the Earth exploration-satellite service (passive), space research service (passive), space research service and radio astronomy service operating in the frequency bands 8 400-8 500 MHz and 10.6-10.7 GHz, respectively

The ITU Radiocommunication Assembly,

considering

a) that the frequency band 9 300-9 800 MHz is allocated to EESS (active) on a primary basis;

b) that the frequency band 9 800-9 900 MHz is allocated to EESS (active) on a secondary basis;

c) that the frequency band 10.6-10.7 GHz is allocated to the RAS on a primary basis;

d) that EESS (active) systems operating active radars around 9 600 MHz use high power chirp emissions in the space-to-Earth direction;

e) that radio astronomy stations operating in the frequency band 10.6-10.7 GHz use extremely sensitive low noise amplifiers;

f) that Report ITU-R RA.2188 provides the power flux-density and e.i.r.p. levels potentially damaging RAS low noise amplifiers/ front-ends;

g) that the level of interference received by RAS stations from the emissions of EESS (active) systems may, under rare conditions of mainbeam to main beam coupling, reach or exceed the critical levels as given by Report ITU-R RA.2188,

recommends

1 that, in order to ensure compatibility of EESS SAR with RAS stations, EESS SAR systems operating around 9 600 MHz should avoid, to the maximum possible extent, to illuminate an area around radio astronomy stations. The size of such an area is defined in Annex 1. Annex 2 provides the list of RAS stations capable to operate in the frequency band 10.6-10.7 GHz and which may perform observations during times of illumination;

2 that, in the event that the conditions referred to in *recommends* **1** are not met, the operator of the EESS SAR system should contact the operator of the concerned radio astronomy station at least seven calendar days before an event for EESS SAR routine operations and at least 24 hours for EESS SAR acquisition of images in cases of emergency only such as disaster management in order to coordinate and, if necessary, to agree on mitigation or other preventive measures.

Annex 1

Determination of the protection area surrounding RAS stations

The emission beam contour corresponding to the margin determined by applying Recommendation ITU-R RA.2188 defines the damage zone for a potential boresight-to-boresight coupling of both antenna beams. Such a contour has the shape of an ellipse with a major axis $\delta\theta_h$ in the horizontal and the minor axis $\delta\theta_v$ in the vertical beam direction, thus defining an area where the power level at the RAS station would exceed –18 dBW. The projection onto the Earth's surface provides the dimension of an area of size with an extension of $\pm\delta h$ in the horizontal direction and $\pm\delta v$ in the vertical direction around the radio astronomy station which should be protected. Table 1 provides the parameter range for the avoidance of accidental damage to an RAS receiver[1] with an antenna diameter of 100 m with regard to SAR-4 as described in Recommendation ITU-R RS.2043.

TABLE 1

Parameters for the avoidance of accidental damage to RA receivers

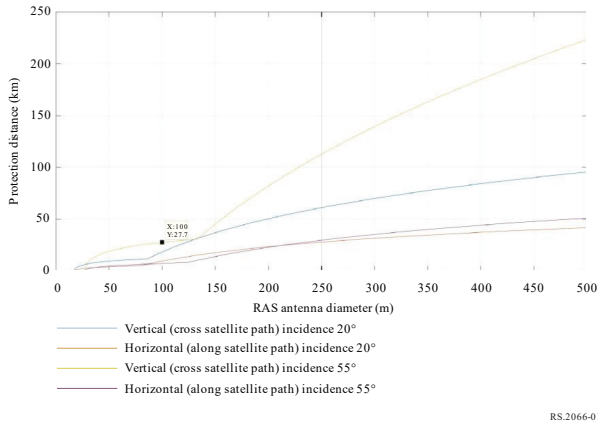
Incident angle Φ	Horizontal offset angle $\delta\theta_h$	Vertical offset angle $\delta\theta_v$	Horizontal separation (km) δh	Vertical separation (km) δv
20°	1.02°	1.8°	9.6	18.2
55°	0.5°	1.1°	7.4	28.1

[1] In the vertical direction, there is an asymmetry of 5.6% for $\delta\theta_v$ and δv between inner and outer off-set angles and distances which has been neglected. Only the larger outer value has been listed. The ground projections of the margin contours which are distorted ellipses were approximated by rectangles.

Figure 1 provides the size of the area around the RAS station to be protected, depending on the RAS antenna diameter and the incidence angle. It can be seen that there is no constraint for RAS stations having an antenna diameter less than 17 m, and that the maximum separation distance from the RAS station is 28 km for most RAS stations.

FIGURE 1

Size of the area around RAS stations to be protected assuming EESS SAR-4 characteristics



More generally, for a given incident angle i, the distance between the SAR satellite and the acquisition area is given by:

$$d = \sqrt{(\mathrm{r} + h)^2 - \mathrm{r}^2 * \sin^2(i)} - \mathrm{r} * \cos(i)$$

where:

r: Earth radius (km)

i: incidence angle (°)

h: SAR altitude (km).

The corresponding angle between the nadir and the acquisition area in the vertical plane is given by:

$$\theta_v = \mathrm{asin}\left(\frac{\mathrm{r} * \sin(i)}{\mathrm{r} + h}\right)$$

where:

r: Earth radius (km)

i: incidence angle (°)

h: SAR altitude (km).

The maximum gain of the RAS antenna can be derived from the antenna diameter and the frequency using the following equation:

$$G_r = 8.9 + 20\log(\pi D f)$$

where:

D: RAS antenna diameter (m)

f: frequency (GHz).

From these values, the SAR antenna gain limit that allows the received power limit of –18 dBW to be met is given by:

$$Ge = Pr_{limit} + L_p - G_r - P_e$$

where:

Pr_{limit}: received power not to be exceeded (–18 dBW below 20 GHz)

L_p: free space loss (dB)

G_r: RAS maximum antenna gain (dBi)

P_e: SAR peak power (dBW).

Using the horizontal and vertical SAR antenna patterns, it is possible to determine the corresponding offset angles $\delta\theta_h$ and $\delta\theta_v$. From these angles, one can derive the horizontal and vertical separation distances δh and δv.

$$\delta h = \mathrm{r} * \mathrm{asin}\left(\frac{\mathrm{dtan}(\delta\theta_h)}{\mathrm{r}}\right)$$

where:

r: Earth radius (km)

d: slant range (km)

$\delta\theta_h$: horizontal offset angle (°).

The slant range between the satellite and the RAS station that meets the received power limit is given by:

$$d + \delta d = (\mathrm{r} + h)\cos(\theta_v + \delta\theta_v) - \sqrt{\mathrm{r}^2 - (\mathrm{r} + h)^2 \sin^2(\theta_v + \delta\theta_v)}$$

where:

r: Earth radius (km)

d: slant range between satellite and acquisition area (km)

h: SAR satellite altitude (km)

θ_v: angle between nadir and acquisition area in the vertical plane (°)

$\delta\theta_v$: vertical offset angle (°).

And also, one can derive the vertical separation distance, δv:

$$\delta v = \mathrm{r}\left(\mathrm{asin}\left(\frac{(d+\delta d)}{\mathrm{r}}\sin(\theta_v + \delta\theta_v)\right) - \mathrm{asin}\left(\frac{d}{\mathrm{r}}\sin(\theta_v)\right)\right)$$

where:

r: Earth radius (km)

d: slant range between satellite and acquisition area (km)

$d + \delta d$: slant range between satellite and RAS station (km)

θ_v: angle between nadir and acquisition area in the vertical plane (°)

$\delta\theta_v$: vertical offset angle (°).

Annex 2

List of radio astronomy stations operating in the band 10.6-10.7 GHz

Region 1

Country	Name	N Latitude	E Longitude	Antenna size (m)
Belgium	Humain	50° 11' 30"	05° 15' 27"	4
Finland	Metsahövi	60° 13' 04"	24° 23' 37"	13.7
Germany	Effelsberg	50° 31' 29"	06° 53' 03"	100
	Stockert	50° 34' 10"	06° 43′ 19 "	10
	Wettzell	49° 08' 41"	12° 52′ 40"	20, 13.2
Italy	Medicina	44° 31' 14"	11° 38’ 49"	32
	Noto	36° 52′ 33"	14° 59' 20"	32
	Sardinia	39° 29' 34"	09° 14' 42"	64
Latvia	Ventspils	57° 33' 12"	21° 51' 17"	32
Norway	Ny Ålesund	78° 55' 45"	11° 52' 15"	20
Portugal	Flores	38° 31' 12"	-31° 07' 48"	13
	Santa Maria	36° 58' 12"	-25° 10' 12"	13
Russia	Badari	51° 45' 27"	102° 13' 16"	32
	Kaliazyn	57° 13' 29"	37° 54' 01"	64
	Pushchino	54° 49' 20"	37° 37′ 53"	22
	Svetloe	61° 05' 00"	29° 46' 54"	32
	Zelenchukskaya	43° 49' 34"	41° 35' 12"	32
South Africa	Hartebeesthoek	–25° 52′ 48"	–27° 40′ 48"	64
	MeerKAT	–30° 43′ 16"	21° 24' 40"	64 antennas of 13.5
Spain	Robledo	40° 25' 38"	–04° 14' 57"	70.34
	Tenerife	28° 30' 00"	-16° 30' 00"	12
	Yebes	40° 31' 27"	–03° 05′ 22"	40
Sweden	Onsala	57° 23' 45"	11° 55' 35"	20
	Onsala	57° 23' 35"	11° 55' 04"	2 antennas of 12
Switzerland	Bleien	47° 20' 26"	08° 06' 44"	5
Turkey	Kayseri	38° 59' 45"	36° 17' 58"	5
UK	Merlin Cambridge (mean)	52° 10' 01"	00° 03' 08"	32
	Merlin Knockin	52° 47' 25"	–02° 59' 50"	25
	Merlin Darnhall	53° 09′ 23"	–02° 32' 09"	25
	Merlin Jodrell Bank (mean)	53° 14′ 07"	–02° 18' 23"	64
	Merlin Pickmere	53° 17′ 19"	–02° 26' 44"	25

List of radio astronomy stations operating in the band 10.6-10.7 GHz

Region 2

Country	Name	N Latitude	E Longitude	Antenna size (m)
Brasil	Itapetinga	–23° 11' 05"	–46° 33' 28"	14
Canada	Algonquin Radio Obsy	45° 57' 19"	–78° 04' 23"	3.7 and 9.1
USA	Arecibo	18° 20' 39"	–66° 45' 10"	305
	GGAO Greenbelt	39° 06' 00"	–76° 29' 24"	12
	Green Bank Telescope	38° 25' 59"	–79° 50' 23"	100
	Haystack	42° 36' 36"	–71° 28' 12"	18
	Kokee Park	22° 07' 34"	–159° 39' 54"	20
	Jansky VLA	33° 58' 22" to 34° 14' 56"	–107° 24' 40" to –107° 48' 22"	27 antennas of 25
	VLBA Brewster, WA	48° 07' 52"	–119° 41' 00"	25
	VLBA Fort Davis, TX	30° 38' 06"	–103° 56' 41"	25
	VLBA Hancock, NH	42° 56' 01"	–71° 59' 12"	25
	VLBA Kitt Peak, AZ	31° 57' 23"	–111° 36' 45"	25
	VLBA Los Alamos, NM	35° 46' 30"	–106° 14' 44"	25
	VLBA Mauna Kea, HI	19° 48' 05"	–155° 27' 20"	25
	VLBA North Liberty, IA	41° 46' 17"	–91° 34' 27"	25
	VLBA Owens Valley, CA	37° 13' 54"	–118° 16' 37"	40
	VLBA Pie Town, NM	34° 18' 04"	–108° 07' 09"	25
	VLBA St. Croix, VI	17° 45' 24"	–64° 35' 01"	25
	Allen Telescope Array	40° 10' 44"	–119° 31' 53"	42 antennas of 6
	Goldstone	35° 25' 33"	–116° 53' 22"	70.3

List of radio astronomy stations operating in the band 10.6-10.7 GHz

Region 3

Country	Name	N Latitude	E Longitude	Antenna size (m)
Australia	Parkes	–33º 00' 00"	148º 15' 44"	64
	Katherine	–14º 22' 32"	132º 09' 09"	12
	Mopra	–31º 16' 04"	149º 05' 58"	22
	ATCA (Narrabri)	–30º 59' 52"	149º 32' 56"	6 antennas of 22
	Tidbinbilla	–35º 24' 18"	148º 58' 59"	70, 34
	Hobart (Mt. Pleasant)	–42º 48' 18"	147º 26' 21"	26
	Ceduna	–31º 52' 05"	133º 48' 37"	30
	Yarragadee	–29º 02' 47"	115º 20' 48"	12
China	Miyun	40º 33′ 29"	116º 58′ 37"	50
	Sheshan	31º 05′ 58"	121º 11′ 59"	25
	Nanshan	43º 28′ 16"	87º 10′ 40"	25
	Tianma	31° 05′ 13"	121° 09′ 48"	65
	CSRH	42° 12′ 31"	115° 14′ 45"	60 antennas of 2
	QTT	43° 36' 04"	89° 40' 57"	110
Japan	Nobeyama	35º 56' 40"	138º 28' 21"	45
	VERA-Mizusawa	39º 08' 01"	141º 07' 57"	20, 10
	VERA-Iriki	31º 44' 52"	130º 26' 24"	20
	VERA-Ogasawara	27º 05' 31"	142º 13' 00"	20
	VERA-Ishigakijima	24º 24' 44"	124º 10' 16"	20
	Ishioka	36º 12' 31"	140º 13' 36"	13.2
	Kashima	35º 57' 21"	140º 39' 36"	34
	Usuda	36º 07' 57"	138º 21' 46"	64
	Nishi-Waseda	35º 42' 25"	139º 43' 20"	2.4 antennas of 64
	Tomakomai	42º 40' 25"	141º 35' 48"	11
	Gifu	35º 28' 03"	136º 44' 14"	11
	Yamaguchi	34º 12' 58"	131º 33' 26"	32
	Tsukuba	36º 06' 11"	140º 05' 19"	32
Korea	KSWC (Jeju)	33º 42' 36"	126º 29' 26"	3
	SGOC (Sejong)	36º 31' 12"	127º 18' 00"	22
	K-SRBL	36° 24' 00"	127° 22' 12"	2 antennas of 2
	KVN-Yonsei	37º 33' 55"	126º 56' 27"	21
	KVN-Ulsan	35º 32' 33"	129º 15' 04"	21
	KVN-Tamna	33º 17' 21"	126º 27' 37"	21
New Zealand	Warkworth	–36º 25' 59"	174º 39' 52"	30, 12

RECOMMENDATION ITU-R S.2157-0

Procedures for the evaluation of interference from any non-geostationary-satellite system into a global set of the generic geostationary-satellite reference links in the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space)

(2023)

NOTE – Approval of this Recommendation should not be construed that ITU-R expressed any views, directly or indirectly, in favour of any of the Methods included in the CPM Report on WRC-23 agenda item 7, Topic G[1].

Scope

This Recommendation provides procedures for assessment of compliance for any non-*geostationary-satellite orbit (non*-GSO*)* system with No. **22.5L** of the Radio Regulations *(RR)* in order to ensure the protection of *geostationary-satellite orbit (*GSO*)* satellite networks in the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space).

Keywords

Single-entry permissible interference, link performance degradation, adaptive coding and modulation, generic GSO reference links, availability and spectral efficiency, precipitation fade

Abbreviations/Glossary

ACM Adaptive coding and modulation

CDF Cumulative distribution function

EPFD Equivalent power flux-density

PDF Probability density function

Related ITU Recommendations, Reports

Recommendation ITU-R P.618 – Propagation data and prediction methods required for the design of Earth-space telecommunication systems

Recommendation ITU-R S.1503 – Functional description to be used in developing software tools for determining conformity of non-geostationary-satellite orbit fixed-satellite service systems or networks with limits contained in Article 22 of the Radio Regulations

Recommendation ITU-R S.2131 – Method for the determination of performance objectives for satellite hypothetical reference digital paths using adaptive coding and modulation

The ITU Radiocommunication Assembly,

considering

a) that geostationary-satellite orbit (GSO) and non-geostationary-satellite orbit (non-GSO) fixed-satellite service (FSS) networks may operate in the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space);

[1] *Note by the Secretariat:* This Note will be removed after WRC-23.

b) that WRC-19 has adopted Nos. **22.5L** and **22.5M**, which contain single-entry and aggregate limits for non-GSO FSS systems in the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space) to protect GSO networks operating in the same frequency bands,

recognizing

a) that the ITU Radiocommunication Sector (ITU-R) has developed a methodology, contained in Recommendation ITU-R S.1503, that results in the equivalent power flux-density (epfd) generated by any non-GSO FSS system considered;

b) that, in accordance with calculations utilizing Recommendation ITU-R S.1503, verification of the worldwide epfd interference of any non-GSO system can be carried out by a set of generic GSO reference link budgets having characteristics that encompass global GSO network deployments that are independent of any specific geographic locations;

c) that Resolution **769 (WRC-19)** addresses the protection of GSO networks from aggregate emissions from non-GSO systems,

recommends

that the procedures specified in Annexes 1 and 2 should be considered to assess compliance for any non-GSO system with No. **22.5L** of the Radio Regulations in order to ensure the protection of GSO satellite networks in the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space).

Annex 1

Procedure for use by the Bureau in checking compliance of non-GSO FSS systems with No. 22.5L of the Radio Regulations in the frequency bands 37.5-39.5 GHz (space-to Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space)

This Annex provides an overview of the process to validate compliance with the single-entry permissible interference of a non-GSO satellite system into GSO satellite networks using the generic GSO reference link parameters in Annex 1 to Resolution **770 (WRC-19)** and the interference impact using the latest version of Recommendation ITU-R S.1503. The procedure to determine compliance with the single-entry permissible interference relies on the following principles.

Principle 1: The two time-varying sources of link performance degradation considered in the verification are link fading (from rain) using the characteristics of the generic GSO reference link described in Resolution **770 (WRC-19)** and interference from a non-GSO system. The total *C*/*N* in the reference bandwidth for a given carrier is:

$$C/N = C/(N_T + I) \tag{1}$$

where:

C : wanted signal power (W) in the reference bandwidth, which varies as a function of fades and also as a function of transmission configuration

N : noise power (W) in the reference bandwidth

N_T : total system noise power (W) in the reference bandwidth

I : time-varying interference power (W) in the reference bandwidth generated by other networks.

Principle 2: The calculation of spectral efficiency is focused on satellite systems utilizing adaptive coding and modulation (ACM) by calculating the throughput degradation as a function of *C*/*N*, which varies depending on the propagation and interference impacts on the satellite link over the long term.

Principle 3: During a fading event in the downlink direction the interfering carrier would be attenuated by the same amount as the wanted carrier under the assumption of co-polarized carriers. This principle results in slight underestimation of the impact of the downlink interference.

Implementation of verification algorithm

The generic GSO reference link parameters described in Annex 1 to Resolution **770 (WRC-19)** should be used as described in the following algorithm to determine if a non-GSO FSS network is compliant with No. **22.5L** of the Radio Regulations.

Within the parametric analysis there are a range of values for each of the following parameters in section 2 of Tables 1 and 2 in Annex 1 to Resolution **770 (WRC-19)**:

– e.i.r.p. density variation
– elevation angle (degrees)
– rain height (m)
– latitude (degree)
– 0.01% rain rate (mm/hr)
– height of Earth station (m)
– Earth station noise temperature (K) or satellite noise temperature (K), as appropriate.

A set of generic GSO reference links should be created using one per service case identified in section 1 of Tables 1 and 2 in Annex 1 to Resolution **770 (WRC-19)**, and one value from each of the parametric analysis parameters in section 2 of Tables 1 and 2. Then, with this set of generic GSO reference links, the following process should be undertaken:

The frequency that should be used in the following steps except for step 2 are 37.5 GHz for the space to Earth direction and 47.2 GHz in the Earth to space direction. The frequency f_{GHz}, that should be used in step 2 is determined by applying the methodology in Recommendation ITU-R S.1503 to the non-GSO system filed frequencies and the frequency bands for which No. ***22.5L*** *of the Radio Regulations applies*

For each of the generic GSO reference links

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Step 0: Determine if this generic GSO reference link is valid and select the appropriate threshold.

If the generic GSO reference link is valid, then

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Step 1: Derive the probability density function (PDF) of the rain fade to use in the convolution

Step 2: Recommendation ITU-R S.1503 should be used to derive the PDF of the EPFD from the non-GSO FSS system

Step 3: Perform a modified convolution (space-to-Earth) or convolution (Earth-to-space) with the PDF of the rain fade and the PDF of the EPFD. This convolution yields a PDF of C/N and C/(N_T+I)

Step 4: Use the C/N and C/(N_T+I) PDFs to determine compliance with No. ***22.5L*** *of the Radio Regulations*

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If the non-GSO system under examination is found to comply with No. ***22.5L*** *of the Radio Regulations with respect to all generic GSO reference links, then the result of the evaluation is favourable finding otherwise it is an unfavourable finding.*

Each of these steps are described further in Attachments 1 and 2 to this Annex for the space-to-Earth and Earth-to-space procedures, respectively.

Attachment 1
to Annex 1

Steps to be applied in the space-to-Earth direction in the frequency bands 37.5-39.5 GHz and 39.5-42.5 GHz to determine compliance with No. 22.5L of the Radio Regulations

By applying the following steps, the single-entry interference impact from a non-GSO system on the availability and spectral efficiency of a generic GSO reference link is determined. The generic GSO reference link parameters of Annex 1 to Resolution **770 (WRC-19)** are used, considering all possible parametric permutations, in conjunction with the worst-case geometry (WCG) epfd output of the latest version of Recommendation ITU-R S.1503. The output of Recommendation ITU-R S.1503 is a set of interference statistics that a non-GSO system creates. These interference statistics are then used to determine the effect of the interference into each generic GSO reference link.

Step 0: Verification of the generic GSO reference link and selection of *C/N* threshold

The following steps should be used to determine if the generic GSO reference link is valid and if so, which of the thresholds $\left(\frac{C}{N}\right)_{Thr,i}$ should be used. It is assumed that R_s = 6 378.137 km, R_{geo} = 42 164 km, k_{dB} = −228.6 dB(J/K) and $c = 2.99792458 \times 10^5$km/s.

Note that the term "cumulative distribution function" is meant to include the concept of the complementary cumulative distribution function depending upon context.

1) Calculate the peak gain of the Earth station antenna in dBi using:

for $20 \leq D/\lambda \leq 100$

$$G_{max} = 20 \log \left(\frac{D}{\lambda}\right) + 7.7 \qquad \text{dBi}$$

for $D/\lambda > 100$

$$G_{max} = 20 \log \left(\frac{D}{\lambda} \right) + 8.4 \qquad \text{dBi}$$

2) Calculate the slant distance in km using:

$$d_{km} = R_s \left(\sqrt{\frac{R_{geo}^2}{R_s^2} - \cos^2(\varepsilon)} - \sin(\varepsilon) \right)$$

3) Calculate the free-space path loss in dB using:

$$L_{fs} = 92.45 + 20\log(f_{GHz}) + 20\log(d_{km})$$

4) Calculate the wanted signal power in the reference bandwidth in dBW accounting for additional link losses:

$$C = eirp + \Delta eirp - L_{fs} + G_{max} - L_o$$

5) Calculate the total noise power in the reference bandwidth in dBW/MHz using:

$$N_T = 10\log(T \cdot B_{MHz} \cdot 10^6) + k_{dB} + M_{ointra} + M_{ointer}$$

6) For each threshold $(C/N)_{Thr,i}$, derive the margin available for precipitation for that case in dB:

$$A_{rain,i} = C - N_T - \left(\frac{C}{N} \right)_{Thr,i}$$

7) If for each threshold $(C/N)_{Thr,i}$ the margin $A_{rain,i} \leq A_{min}$, then this generic GSO reference link is not valid.

8) For each of the thresholds $(C/N)_{Thr,i}$ for which $A_{rain,i} > A_{min}$, undertake step 9.

9) Using the precipitation model in Annex 2 to this Recommendation together with the selected rain rate, Earth station height, rain height, Earth station latitude, elevation angle, frequency, calculated rain fade margin and an assumed polarization of vertical, calculate the associated percentage of time, $p_{rain,i}$.

10) If for each threshold $(C/N)_{Thr,i}$ the associated percentage of time is not within the range:

$$0.01\% \leq P_{rain,i} \leq 10\%$$

then this generic GSO reference link is not valid.

11) If at least one threshold meets the criteria in steps 7 and 10, then the lowest threshold, $(C/N)_{Thr}$ that meets these criteria is used in the analysis.

NOTE – A_{min} is 3 dB.

Step 1: Generation of precipitation fade PDF

The precipitation fade PDF should be generated using Annex 2 to this Recommendation from the selected rain rate, Earth station height, Earth station latitude, rain height, elevation angle, frequency (summarized in Table 2 of Annex 2) and an assumed polarization of vertical as follows:

1) Calculate the maximum fade depth $A_{rain}(p)$ using $p = p_{min}$, noting that p_{min} is provided in Annex 2.

2) Create a set of N bins of 0.1 width bins of precipitation fade A_{rain} between 0 dB and round to one digit to the right of the decimal point of $(A_{rain}(p_{min})) + 0.1$ dB.

3) For each of the bins, determine the associate probability p to create a cumulative distribution function (CDF) of A_{rain}

$$CDF_n = Probability\ that\ A_{rain} \geq \big((n-1) * 0.1\big)dB \qquad for\ n < N$$

$$CDF_n = 0\% \quad for\ n = N$$

with n = 1, 2, 3, …N.

4) For each of the bins, convert this CDF into a PDF of A_{rain}

$$PDF_n = \frac{CDF_n - CDF_{n+1}}{100} \qquad for\ n < N$$

$$PDF_n = 0\% \quad for\ n = N$$

with: $\sum_{n=1}^{N} PDF_n = 1$

A bin size of 0.1 dB should be used to ensure consistency with the output from Recommendation ITU-R S.1503. Each bin of the CDF contains the probability that the precipitation fade is at least A_{rain} dB. Each bin of the PDF contains the probability that the precipitation fade is between A_{rain} and A_{rain} + 0.1 dB.

Step 2: Generation of epfd PDF

Recommendation ITU-R S.1503 should be used to determine the epfd CDF from the non-GSO FSS parameters and the frequency, dish size and Earth station antenna gain pattern. The epfd CDF will be calculated at the worst-case geometry from Recommendation ITU-R S.1503. The epfd CDF will be composed of N bins spaced by 0.1 dB.

The epfd CDF should then be converted into a PDF as follows:

1) Ensure than the percentage of time of the first bins of the epfd CDF is 100% and the last bins is 0%

2) For each of the bins, convert this CDF into a PDF of epfd

$$PDF_n = \frac{CDF_n - CDF_{n+1}}{100} \qquad for\ n < N$$

$$PDF_n = 0 \quad for\ n = N$$

with: $\sum_{n=1}^{N} PDF_n = 1$

Each bin of the epfd CDF contains the probability that the epfd is at least X dB W/m^2 in the reference bandwidth. Each bin of the PDF contains the probability that the epfd is between X and X + 0.1 dB.

Step 3: Creation of *C*/*N* and *C*/(*N*+*I*) CDFs by modified convolution of precipitation fade PDF with epfd PDF

For the selected generic GSO reference link, the *C*/*N* and *C*/(*N*+*I*) PDFs should be generated using the following steps to undertake the modified discrete convolution:

Initialize the C/N and C/(N+I) distributions with bin size of 0.1 dB

Calculate the effective area of an isotropic antenna at wavelength λ using:

$$A_{ISO} = 10\log\left(\frac{\lambda^2}{4\pi}\right)$$

Calculate the wanted signal power accounting for additional link losses and antenna gain at edge of coverage:

$$C = eirp + \Delta eirp - L_{fs} + G_{max} - L_o$$

Calculate the system noise power using:

$$N_T = 10\log(T \cdot B_{MHz} \cdot 10^6) + k_{dB} + M_{ointra}$$

For each value A_{rain} in the precipitation fade PDF

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Calculate the faded wanted signal power using:

$$C_f = C - A_{rain}$$

Calculate the C/N using:

$$\frac{C}{N} = C_f - N_T$$

Update the C/N distribution with this C/N and the probability associated with this A_{rain}

For each value EPFD in the EPFD PDF

{

Calculate the interference from the EPFD taking into account the precipitation fading using:

$$I = EPFD + G_{peak} + A_{iso} - A_{rain}$$

Calculate the noise plus interference using:

$$(N_T + I) = 10\log\left(10^{N_T/10} + 10^{I/10}\right)$$

Calculate the C/(N+I) using:

$$\frac{C}{N+I} = C_f - (N_T + I)$$

Identify the relevant C/(N+I) bin for this C/(N+I) value

Increment this bin's probability with the product of the probabilities of this precipitation fade and EPFD

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Step 4: Use of *C*/*N* and *C*/(*N*+*I*) distributions with the criteria in No. 22.5L of the Radio Regulations

The *C*/*N* and *C*/(*N*+*I*) distributions should then be used to check against the availability and spectral efficiency criteria in No. **22.5L** of the Radio Regulations as follows:

Step 4A: Check on unavailability increase

Using the selected threshold $\left(\frac{C}{N}\right)_{Thr}$ for the generic GSO reference link, determine the following:

U_R = Sum of the probabilities from all bins for which $C/N < \left(\frac{C}{N}\right)_{Thr}$

U_{RI} = Sum of the probabilities from all bins for which $C/(N+I) < \left(\frac{C}{N}\right)_{Thr}$

Then the condition to be verified for compliance is:

$$U_{RI} \leq 1.03 \times U_R$$

Step 4B: Check on the time-weighted average spectral efficiency decrease

Determine the long-term time-weighted average spectral efficiency, SE_R, assuming precipitation only by:

Set $SE_R = 0$

For all bins in the C/N PDF above the threshold $\left(\frac{C}{N}\right)_{Thr}$

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Equation (3) in Annex to Recommendation ITU-R S.2131-1 should be used to convert the C/N to a spectral efficiency

Increment SE_R *by the spectral efficiency multiplied by the probability associated with this C/N*

}

Determine the long-term time-weighted average spectral efficiency, SE_{RI}, assuming precipitation and interference by:

Set $SE_{RI} = 0$

For all bins in the C/(N+I) PDF above the threshold $\left(\frac{C}{N}\right)_{Thr}$

{

Equation (3) of Annex to Recommendation ITU-R S.2131-1 should be used to convert the C/(N+I) to a spectral efficiency

Increment SE_{RI} *by the spectral efficiency multiplied by the probability associated with this C/(N+I)*

}

Then the condition to be verified for compliance is:

$$SE_{RI} \geq SE_R * (1 - 0.03)$$

Attachment 2
to Annex 1

Algorithm steps to be applied in the Earth-to-space direction in the frequency bands 47.2-50.2 GHz and 50.4-51.4 GHz to determine compliance with No. 22.5L of the Radio Regulations

By applying the following steps, the single-entry interference impact from a non-GSO system on the availability and spectral efficiency of a generic GSO reference link is determined. The generic GSO reference link parameters of Annex 1 to Resolution **770 (WRC-19)** are used, considering all possible parametric permutations, in conjunction with the worst-case geometry ("WCG") epfd output of the latest version of Recommendation ITU-R S.1503. The output of Recommendation ITU-R S.1503 is a set of interference statistics that a non-GSO system creates. These interference statistics are then used to determine the effect of the interference into each generic GSO reference link.

Step 0: Verification of the generic GSO reference link and selection of *C/N* threshold

The following steps should be used to determine if the generic GSO reference link is valid and if so, which of the thresholds $\left(\frac{C}{N}\right)_{Thr,i}$ should be used. It is assumed that R_s = 6 378.137 km, R_{geo} = 42 164 km, k_{dB} = −228.6 dB(J/K) and $c = 2.99792458 \times 10^5$ km/s.

Note that the term cumulative distribution function is meant to include the concept of the complementary cumulative distribution function depending upon context.

1) Calculate the slant distance in km using:

$$d_{km} = R_s\left(\sqrt{\frac{R_{geo}^2}{R_s^2} - \cos^2(\varepsilon)} - \sin(\varepsilon)\right)$$

2) Calculate the free-space path loss in dB using:

$$L_{fs} = 92.45 + 20\log(f_{GHz}) + 20\log(d_{km})$$

3) Calculate the wanted signal power in the reference bandwidth in dBW accounting for additional link losses and antenna gain at edge of coverage:

$$C = eirp + \Delta eirp - L_{fs} + G_{max} - L_o + G_{rel}$$

4) Calculate the total noise power in the reference bandwidth in dBW/MHz using:

$$N_T = 10\log(T \cdot B_{MHz} \cdot 10^6) + k_{dB} + M_{ointra} + M_{ointer}$$

5) For each threshold $(C/N)_{Thr,i}$, derive the precipitation margin for that case in dB:

$$A_{rain,i} = C - N_T - \left(\frac{C}{N}\right)_{Thr,i}$$

6) If for each threshold $(C/N)_{Thr,i}$ the margin $A_{rain,i} \leq A_{min}$, then this generic GSO reference link is not valid.

7) For each of the thresholds $(C/N)_{Thr,i}$ for which $A_{rain,i} > A_{min}$, undertake step 8.

8) Using the precipitation model in Annex 2 together with the selected rain rate, Earth station height, rain height, Earth station latitude, elevation angle, frequency, calculated precipitation fade margin and an assumed polarization of vertical, calculate the associated percentage of time, $p_{rain,i}$.

9) If for each threshold $(C/N)_{Thr,i}$ the associated percentage of time is not within the range:

$$0.01\% \leq p_{rain,i} \leq 10\%$$

then this generic GSO reference link is not valid.

10) If at least one threshold meets the criteria in steps 6 and 9, then the lowest threshold, $(C/N)_{Thr}$ that meets these criteria should be used in the analysis.

NOTE – A_{min} is 3 dB and the antenna gain relative to peak towards the Earth station, G_{rel} = −3 dB.

Step 1: Generation of precipitation fade PDF

The precipitation fade PDF should be generated using Annex 2 to this Recommendation from the selected rain rate, Earth station height, Earth station latitude, rain height, elevation angle, frequency and an assumed polarization of vertical as follows:

1) Calculate the maximum fade depth $A_{rain}(p)$ using $p = p_{min}$, noting that p_{min} is provided in Annex 2.

2) Create a set of N bins of 0.1 dB width between 0 dB and round to one digit to the right of the decimal point of $(A_{rain}(p_{min}))$ + 0.1 dB.

3) For each of the bins, determine the associate probability p to create a cumulative distribution function (CDF) of A_{rain}

$$CDF_n = Probability\ that\ A_{rain} \geq \left((n-1) * 0.1\right) dB \qquad for\ n < N$$
$$CDF_n = 0\% \qquad for\ n = N$$

with n = 1, 2, 3, …N.

4) For each of the bins, convert this CDF into a PDF of A_{rain}

$$PDF_n = CDF_n - CDF_{n+1} \qquad for\ n < N$$
$$PDF_n = 0\% \quad for\ n = N$$

with: $\sum_{n=1}^{N} PDF_n = 100\%$

A bin size of 0.1 dB should be used to ensure consistency with the output from Recommendation ITU-R S.1503. Each bin of the CDF contains the probability that the precipitation fade is at least A_{rain} dB. Each bin of the PDF contains the probability that the precipitation fade is between A_{rain} and A_{rain} + 0.1 dB.

Step 2: Generation of epfd PDF

Recommendation ITU-R S.1503 should be used to determine the epfd CDF from the non-GSO FSS parameters and the frequency, dish size and Earth station antenna gain pattern. The epfd CDF will be calculated at the worst-case geometry from Recommendation ITU-R S.1503.

The epfd CDF should then be converted into a PDF.

Step 3: Creation of *C*/*N* and *C*/(*N*+*I*) CDFs by convolution of precipitation fade PDF with epfd PDF

For the selected generic GSO reference link, the *C*/*N* and *C*/(*N*+*I*) PDFs should be generated using the following steps to undertake the discrete convolution:

Initialize the C/N and C/(N+I) distributions with bin size of 0.1 dB

Calculate the effective area of an isotropic antenna at wavelength λ using:

$$A_{ISO} = 10 \log\left(\frac{\lambda^2}{4\pi}\right)$$

Calculate the wanted signal power accounting for additional link losses and antenna gain at edge of coverage:

$$C = eirp + \Delta eirp - L_{fs} + G_{max} - L_o + G_{rel}$$

Calculate the system noise power using:

$$N_T = 10 \log(T \cdot B_{MHz} \cdot 10^6) + k_{dB} + M_{ointra}$$

For each value A_{rain} in the precipitation fade PDF

{

Calculate the faded wanted signal power using:

$$C_f = C - A_{rain}$$

Calculate the C/N using:

$$\frac{C}{N} = C_f - N_T$$

Update the C/N distribution with this C/N and the probability associated with this A_{rain}

For each value EPFD in the EPFD PDF

{

Calculate the interference from the EPFD:

$$I = EPFD + G_{peak} + A_{iso}$$

Calculate the noise plus interference using:

$$(N_T + I) = 10\log\left(10^{N_T/10} + 10^{I/10}\right)$$

Calculate the C/(N+I) using:

$$\frac{C}{N+I} = C_f - (N_T + I)$$

Identify the relevant C/(N+I) bin for this C/(N+I) value

Increment this bin's probability with the product of the probabilities of this precipitation fade and EPFD

}

}

Step 4: Use of *C*/*N* and *C*/(*N*+*I*) distributions with the criteria in No. 22.5L of the Radio Regulations

The *C*/*N* and *C*/(*N*+*I*) distributions should then be used to check against the availability and spectral efficiency criteria in No. **22.5L** of the Radio Regulations as follows:

Step 4A: Check on unavailability increase

Using the selected threshold $\left(\frac{C}{N}\right)_{Thr}$ for the generic GSO reference link, determine the following:

U_R = Sum of the probabilities from all bins for which $C/N < \left(\frac{C}{N}\right)_{Thr}$

U_{RI} = Sum of the probabilities from all bins for which $C/(N+I) < \left(\frac{C}{N}\right)_{Thr}$

Then the conditions to be verified for compliance are:

$$U_{RI} \leq 1.03 \times U_R$$

Step 4B: Check on the time-weighted average spectral efficiency decrease

Determine the long-term time-weighted average spectral efficiency, SE_R, assuming precipitation only by:

Set $SE_R = 0$

For all bins in the C/N PDF above the threshold $\left(\frac{C}{N}\right)_{Thr}$

{

Equation (3) in Annex to Recommendation ITU-R S.2131-1 should be used to convert the C/N to a spectral efficiency

Increment SE_R *by the spectral efficiency multiplied by the probability associated with this C/N*

}

Determine the long-term time-weighted average spectral efficiency, SE_{RI}, assuming precipitation and interference by:

Set $SE_{RI} = 0$

For all bins in the C/(N+I) PDF above the threshold $\left(\frac{C}{N}\right)_{Thr}$

{

Equation (3) in Annex to Recommendation ITU-R S.2131-1 should be used to convert the C/(N+I) to a spectral efficiency

Increment SE_{RI} *by the spectral efficiency multiplied by the probability associated with this C/(N+I)*

}

Then the conditions to be verified for compliance are:

$$SE_{RI} \geq SE_R * (1 - 0.03)$$

Annex 2

Calculation of precipitation fade statistics

The long-term statistics of the precipitation fade to be used are provided by the following equation:

$$\begin{array}{cc} A_{rain}(p_{min}) & \text{for } 0\% \leq p \leq p_{min} \\ A_{rain}(p) & \text{for } p_{min} < p \leq p_1 \\ A_{rain}(p_1)(\log_{10}(p) - 1)/(\log_{10}(p_1) - 1) & p_1 < p \leq p_{max} \\ 0 \text{ dB} & p_{max} < p \leq 100\% \end{array}$$

where p_{max} is the probability of rain fade higher than 0 dB (see parameter of 2.9 in Tables 1 and 2 in Annex 1 to Resolution **770 (WRC-19)**); $A_{rain}(p)$ is calculated using § 2.2.1.1 of Recommendation ITU-R P.618-13; and p_1 and p_{min} are provided in Table 1 for the GSO space-to-Earth direction (*F* = 37.5 GHz), in Table 2 for the GSO Earth-to-space direction (*F* = 47.2 GHz) and the rain index and the associated rain conditions for both directions are provided in Table 3.

TABLE 1

p_1 and p_{min} to be used for the space-to-Earth direction (downlink)

Index	P_1 (%)	p_{min} (%)	Index	P_1 (%)		p_{min} (%)	Index	P_1 (%)	p_{min} (%)	Index	P_1 (%)	p_{min} (%)
1	2.4116	0.002233	15	2.27683		0.001509	29	2.5255	0.001016	43	2.1999	0.001004
2	2.43056	0.002184	16	2.132474		0.002155	30	2.5531	0.001021	44	2.22281	0.001006
3	2.45185	0.002007	17	2.15401		0.002046	31	2.24996	0.002127	45	2.24985	0.001
4	2.17104	0.004299	18	2.17912		0.001918	32	2.26854	0.002023	46	2.53394	0.001595
5	2.1888	0.004098	19	2.62353		0.001001	33	2.28952	0.001914	47	2.5582	0.001529
6	2.20875	0.003859	20	2.692		0.001006	34	2.14671	0.002772	48	2.58521	0.001417
7	2.072122	0.005539	21	2.8211		0.001015	35	2.16454	0.002648	49	2.20414	0.003914
8	2.08942	0.005269	22	2.37672		0.001007	36	2.184672	0.002505	50	2.22922	0.003662
9	2.10884	0.005003	23	2.43951		0.001006	37	2.56214	0.001013	51	2.25721	0.003423
10	2.46476	0.001003	24	2.5431		0.001004	38	2.59324	0.001005	52	2.05972	0.005707
11	2.48883	0.001012	25	2.276		0.001	39	2.62902	0.001013	53	2.08493	0.005346
12	2.5169	0.001008	26	2.33666		0.001003	40	2.30243	0.001005	54	2.113093	0.004968
13	2.22858	0.001696	27	2.43675		0.001007	41	2.3264	0.001			
14	2.25085	0.001597	28	2.50513		0.001055	42	2.35466	0.001008			

TABLE 2

p_1 and p_{min} to be used for the Earth-to-space direction (uplink)

Index	P_1 (%)	p_{min} (%)	Index	P_1 (%)	p_{min} (%)	Index	P_1 (%)	p_{min} (%)	Index	P_1 (%)	p_{min} (%)
1	2.33455	0.002786	15	2.20921	0.001796	29	2.44635	0.001235	43	2.131202	0.001002
2	2.35384	0.002625	16	2.066286	0.002558	30	2.4716	0.001185	44	2.155341	0.001001
3	2.37551	0.002469	17	2.08869	0.002422	31	2.1799	0.002555	45	2.183783	0.001003
4	2.1054	0.005082	18	2.1148	0.002274	32	2.199252	0.002421	46	2.4509	0.002042
5	2.123611	0.004846	19	2.54793	0.00101	33	2.22109	0.002291	47	2.47605	0.001865
6	2.144072	0.004584	20	2.6164	0.001009	34	2.07934	0.003305	48	2.50405	0.001724
7	2.010594	0.006442	21	2.7466	0.001009	35	2.098044	0.003155	49	2.13059	0.004723
8	2.0284	0.006179	22	2.3119	0.001003	36	2.119153	0.002987	50	2.15691	0.004433
9	2.048392	0.005855	23	2.3766	0.001002	37	2.47937	0.001004	51	2.18624	0.004149
10	2.38588	0.001116	24	2.48305	0.001007	38	2.5116	0.00101	52	1.988883	0.00683
11	2.4105	0.001048	25	2.21479	0.001002	39	2.5486	0.001013	53	2.01554	0.006349
12	2.4392	0.001007	26	2.27762	0.001005	40	2.23144	0.001003	54	2.045274	0.005903
13	2.159292	0.002035	27	2.38105	0.001003	41	2.25648	0.001006			
14	2.18234	0.001915	28	2.42572	0.001315	42	2.28598	0.001003			

TABLE 3

Rain index and corresponding rain conditions

Rain index	ε	h_{rain}	Lat	$R_{0.01}$	h_{ES}	Rain index	ε	h_{rain}	Lat	$R_{0.01}$	h_{ES}
1	20	5 000	0	10	0	28	55	5 000	0	10	0
2	20	5 000	0	10	500	29	55	5 000	0	10	500
3	20	5 000	0	10	1 000	30	55	5 000	0	10	1 000
4	20	5 000	0	50	0	31	55	5 000	0	50	0
5	20	5 000	0	50	500	32	55	5 000	0	50	500
6	20	5 000	0	50	1 000	33	55	5 000	0	50	1 000
7	20	5 000	0	100	0	34	55	5 000	0	100	0
8	20	5 000	0	100	500	35	55	5 000	0	100	500
9	20	5 000	0	100	1 000	36	55	5 000	0	100	1 000
10	20	3 950	30	10	0	37	55	3 950	30	10	0
11	20	3 950	30	10	500	38	55	3 950	30	10	500
12	20	3 950	30	10	1 000	39	55	3 950	30	10	1 000
13	20	3 950	30	50	0	40	55	3 950	30	50	0
14	20	3 950	30	50	500	41	55	3 950	30	50	500
15	20	3 950	30	50	1 000	42	55	3 950	30	50	1 000
16	20	3 950	30	100	0	43	55	3 950	30	100	0
17	20	3 950	30	100	500	44	55	3 950	30	100	500
18	20	3 950	30	100	1 000	45	55	3 950	30	100	1 000
19	20	1 650	61.8	10	0	46	90	5 000	0	10	0
20	20	1 650	61.8	10	500	47	90	5 000	0	10	500
21	20	1 650	61.8	10	1 000	48	90	5 000	0	10	1 000
22	20	1 650	61.8	50	0	49	90	5 000	0	50	0
23	20	1 650	61.8	50	500	50	90	5 000	0	50	500
24	20	1 650	61.8	50	1 000	51	90	5 000	0	50	1 000
25	20	1 650	61.8	100	0	52	90	5 000	0	100	0
26	20	1 650	61.8	100	500	53	90	5 000	0	100	500
27	20	1 650	61.8	100	1 000	54	90	5 000	0	100	1 000

Cross-reference list of the regulatory provisions, including footnotes and Resolutions, incorporating ITU-R Recommendations by reference

Recommendation ITU-R	Title of the Recommendation	RR provisions and footnotes with ITU-R Recommendations contained in RR Volume 4
TF.460-6	Standard-frequency and time-signal emissions	No. **1.14** (via Resolution **655 (Rev.WRC-23)**)
M.489-2	Technical characteristics of VHF radiotelephone equipment operating in the maritime mobile service in channels spaced by 25 kHz	Nos. **51.77**, **52.231**, Appendix **18** (*General notes e)*)
M.492-6	Operational procedures for the use of direct-printing telegraph equipment in the maritime mobile service	No. **56.2**
P.525-4	Calculation of free-space attenuation	No. **5.444B** (via Resolution **748 (Rev.WRC-19)**)
P.526-15	Propagation by diffraction	No. **5.444B** (via Resolution **748 (Rev.WRC-19)**)
M.541-11	Operational procedures for the use of digital selective-calling equipment in the maritime mobile service	Nos. **51.35**, **52.112**, **52.149**, **52.153**, **54.2**
M.585-9 (Annex 1)	Assignment and use of identities in the maritime mobile service	Nos. **19.99**, **19.102**, **19.111**
M.633-5	Transmission characteristics of a satellite emergency position-indicating radio beacon (satellite EPIRB) operating through a satellite system in the 406.0-406.1 MHz band	No. **34.1**
S.672-4	Satellite antenna radiation pattern for use as a design objective in the fixed-satellite service employing geostationary satellites	TABLE **22-2** (and No. **22.5D.3**), TABLE **22-3** (and No. **22.5F.3**)
M.690-3	Technical characteristics of emergency position-indicating radio beacons operating on the carrier frequencies of 121.5 MHz and 243 MHz	Appendix **15** (Table 15-2)
RA.769-2 (parts related to the application of Nos. **5.372**, **5.511G**, **5.511H**, **5.531C**, **5.531E** and **5.510A**)	Protection criteria used for radio astronomical measurements	Nos. **5.372**, **5.511G**, **5.511H**, **5.531C**, **5.531E** and No. **5.510A** (via Resolution **678 (WRC-23)**)
P.838-3	Specific attenuation model for rain for use in prediction methods	Appendix **30A** (Annex 3 § 2.2 Step 6)
M.1084-5	Interim solutions for improved efficiency in the use of the band 156-174 MHz by stations in the maritime mobile service	Appendix **18** (NOTE B) (prior to the table)

Recommendation ITU-R	Title of the Recommendation	RR provisions and footnotes with ITU-R Recommendations contained in RR Volume 4
SM.1138-3	Determination of necessary bandwidths including examples for their calculation and associated examples for the designation of emissions	Appendix **1** (§ 1 and § 2)
SA.1154-0	Provisions to protect the space research (SR), space operations (SO) and Earth-exploration satellite services (EES) and to facilitate sharing with the mobile service in the 2 025-2 110 MHz and 2 200-2 290 MHz bands	No. **5.391**
M.1171-1	Radiotelephony procedures for routine calls in the maritime mobile service	Nos. **52.192**, **52.195**, **52.213**, **52.224**, **52.234**, **52.240**, **57.1**
M.1172-0	Miscellaneous abbreviations and signals to be used for radiocommunications in the maritime mobile service	No. **19.48**
M.1173-1	Technical characteristics of single-sideband transmitters used in the maritime mobile service for radiotelephony in the bands between 1 606.5 kHz (1 605 kHz Region 2) and 4 000 kHz and between 4 000 kHz and 27 500 kHz	Nos. **52.181**, **52.229**, Appendix **17** (Part B, Section I § 2 and § 6)
M.1174-4	Technical characteristics of equipment used for on-board vessel communications in the bands between 450 and 470 MHz	Nos. **5.287**, **5.288**
M.1187-1	A method for the calculation of the potentially affected region for a mobile-satellite service network in the 1-3 GHz range using circular orbits	Appendix **4** (Annex 2 item C.11.b)
S.1256-0	Methodology for determining the maximum aggregate power flux-density at the geostationary-satellite orbit in the band 6 700-7 075 MHz from feeder links of non-geostationary satellite systems in the mobile-satellite service in the space-to-Earth direction	No. **22.5A**
RS.1260-2	Feasibility of sharing between active spaceborne sensors and other services in the range 420-470 MHz	No. **5.279A**
BO.1293-2	Protection masks and associated calculation methods for interference into broadcast-satellite systems involving digital emissions	Appendix **30A** (Annex 3 § 3.3), Appendix **30** (Annex 5 § 3.4)
S.1340-0	Sharing between feeder links for the mobile-satellite service and the aeronautical radionavigation service in the Earth-to-space direction in the band 15.4-15.7 GHz	No. **5.511C**
S.1428-1	Reference FSS earth-station radiation patterns for use in interference assessment involving non-GSO satellites in frequency bands between 10.7 GHz and 30 GHz	TABLE **22-1A**, TABLE **22-1B**, TABLE **22-1C** (and No. **22.5C.6**)

Recommendation ITU-R	Title of the Recommendation	RR provisions and footnotes with ITU-R Recommendations contained in RR Volume 4
BO.1443-3	Reference BSS earth station antenna patterns for use in interference assessment involving non-GSO satellites in frequency bands covered by RR Appendix 30	TABLE **22-1D** (and Nos. **22.5C.11** and **22.5C.13**)
RA.1513-2	Levels of data loss to radio astronomy observations and percentage-of-time criteria resulting from degradation by interference for frequency bands allocated to the radio astronomy service on a primary basis	Nos. **5.372**, **5.511G**, **5.511H**, **5.531C**, **5.531E** and No. **5.510A** (via Resolution **678 (WRC-23)**)
M.1583-1	Interference calculations between non-geostationary mobile-satellite service or radionavigation-satellite service systems and radio astronomy telescope sites	No. **5.372**, No. **5.443B** (via Resolution **741 (Rev.WRC-15)**), Appendix **4** Annex 2 (item A.17.b.3) (via Resolution **741 (Rev.WRC-15)**)
S.1586-1	Calculation of unwanted emission levels produced by a non-geostationary fixed-satellite service system at radio astronomy sites	No. **5.551H**
F.1613-0	Operational and deployment requirements for fixed wireless access systems in the fixed service in Region 3 to ensure the protection of systems in the Earth exploration-satellite service (active) and the space research service (active) in the band 5 250-5 350 MHz	No. **5.447E**
RA.1631-0	Reference radio astronomy antenna pattern to be used for compatibility analyses between non-GSO systems and radio astronomy service stations based on the epfd concept	No. **5.208B** (via Resolution **739 (Rev.WRC-19)**, No. **5.372**, No. **5.443B** (via Resolution **741 (Rev.WRC-15)**), No. **5.551H**, Appendix **4** Annex 2 (item A.17.b.3) (via Resolution **741 (Rev.WRC-15)**)
M.1642-2	Methodology for assessing the maximum aggregate equivalent power flux-density at an aeronautical radionavigation service station from all radionavigation-satellite service systems operating in the 1 164-1 215 MHz band	Nos. **5.328A** (via Resolution **609 (Rev. WRC-07)**)
M.1643-0	Technical and operational requirements for aircraft earth stations of aeronautical mobile-satellite service including those using fixed-satellite service network transponders in the band 14-14.5 GHz (Earth-to-space)	No. **5.504B** (refers to Annex 1, Part C of Rec. ITU-R M.1643-0), Nos. **5.504C**, **5.508A** and **5.509A** (refer to Annex 1, Part B of Rec. ITU-R M.1643-0)
M.1652-1 (Annex 1 and Annex 5)	Dynamic frequency selection in wireless access systems including radio local area networks for the purpose of protecting the radiodetermination service in the 5 GHz band	Nos. **5.446A**, **5.447F**, **5.450A** (via Resolution **229 (Rev.WRC-23)**)

Recommendation ITU-R	Title of the Recommendation	RR provisions and footnotes with ITU-R Recommendations contained in RR Volume 4
M.1827-1	Guideline on technical and operational requirements for stations of the aeronautical mobile (R) service limited to surface application at airports in the frequency band 5 091-5 150 MHz	No. **5.444B** (via Resolution **748 (Rev.WRC-19)**)
M.2013-0	Technical characteristics of, and protection criteria for non-ICAO aeronautical radionavigation systems, operating around 1 GHz	No. **5.327A** (via Resolution **417 (Rev.WRC-15)**)
RS.2065-0	Protection of space research service (SRS) space-to-Earth links in the 8 400-8 450 MHz and 8 450-8 500 MHz bands from unwanted emissions of synthetic aperture radars operating in the Earth exploration-satellite service (active) around 9 600 MHz	No. **5.474C**
RS.2066-0	Protection of the radio astronomy service in the frequency band 10.6-10.7 GHz from unwanted emissions of synthetic aperture radars operating in the Earth exploration-satellite service (active) around 9 600 MHz	No. **5.474B**
S.2157-0	Procedures for the evaluation of interference from any non-geostationary-satellite system into a global set of the generic geostationary-satellite reference links in the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space)	Nos. **5.550C**, **22.5L.1** (via Resolution **770 (Rev.WRC-23)**)

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Geneva, 2024

Worldwide allotment areas
(to be used with map 2a)

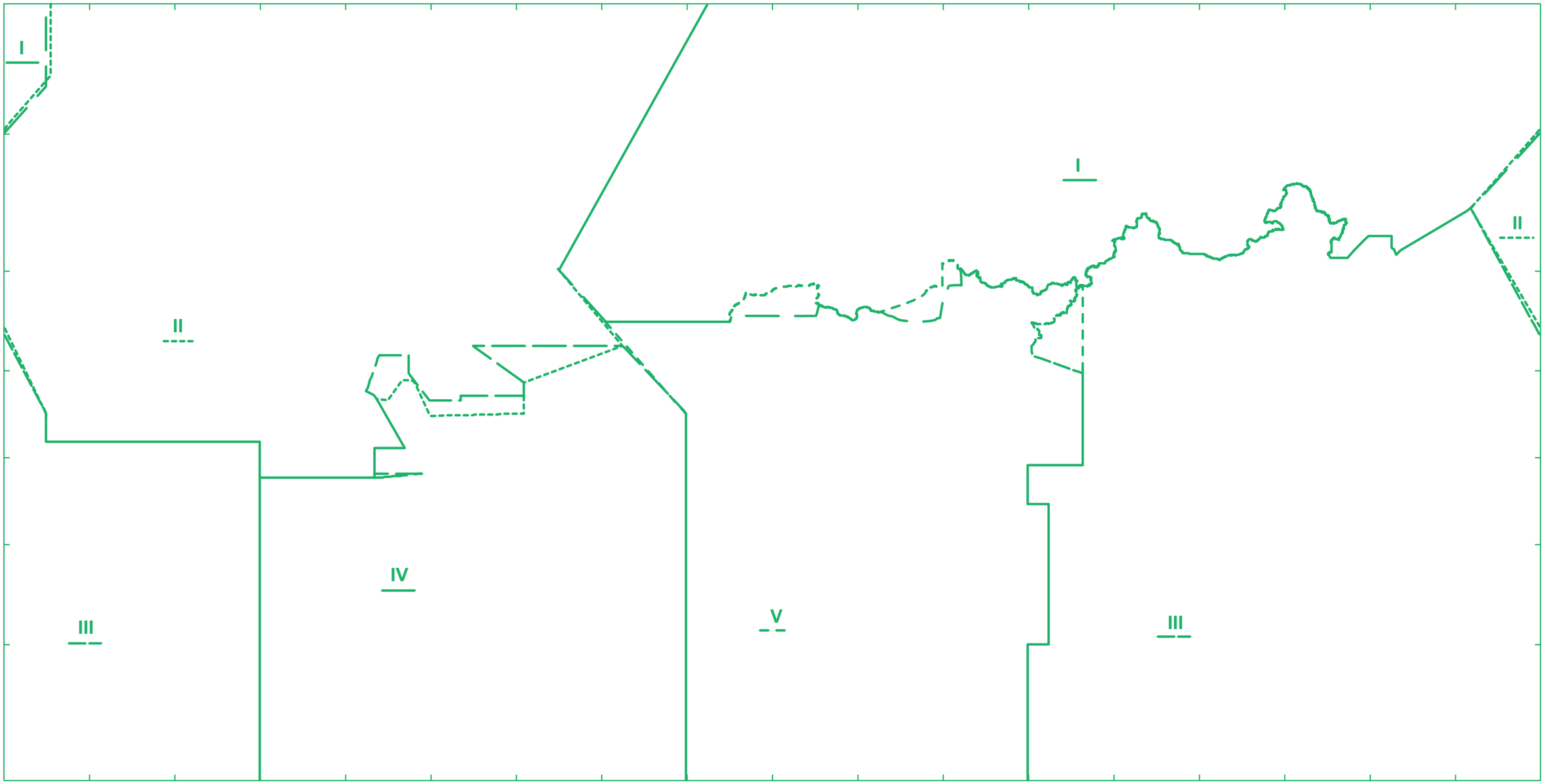
مناطق التعيين العالمية
(تستعمل مع الخريطة 2 أ)

世界范围分配区
（与地图2a一起使用）

Zonas de adjudicación mundial
(a utilizar con el mapa 2a)

Zones mondiales d'allotissement
(à utiliser avec la carte 2a)

Всемирные зоны веделения
(Используется с картой 2a)



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Worldwide allotment areas
(to be used with map 2b)

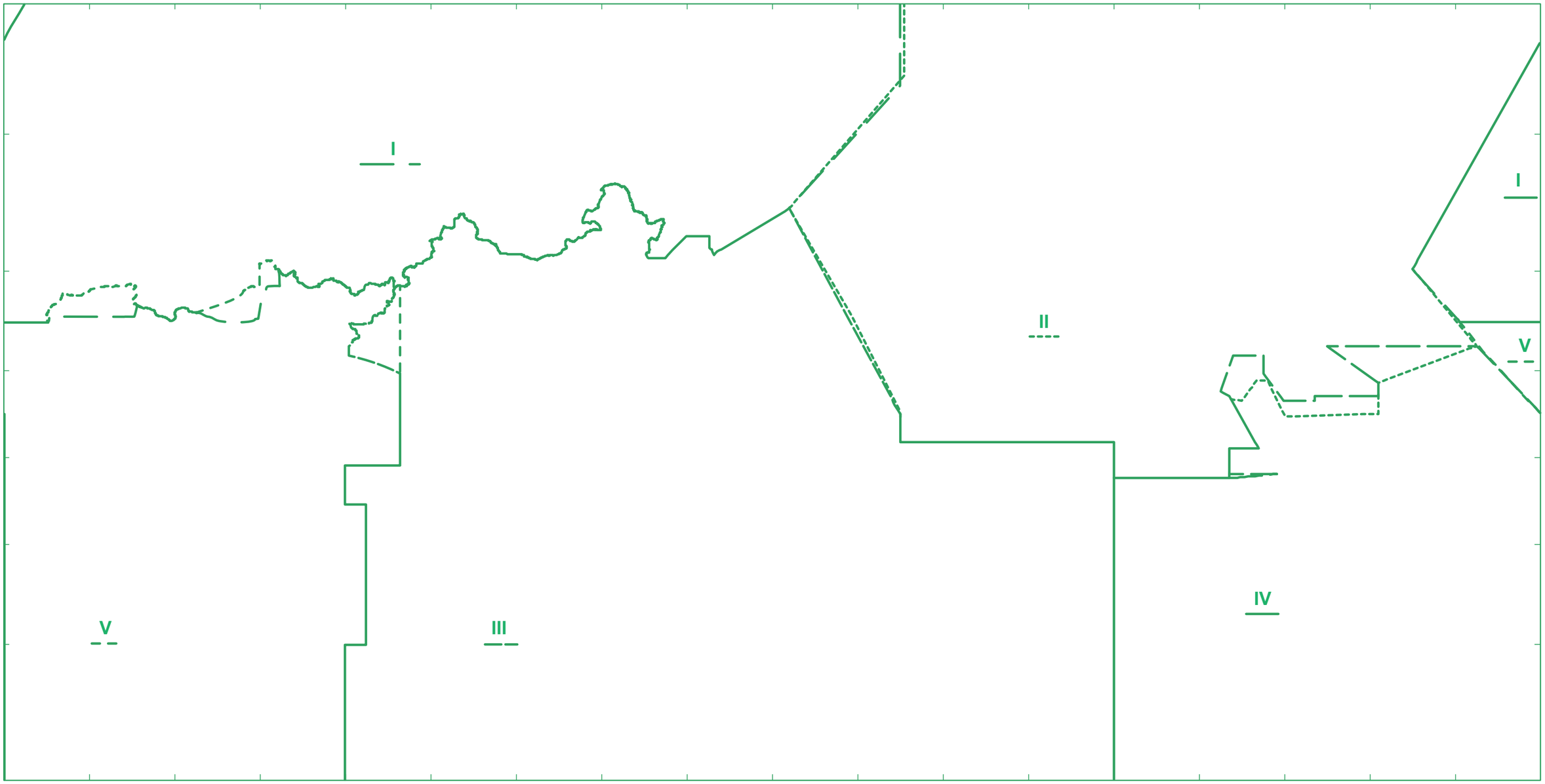
مناطق التعيين العالمية
(تستعمل مع الخريطة 2 ب)

世界范围分配区
（与地图2b一起使用）

Zonas de adjudicación mundial
(a utilizar con el mapa 2b)

Zones mondiales d'allotissement
(à utiliser avec la carte 2b)

Всемирные зоны выделений
(Используется с картой 2b)



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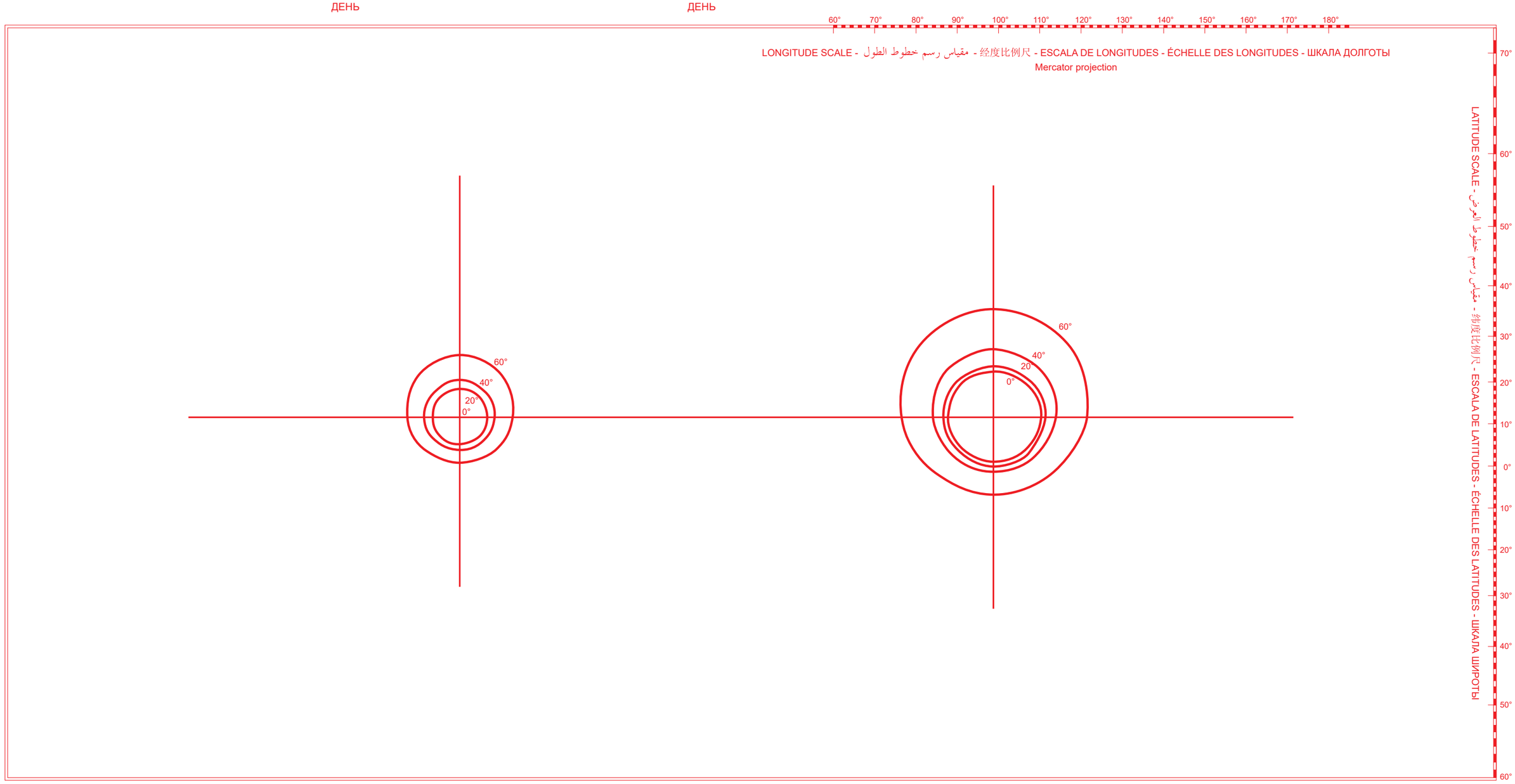
3.0 3.5 MHz DAY
نهاراً
白天
DÍA
JOUR
ДЕНЬ

4.7 MHz DAY
نهاراً
白天
DÍA
JOUR
ДЕНЬ



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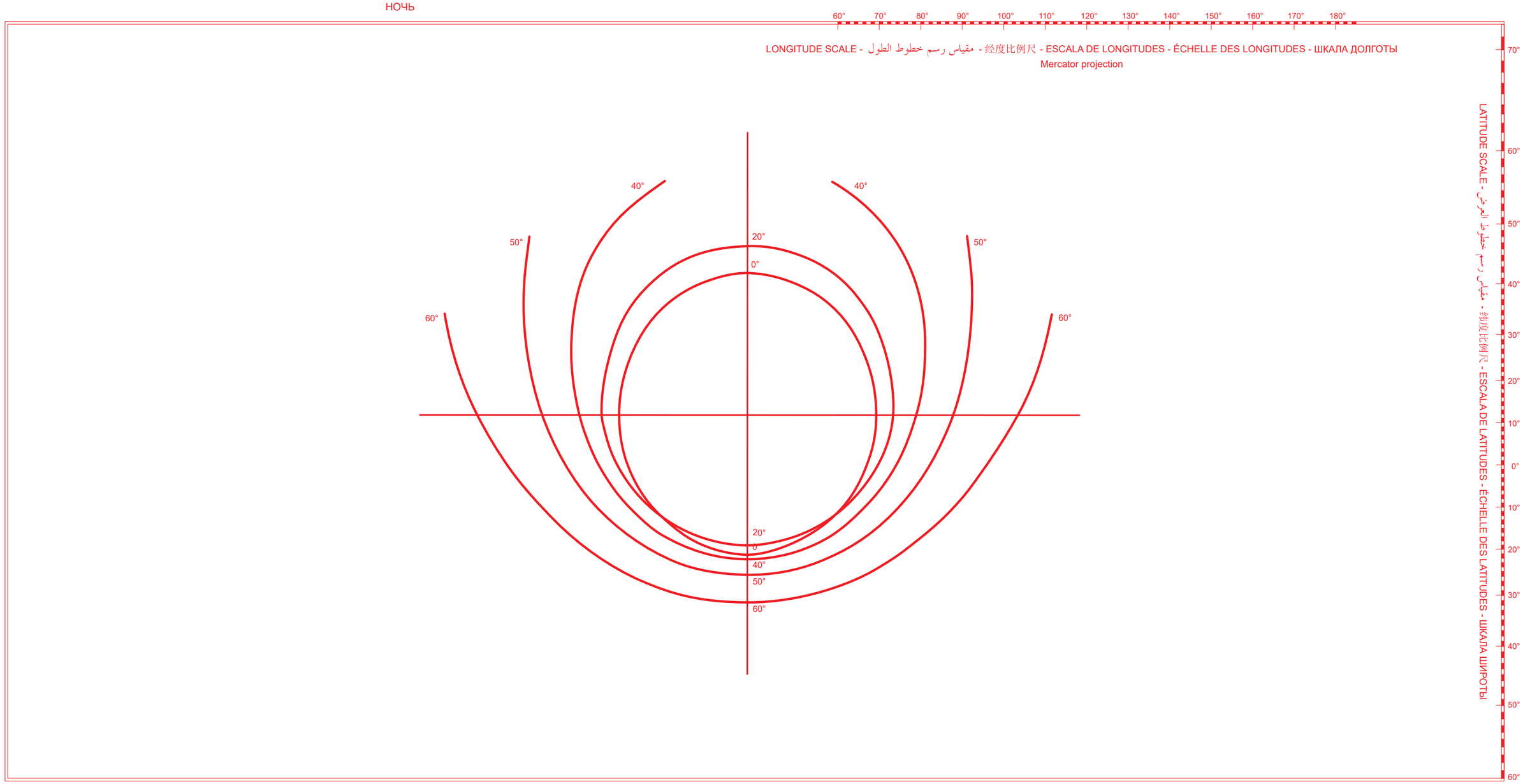
3 MHz NIGHT
ليلاً
夜晚
NOCHE
NUIT
НОЧЬ



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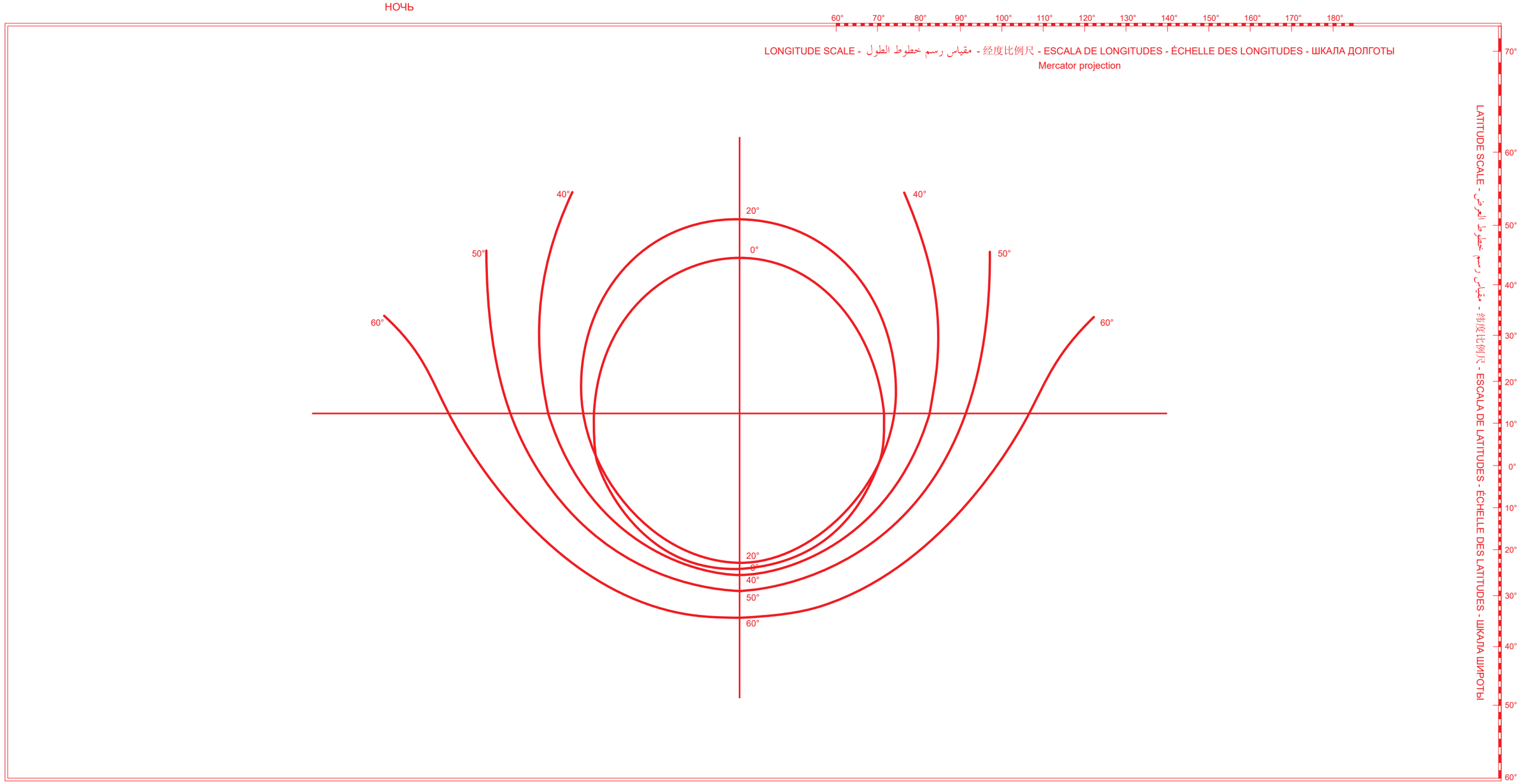
3.5 MHz NIGHT
ليلاً
夜晚
NOCHE
NUIT
НОЧЬ



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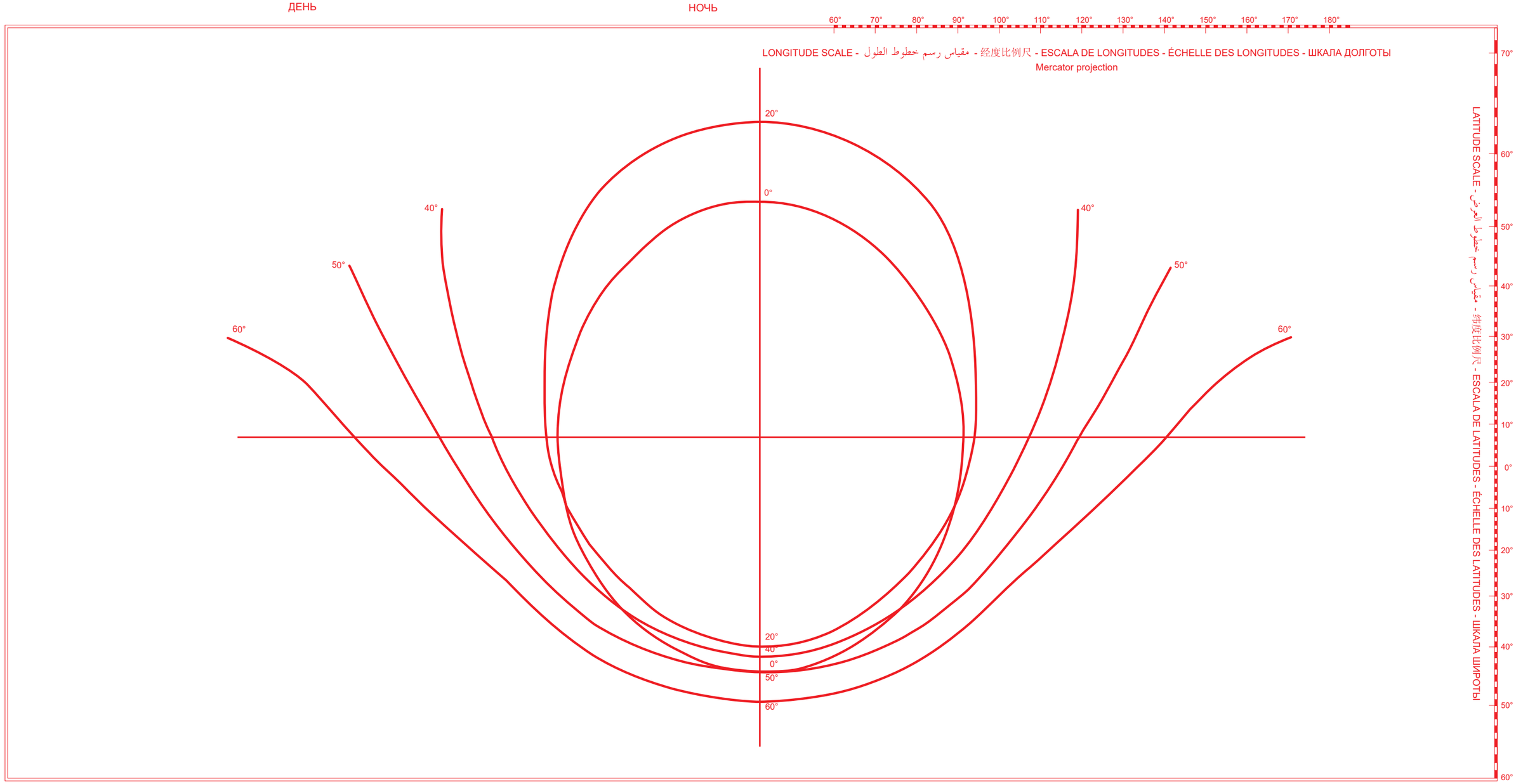
10.0 MHz DAY
نهاراً
白天
DÍA
JOUR
ДЕНЬ

4.7 MHz NIGHT
ليلاً
夜晚
NOCHE
NUIT
НОЧЬ



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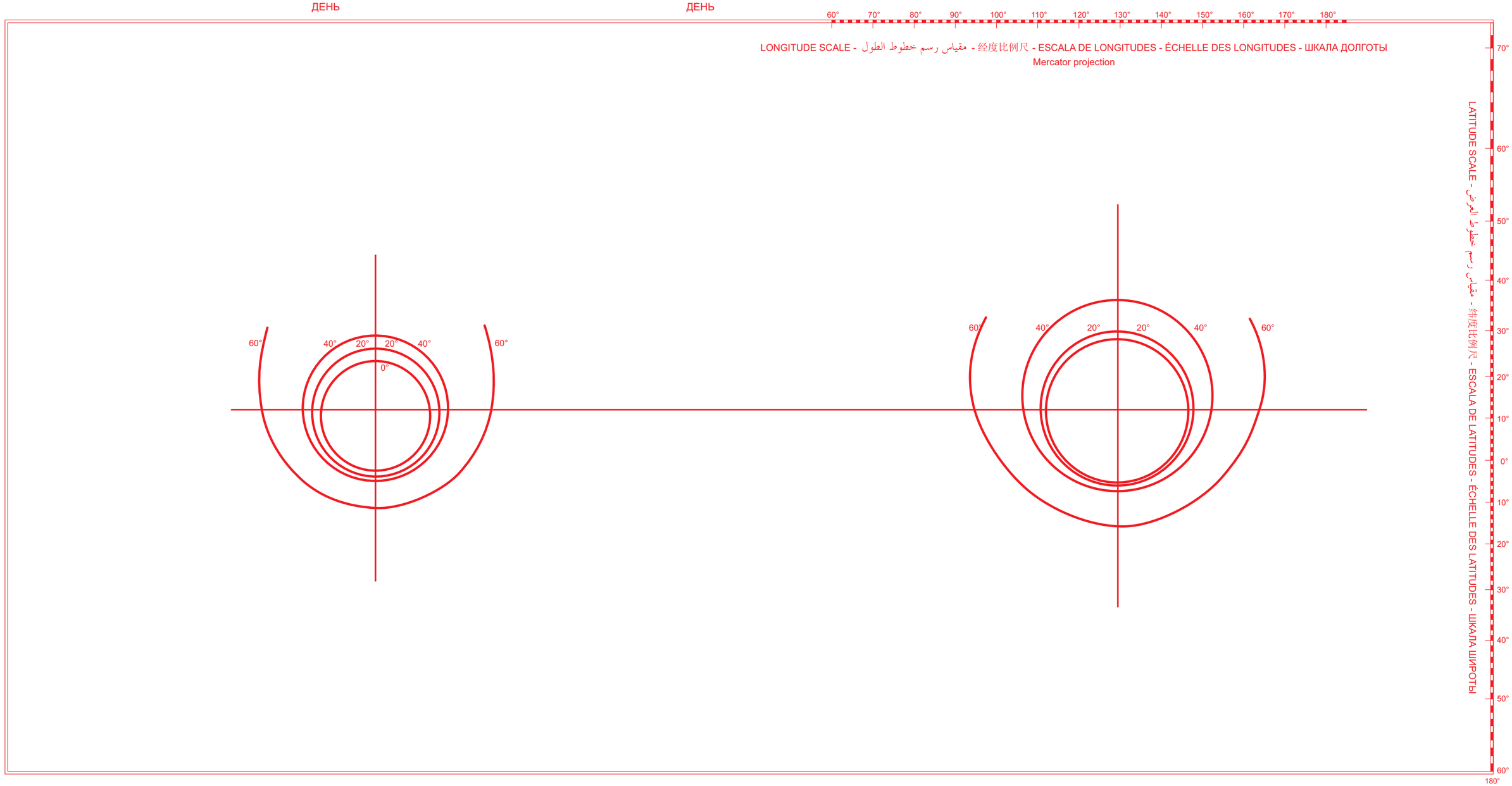
5.6 MHz DAY
نهاراً
白天
DÍA
JOUR
ДЕНЬ

6.6 MHz DAY
نهاراً
白天
DÍA
JOUR
ДЕНЬ



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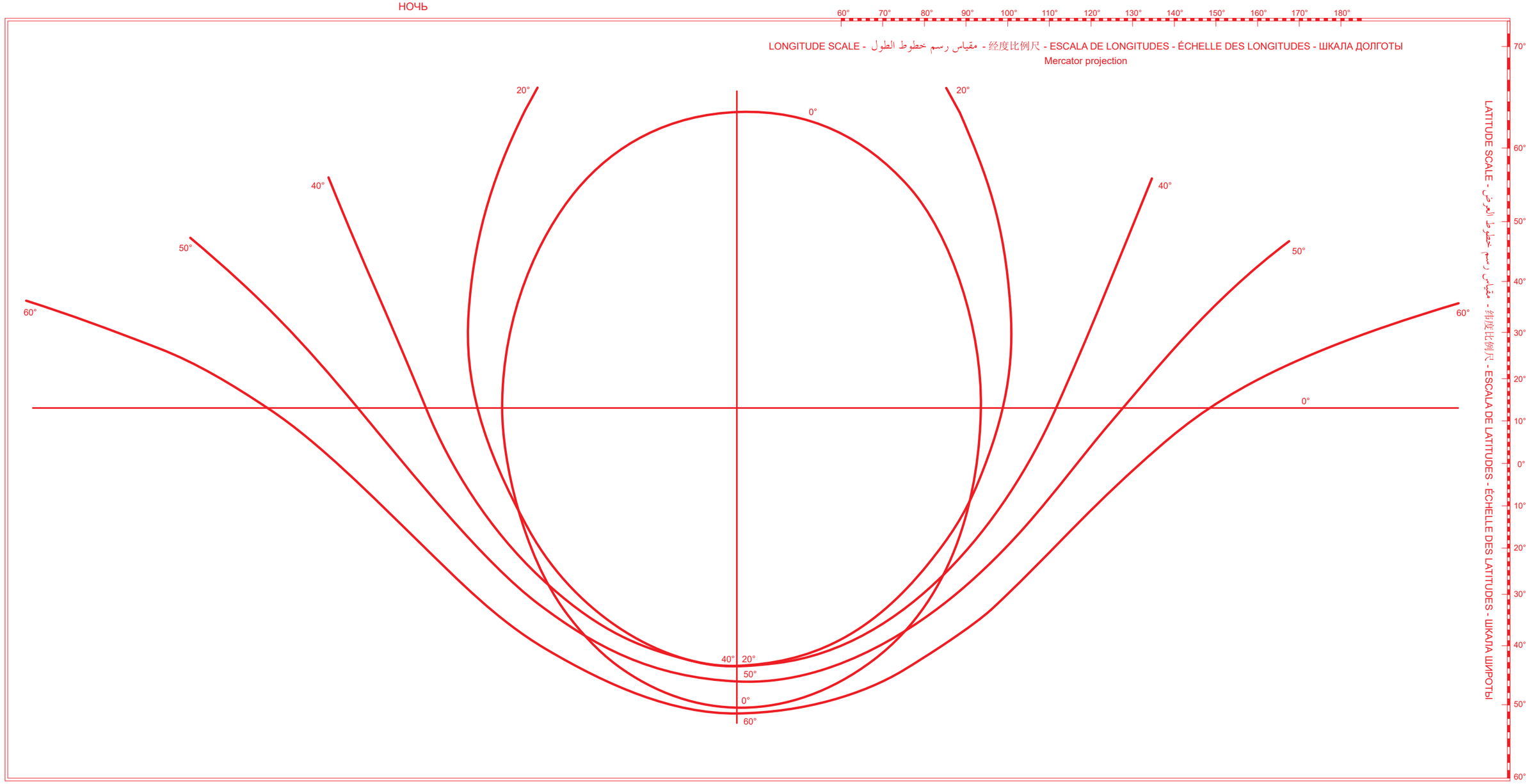
5.6 6.6 MHz NIGHT
ليلاً
夜晚
NOCHE
NUIT
НОЧЬ



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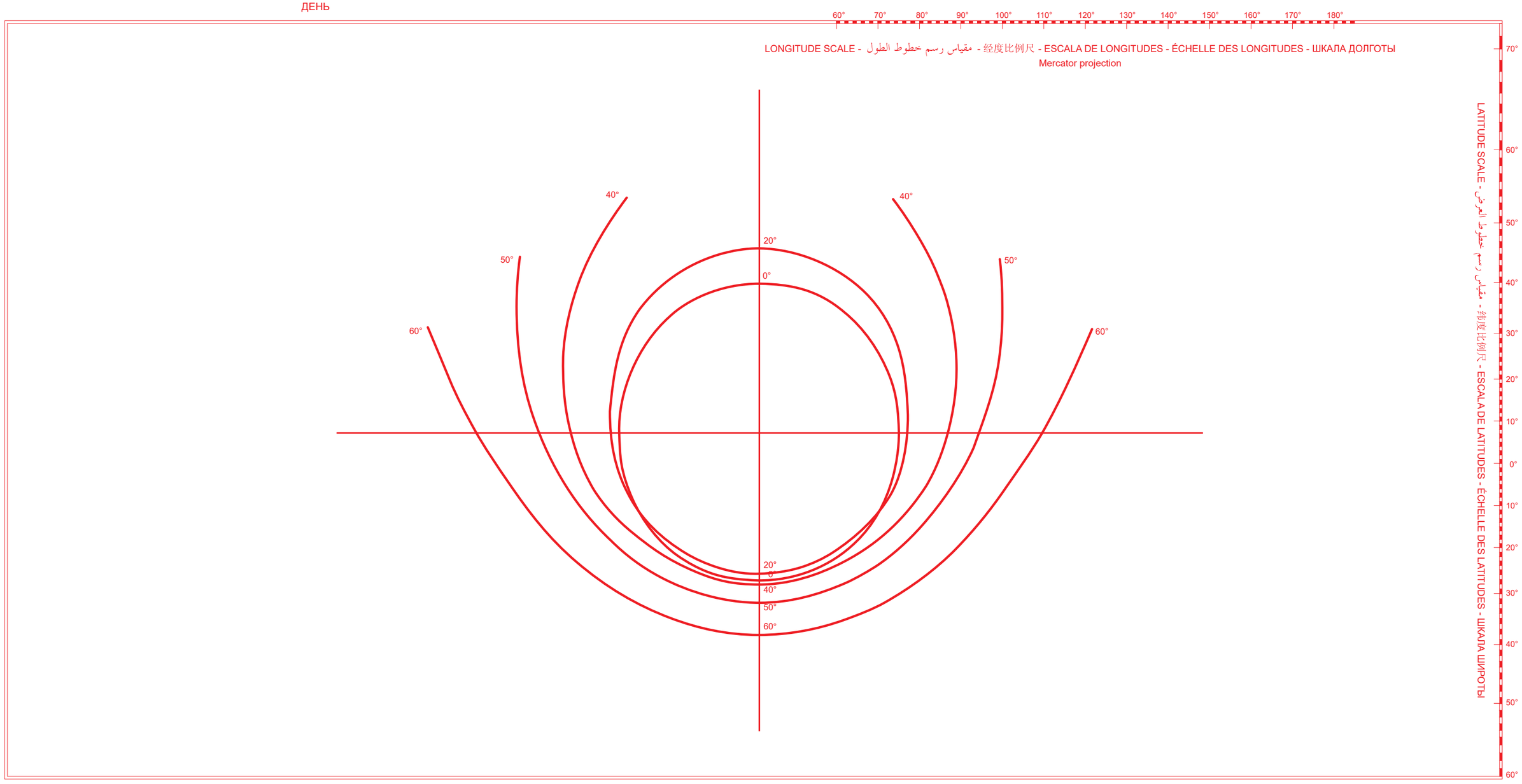
9 MHz DAY
نهاراً
白天
DÍA
JOUR
ДЕНЬ



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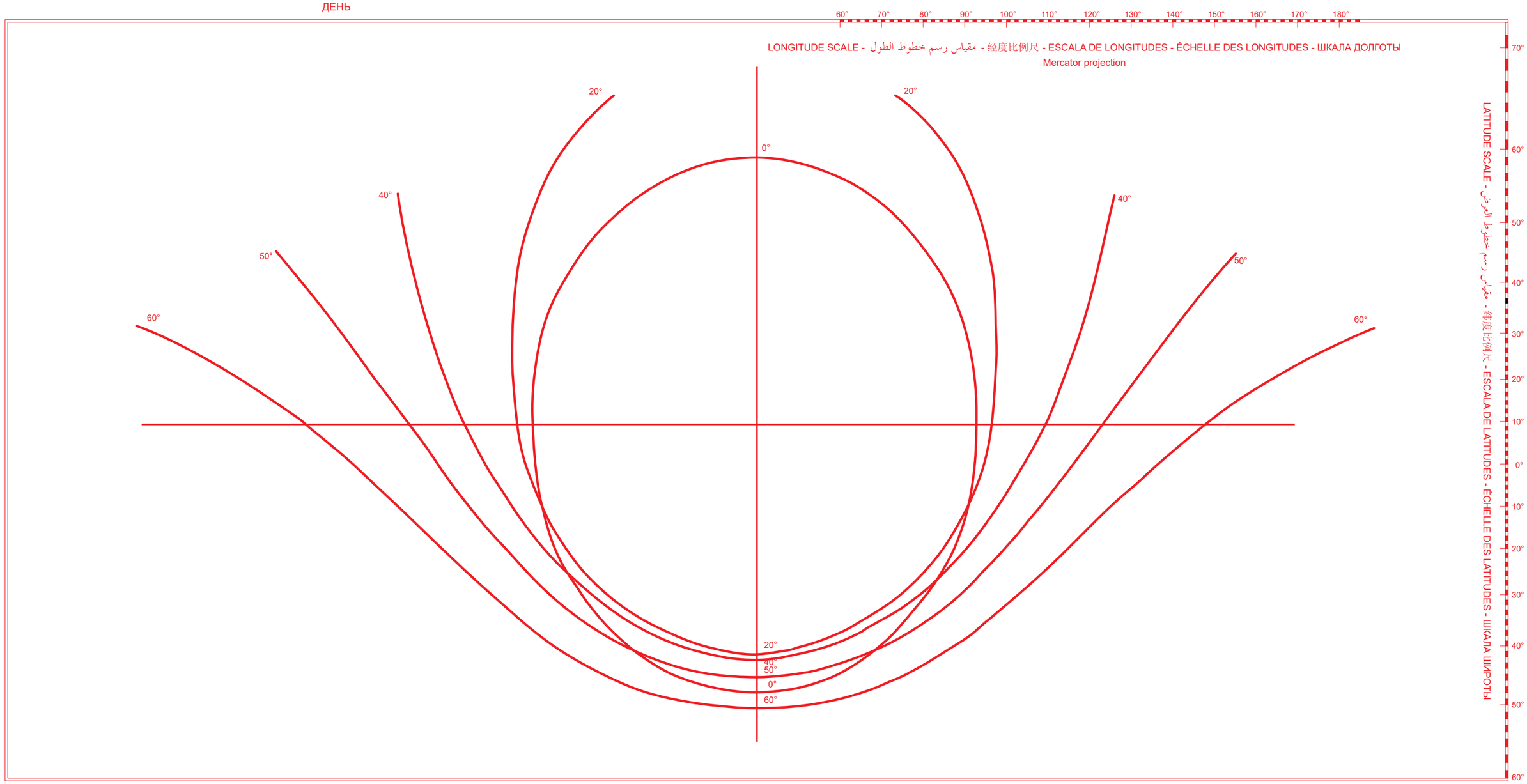
11.3 MHz DAY
نهاراً
白天
DÍA
JOUR
ДЕНЬ



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Wordwide allotment areas
(to used with map 5)

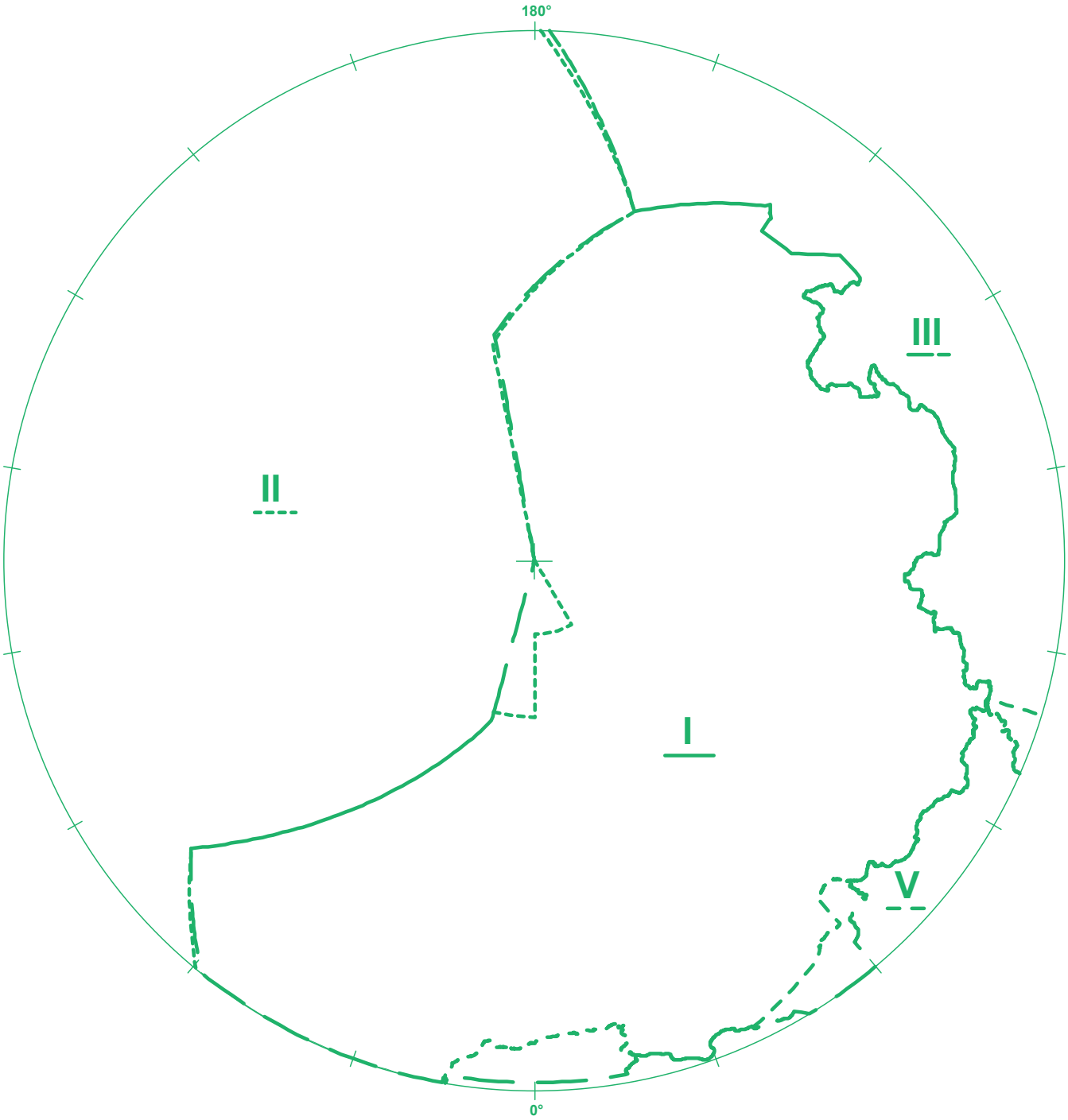
مناطق التعيين العالمية
(كي تستخدم مع الخريطة 5)

世界范围分配区
（与地图5一并使用）

Zonas de adjudicación mundial
(a utilizar con el mapa 5)

Zones mondiales d'allotissement
(a utilser avec la carte 5)

Мировые зоны выделения
(используется с картой 5)



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Wordwide allotment areas
(to used with map 7)

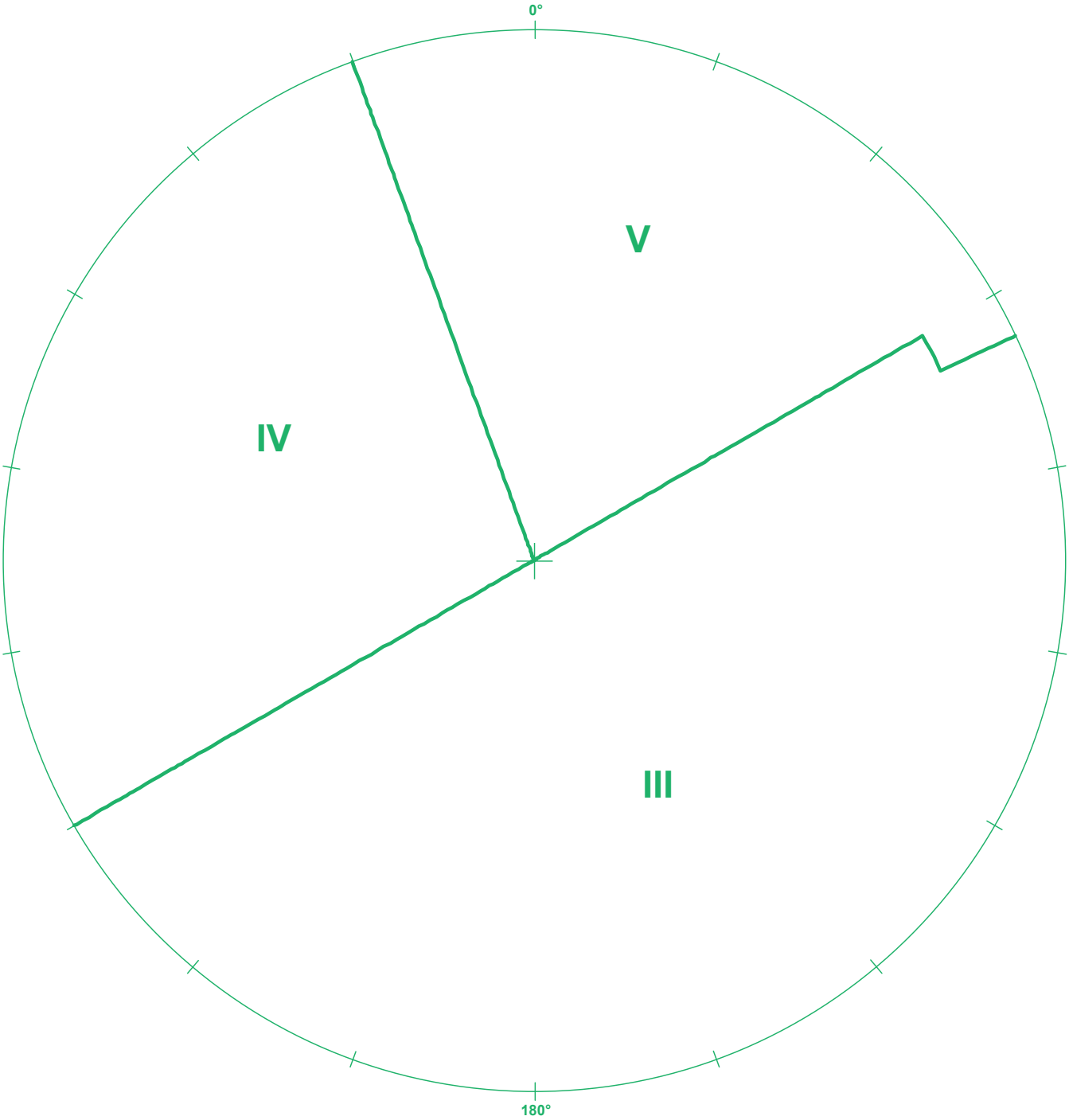
مناطق التعيين العالمية
(كي تستخدم مع الخريطة 7)

世界范围分配区
（与地图7一并使用）

Zonas de adjudicación mundial
(a utilizar con el mapa 7)

Zones mondiales d'allotissement
(a utilser avec la carte 7)

Мировые зоны выделения
(используется с картой 7)



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Lambert azimuthal
equal area projection
Interference range contours

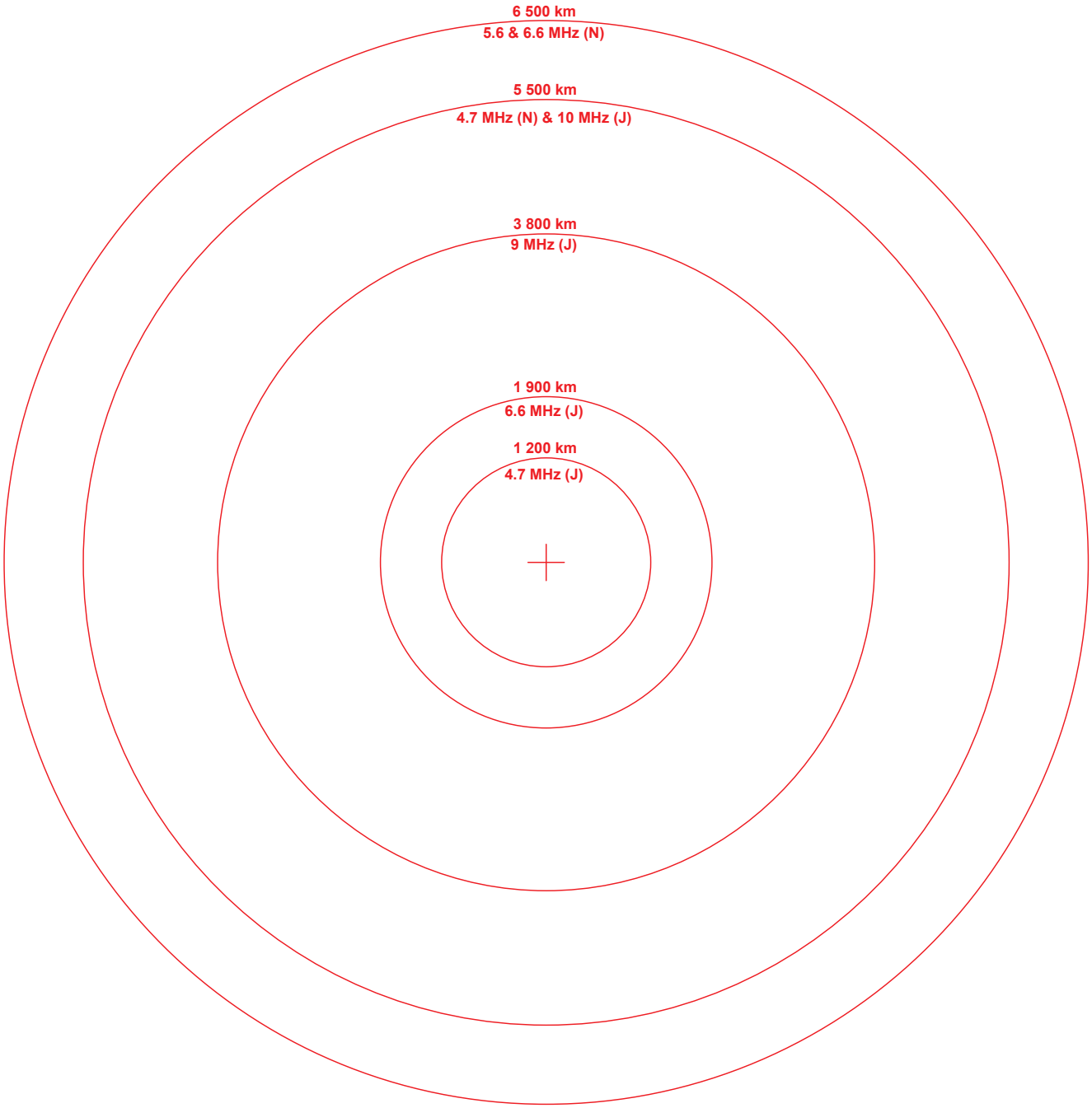
أسقاط لامبرت السمتي متساوي السطوح
أكفة مديات التداخل

兰伯特方位
等积投影
干扰范围等值线

Proyección acimutal
equivalente de Lambert
Curvas de alcances de
interferencia

Projection azimutale
équivalente de Lambert
Courbes indiquant les portées
de brouillage

Ламбертова азимутальная проекция
равных площадей
Контуры зоны действия помех



4.7 MHz	DAY 日 JOUR	نهار DÍA ДЕНЬ	1 200 km
6.6 MHz	DAY 日 JOUR	نهار DÍA ДЕНЬ	1 900 km
9.0 MHz	DAY 日 JOUR	نهار DÍA ДЕНЬ	3 800 km

10 MHz	DAY 日 JOUR	نهار DÍA ДЕНЬ	5 500 km
4.7 MHz	NIGHT c NUIT	ليل NOCHE НОЧЬ	5 500 km
5.6 & 6.6 MHz	NIGHT c NUIT	ليل NOCHE НОЧЬ	6 500 km

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Lambert azimuthal
equal area projection
Interference range contours

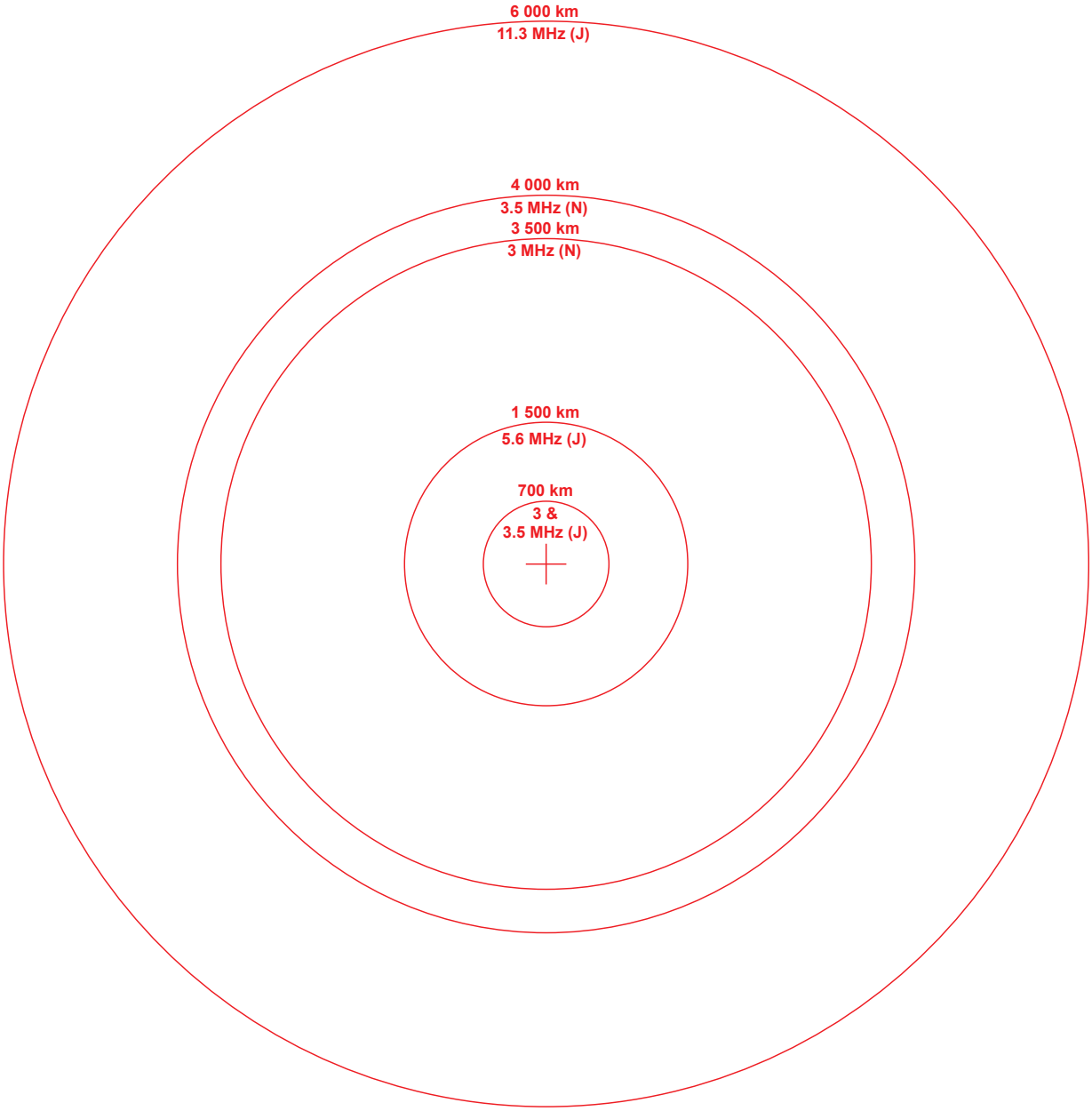
أسقاط لامبرت السمتي متساوي السطوح
أكفة مديات التداخل

兰伯特方位
等积投影
干扰范围等值线

Proyección acimutal
equivalente de Lambert
Curvas de alcances de
interferencia

Projection azimutale
équivalente de Lambert
Courbes indiquant les portées
de brouillage

Ламбертова азимутальная проекция
равных площадей
Контуры зоны действия помех



3 & 3.5 MHz	DAY 日 JOUR	نهار DÍA ДЕНЬ	700 km
5.6 MHz	DAY 日 JOUR	نهار DÍA ДЕНЬ	1 500 km
3 MHz	NIGHT 夜 NUIT	ليل NOCHE НОЧЬ	3 500 km
3.5 MHz	NIGHT 夜 NUIT	ليل NOCHE НОЧЬ	4 000 km
11.3 MHz	DAY 日 JOUR	نهار DÍA ДЕНЬ	6 000 km

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MAP 1a
Major world air route areas
(180° W-180° W)

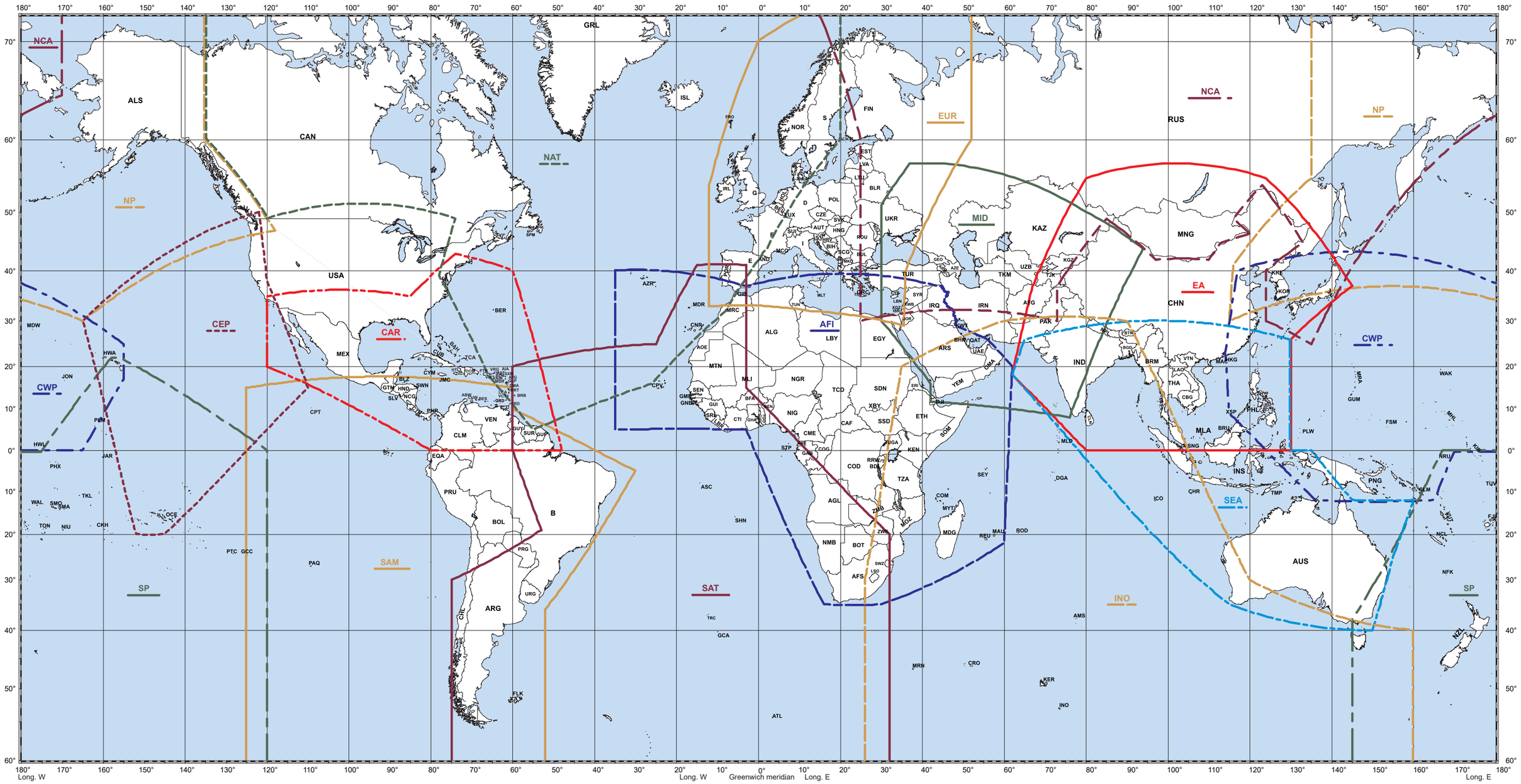
الخريطة 1أ
مناطق الخطوط الجوية العالمية الرئيسية
(180° غرباً -180°غرباً)

地图 1a
主要国际航线区域
(西经180度– 西经180度)

MAPA 1a
Zonas de paso de rutas aéreas
mundiales principales (180° O-180° O)

CARTE 1a
Zones de passage des lignes aériennes
mondiales principales (180° O-180° O)

КАРТА 1a
Зоны основных всемирных
воздушных трасс (180° з. д.-180° з. д.)



AFI	AFRICA	إفريقيا	非洲	ÁFRICA	AFRIQUE	Африка
CAR	CARIBBEAN	الكاريبي	加勒比	CARIBE	CARAÏBES	Карибский бассейн
CEP	CENTRAL EAST PACIFIC	وسط شرق المحيط الهادئ	中东太平洋	PACÍFICO ESTE CENTRAL	CENTRE EST PACIFIQUE	Центрально-Восточная часть Тихого океана
CWP	CENTRAL WEST PACIFIC	وسط غرب المحيط الهادئ	中西太平洋	PACÍFICO OESTE CENTRAL	CENTRE OUEST PACIFIQUE	Центрально-Западная часть Тихого океана
EA	EAST ASIA	شرق آسيا	东亚	ASIA ORIENTAL	ASIE DE L'EST	Восточная Азия
EUR	EUROPE	أوروبا	欧洲	EUROPA	EUROPE	Европа
INO	INDIAN OCEAN	المحيط الهندي	印度洋	OCÉANO ÍNDICO	OCÉAN INDIEN	Индийский океан
MID	MIDDLE EAST	الشرق الأوسط	中东	ORIENTE MEDIO	MOYENT-ORIENT	Ближний Восток
NAT	NORTH ATLANTIC	شمال المحيط الأطلسي	北大西洋	ATLÁNTICO NORTE	NORD ATLANTIQUE	Северная часть Атлантического океана
NCA	NORTH CENTRAL ASIA	شمال وسط آسيا	中北亚	ASIA CENTRO-SEPTENTRIONAL	NORD CENTRE ASIE	Северо-Центральная Азия
NP	NORTH PACIFIC	شمال المحيط الهادئ	北太平洋	PACÍFICO NORTE	NORD PACIFIQUE	Северная часть Тихого океана
SAM	SOUTH AMERICA	أمريكا الجنوبية	南美洲	AMÉRICA DEL SUR	SUD AMÉRIQUE	Южная Америка
SAT	SOUTH ATLANTIC	جنوب المحيط الأطلسي	南大西洋	ATLÁNTICO SUR	SUD ATLANTIQUE	Южная часть Атлантического океана
SEA	SOUTH EAST ASIA	جنوب شرق آسيا	东南亚	ASIA SUDORIENTAL	SUD-EST ASIATIQUE	Юго-Восточная Азия
SP	SOUTH PACIFIC	جنوب المحيط الهادئ	南太平洋	PACÍFICO SUR	SUD PACIFIQUE	Южная часть Тихого океана

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MAP 1b
Major world air route areas
(20° W-20° W)

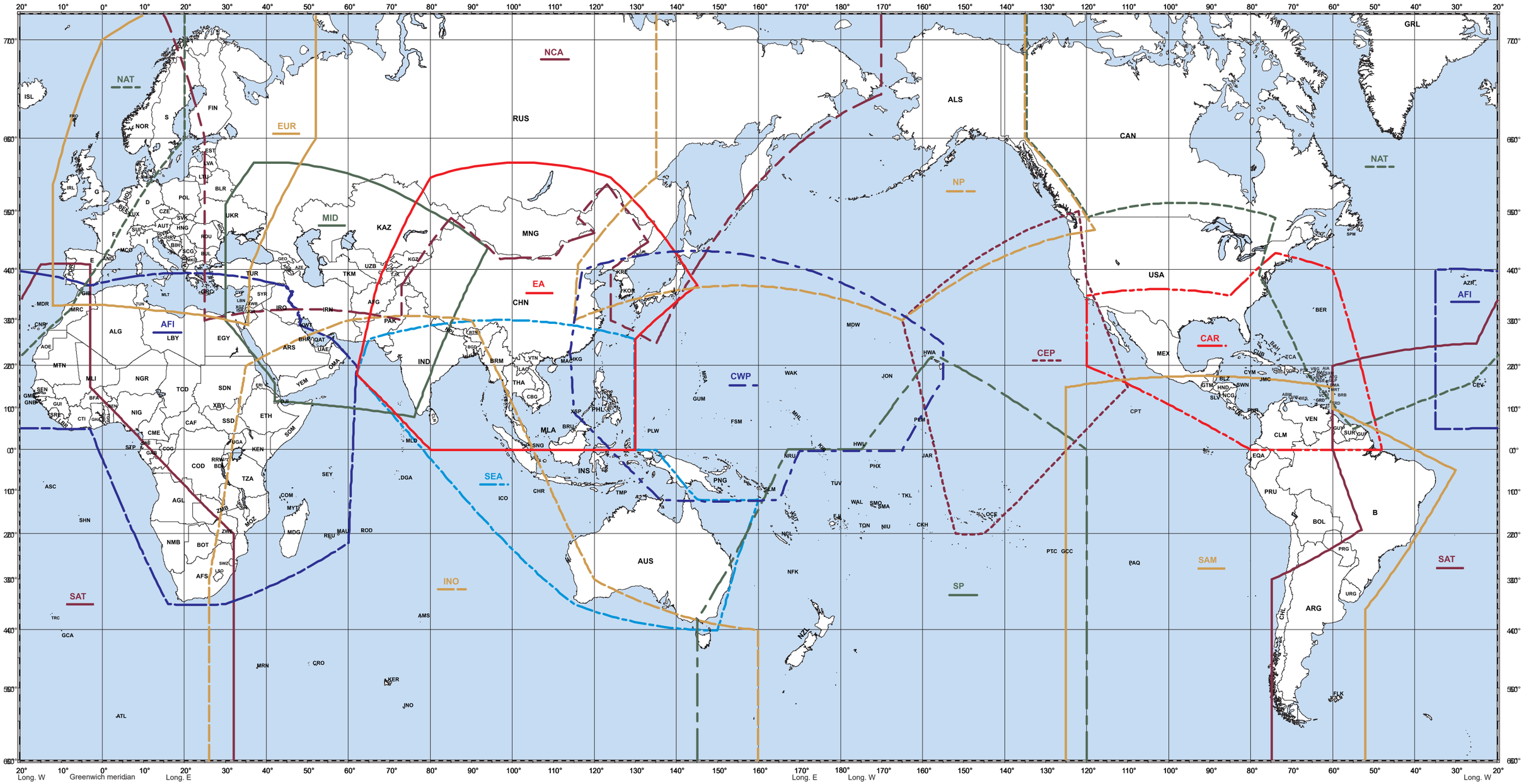
الخريطة 1ب
مناطق الخطوط الجوية العالمية الرئيسية
(20° غرباً - 20° غرباً)

地图 1b
主要国际航线区域
(西经20度– 西经20度)

MAPA 1b
Zonas de paso de rutas aéreas
mundiales principales (20° O-20° O)

CARTE 1b
Zones de passage des lignes aériennes
mondiales principales (20° O-20° O)

КАРТА 1b
Зоны основных всемирных
воздушных трасс (20° з. д.-20° з. д.)



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CWP	CENTRAL WEST PACIFIC	وسط غرب المحيط الهادئ	中西太平洋	PACÍFICO OESTE CENTRAL	CENTRE OUEST PACIFIQUE	Центрально-Западная часть Тихого океана
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SAT	SOUTH ATLANTIC	جنوب المحيط الأطلسي	南大西洋	ATLÁNTICO SUR	SUD ATLANTIQUE	Южная часть Атлантического океана
SEA	SOUTH EAST ASIA	جنوب شرق آسيا	东南亚	ASIA SUDORIENTAL	SUD-EST ASIATIQUE	Юго-Восточная Азия
SP	SOUTH PACIFIC	جنوب المحيط الهادئ	南太平洋	PACÍFICO SUR	SUD PACIFIQUE	Южная часть Тихого океана

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MAP 2a
Regional and domestic air route areas (180° W-180° W)

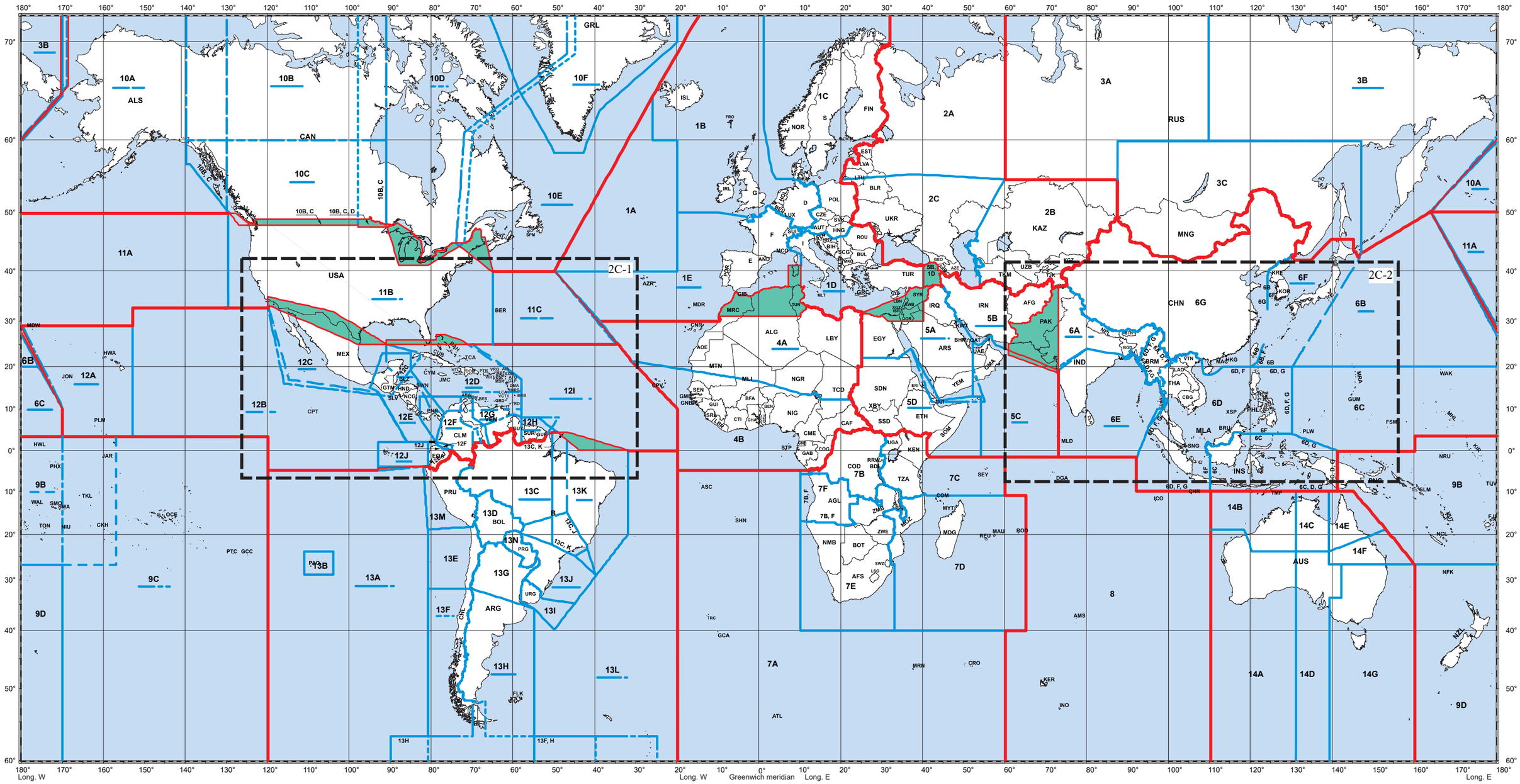
الخريطة 2أ
مناطق الخطوط الجوية الإقليمية والوطنية
(180° غرباً - 180° غرباً)

地图2a
区域航线区域和国内航线区域
(西经180度– 西经180度)

MAPA 2a
Zonas de rutas aéreas regionales y nacionales (180° O-180° O)

CARTE 2a
Zones des lignes aériennes régionales et nationales (180° O-180° O)

КАРТА 2a
Зоны региональных и национальных воздушных трасс (180° з. д.-180° з. д.)



Main area	منطقة رئيسية	主区域
Zona principal	Zone principale	Главная зона
Sub-area	منطقة فرعية	次区域
Subzona	Zone secondaire	Субзона

The coloured areas show the overlap between the main areas.
المناطق الملونة تمثل تراكب المناطق الرئيسية
彩色区域表示主区域之间的重叠部分
Las zonas coloreadas representan la superposición de las zonas principales.
Les zones coloriées représentent le chevauchement des zones principales.
Закрашенные зоны показывают перекрытие главных зон.

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MAP 2b
Regional and domestic air route areas (20° W-20° W)

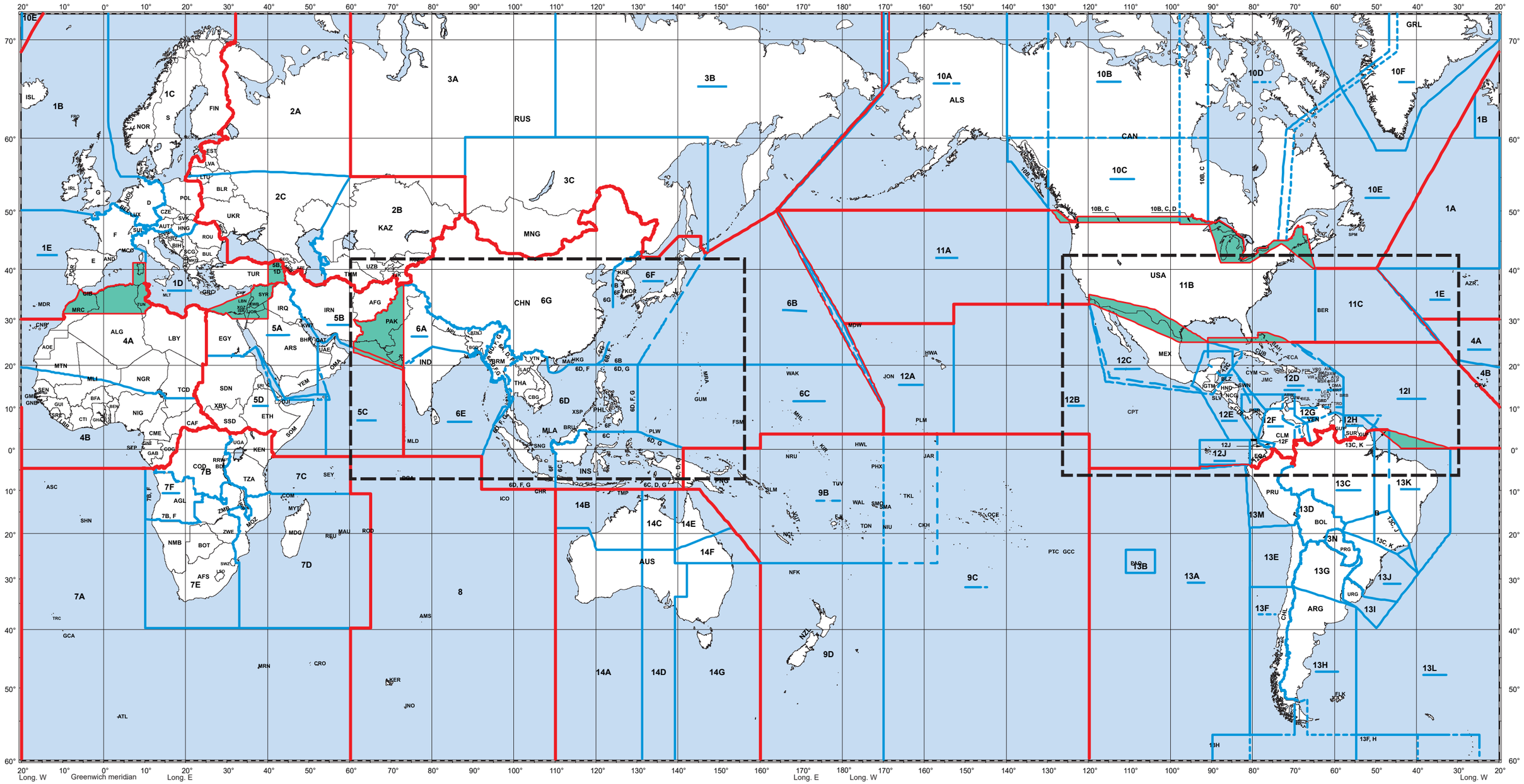
الخريطة 2 ب
مناطق الخطوط الجوية الإقليمية والوطنية
(20° غرباً - 20°غرباً)

地图2b
区域航线区域和国内航线区域
(西经20度- 西经20度)

MAPA 2b
Zonas de rutas aéreas regionales y nacionales (20° O-20° O)

CARTE 2b
Zones des lignes aériennes régionales et nationales (20° O-20° O)

КАРТА 2b
Зоны региональных и национальных воздушных трасс (20° з. д.-20° з. д.)



Main area	منطقة رئيسية	主区域
Zona principal	Zone principale	Главная зона
Sub-area	منطقة فرعية	次区域
Subzona	Zone secondaire	Субзона

The coloured areas show the overlap between the main areas.
المناطق الملونة تمثل تراكب المناطق الرئيسية
彩色区域表示主区域之间的重叠部分
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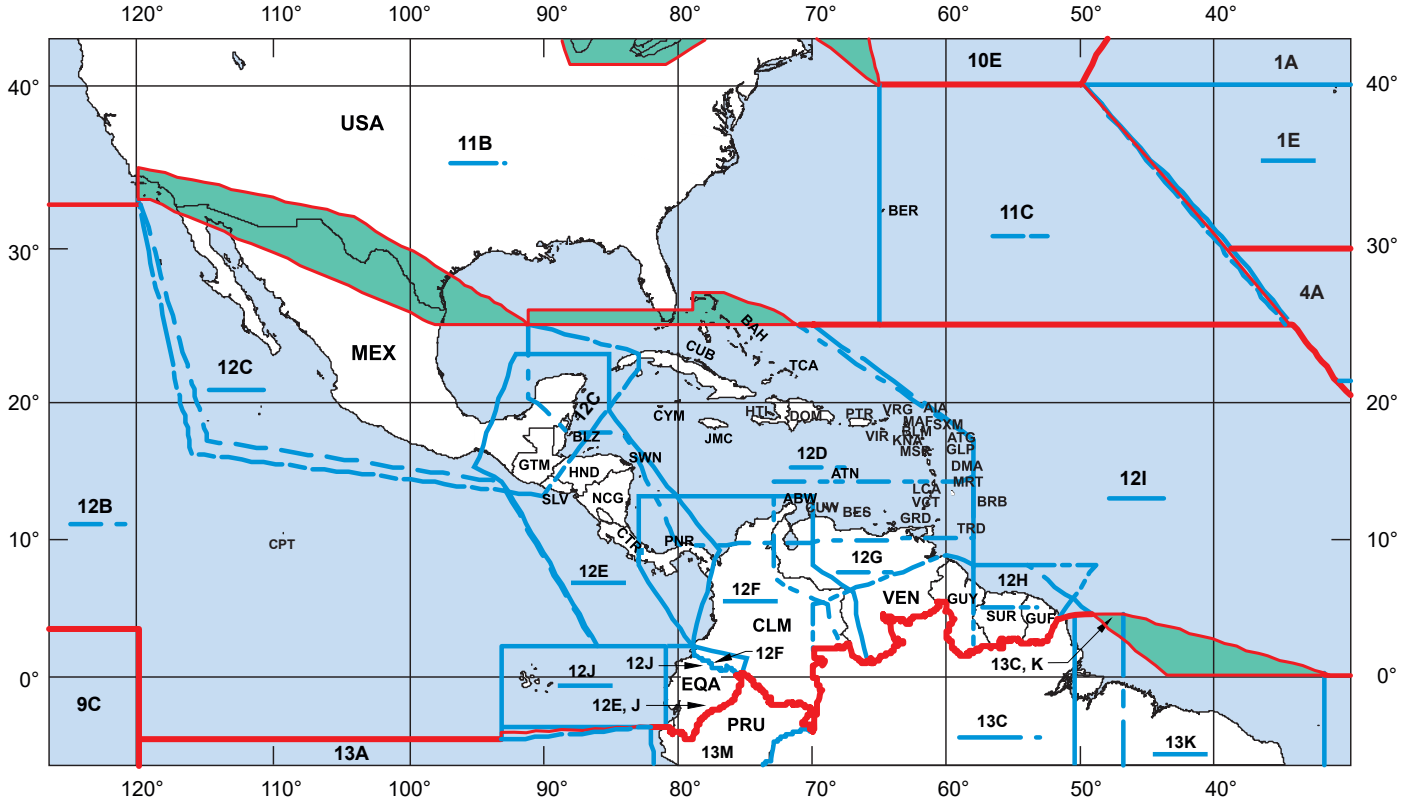
Extract of map 2a
Extracto del mapa 2a

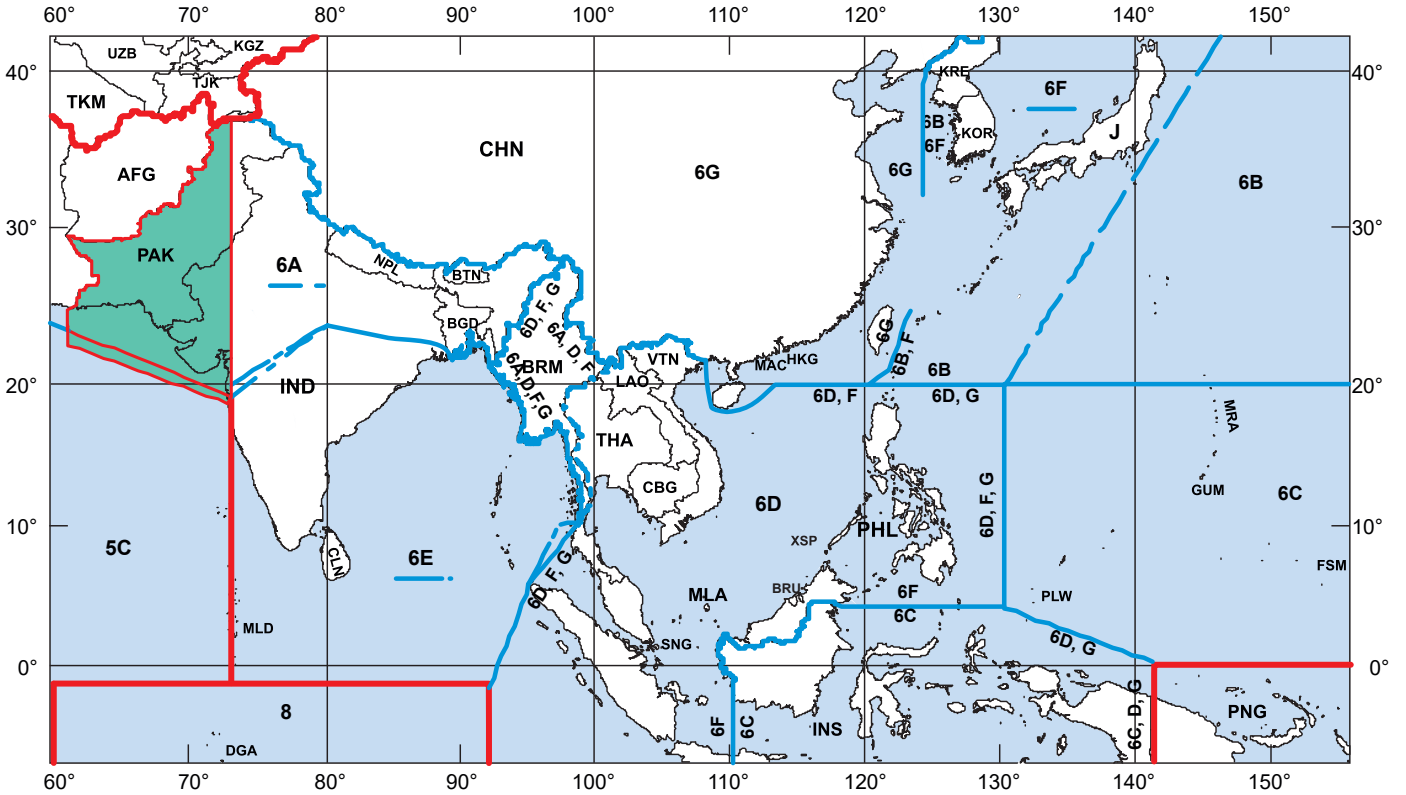
مقتطف من الخريطة 2 أ
Extrait de la carte 2a

摘自地图2a
Фрагмент карты 2a

2C-1



2C-2



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تبين هذه الخريطة حدود مناطق الطيران فقـــط لأغراض الاتصالات الراديوية في الخدمة المتنقلة للطيران (R).

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На данной карте отмечены границы зон воздушной навигации исключительно в целях радиосвязи в воздушной подвижной (R) службе.

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MAP 3a
VOLMET allotment and reception areas (180° W-180° W)

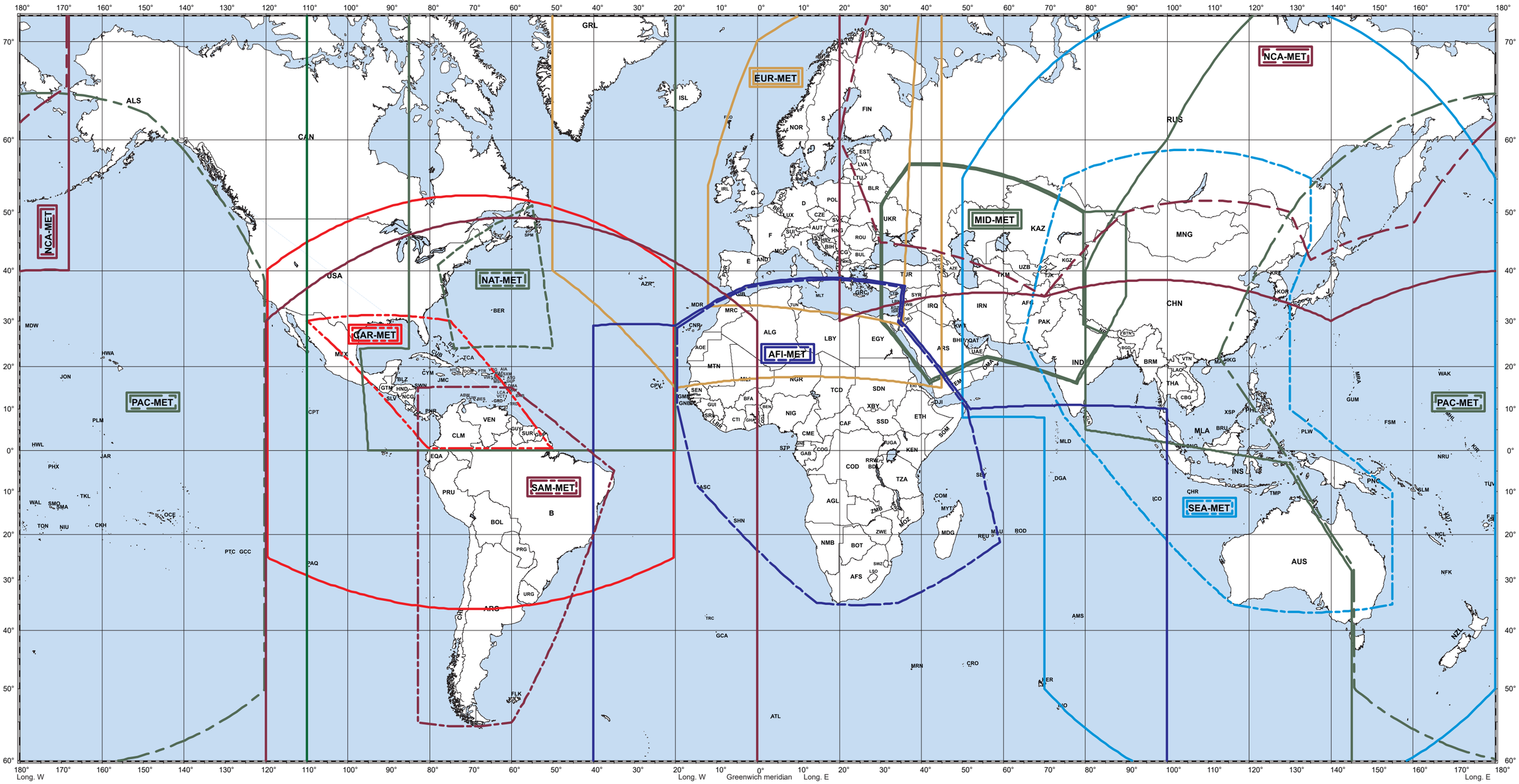
الخريطة 3أ
مناطق التعيين والاستقبال VOLMET
(180° غرباً – 180° غرباً)

地图 3a
飞行气象信息分配(VOLMET)和接收区域
(西经180度– 西经180度)

MAPA 3a
Zonas de adjudicación y de recepción VOLMET (180° O-180° O)

CARTE 3a
Zones d'allotissement et de réception VOLMET (180° O-180° O)

КАРТА 3a
Зоны выделения и приема VOLMET (180° з. д.-180° з. д.)



AFI-MET	AFRICA-INDIAN OCEAN	إفريقيا–المحيط الهندي	非洲–印度洋	ÁFRICA-OCÉANO ÍNDICO	AFRIQUE-OCÉAN INDIEN	Африка – Индийский океан
CAR-MET	CARIBBEAN	الكاريبي	加勒比	CARIBE	CARAÏBES	Карибский бассейн
EUR-MET	EUROPE	أوروبا	欧洲	EUROPA	EUROPE	Европа
MID-MET	MIDDLE EAST	الشرق الأوسط	中东	ORIENTE MEDIO	MOYEN-ORIENT	Ближний Восток
NAT-MET	NORTH ATLANTIC	شمال المحيط الأطلسي	北大西洋	ATLÁNTICO NORTE	ATLANTIQUE NORD	Северная часть Атлантического океана
NCA-MET	NORTH CENTRAL ASIA	شمال وسط آسيا	中北亚	ASIA CENTRO-SEPTENTRIONAL	NORD CENTRE ASIE	Северо-Центральная Азия
PAC-MET	PACIFIC	المحيط الهادئ	太平洋	PACÍFICO	PACIFIQUE	Тихий океан
SAM-MET	SOUTH AMERICA	أمريكا الجنوبية	南美	AMÉRICA DEL SUR	SUD AMÉRIQUE	Южная Америка
SEA-MET	SOUTH EAST ASIA	جنوب شرق آسيا	东南亚	ASIA SUDORIENTAL	SUD-EST ASIATIQUE	Юго-Восточная Азия

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MAP 3b
VOLMET allotment and reception areas (20° W-20° W)

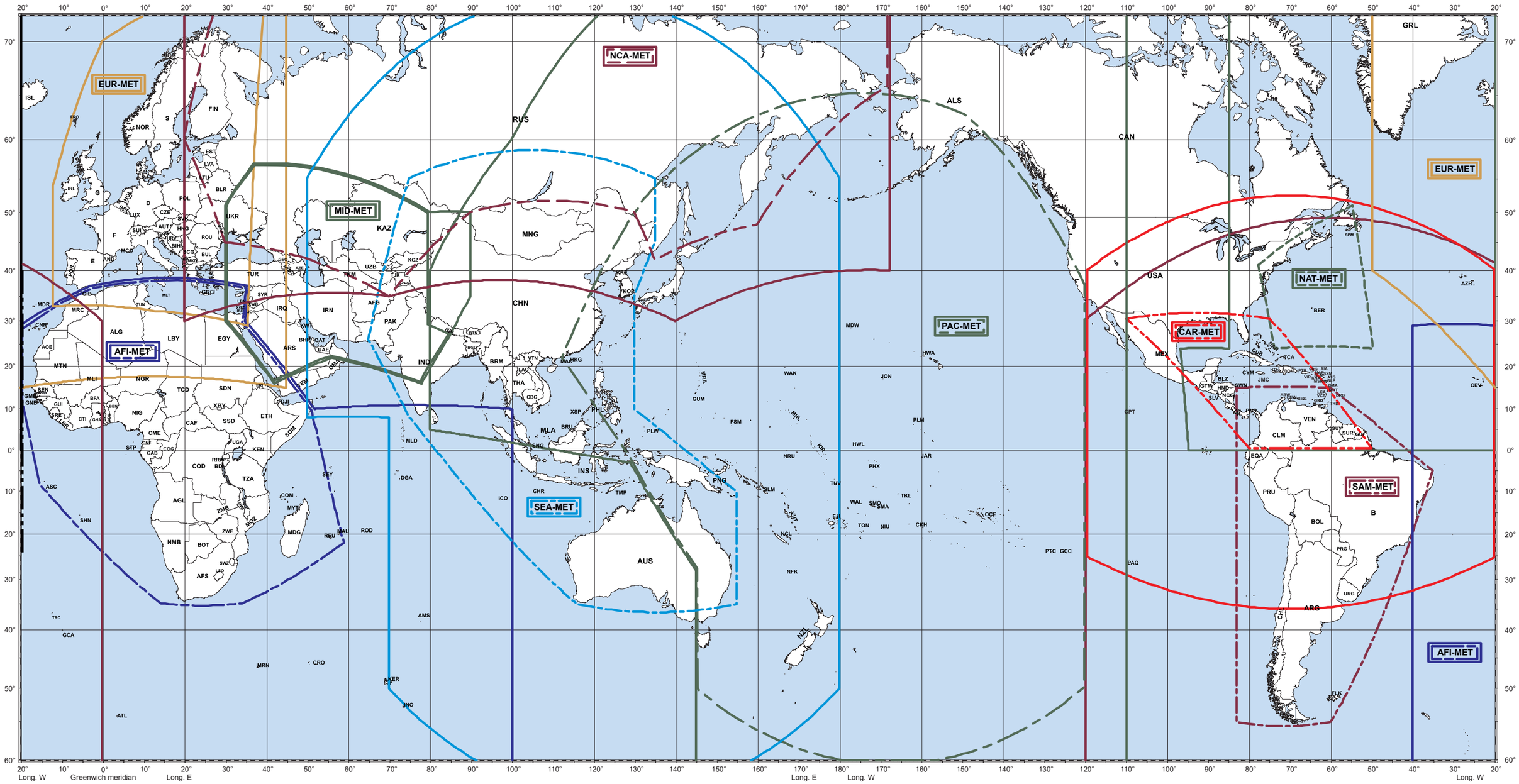
الخريطة 3 ب
مناطق التعيين والاستقبال VOLMET
(20° غرباً – 20° غرباً)

地图 **3b**
飞行气象信息分配(VOLMET)和接收区域
(西经20度– 西经20度)

MAPA 3b
Zonas de adjudicación y de recepción VOLMET (20° O-20° O)

CARTE 3b
Zones d'allotissement et de réception VOLMET (20° O-20° O)

KAPTA 3b
Зоны выделения и приема VOLMET (20° з. д.-20° з. д.)



AFI-MET	AFRICA-INDIAN OCEAN	إفريقيا–المحيط الهندي	非洲–印度洋	ÁFRICA-OCÉANO ÍNDICO	AFRIQUE-OCÉAN INDIEN	Африка – Индийский океан
CAR-MET	CARIBBEAN	الكاريبي	加勒比	CARIBE	CARAÏBES	Карибский бассейн
EUR-MET	EUROPE	أوروبا	欧洲	EUROPA	EUROPE	Европа
MID-MET	MIDDLE EAST	الشرق الأوسط	中东	ORIENTE MEDIO	MOYEN-ORIENT	Ближний Восток
NAT-MET	NORTH ATLANTIC	شمال المحيط الأطلسي	北大西洋	ATLÁNTICO NORTE	ATLANTIQUE NORD	Северная часть Атлантического океана
NCA-MET	NORTH CENTRAL ASIA	شمال وسط آسيا	中北亚	ASIA CENTRO-SEPTENTRIONAL	NORD CENTRE ASIE	Северо-Центральная Азия
PAC-MET	PACIFIC	المحيط الهادئ	太平洋	PACÍFICO	PACIFIQUE	Тихий океан
SAM-MET	SOUTH AMERICA	أمريكا الجنوبية	南美	AMÉRICA DEL SUR	SUD AMÉRIQUE	Южная Америка
SEA-MET	SOUTH EAST ASIA	جنوب شرق آسيا	东南亚	ASIA SUDORIENTAL	SUD-EST ASIATIQUE	Юго-Восточная Азия

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MAP 4
Major world air route areas
Lambert azimuthal
equal area projection

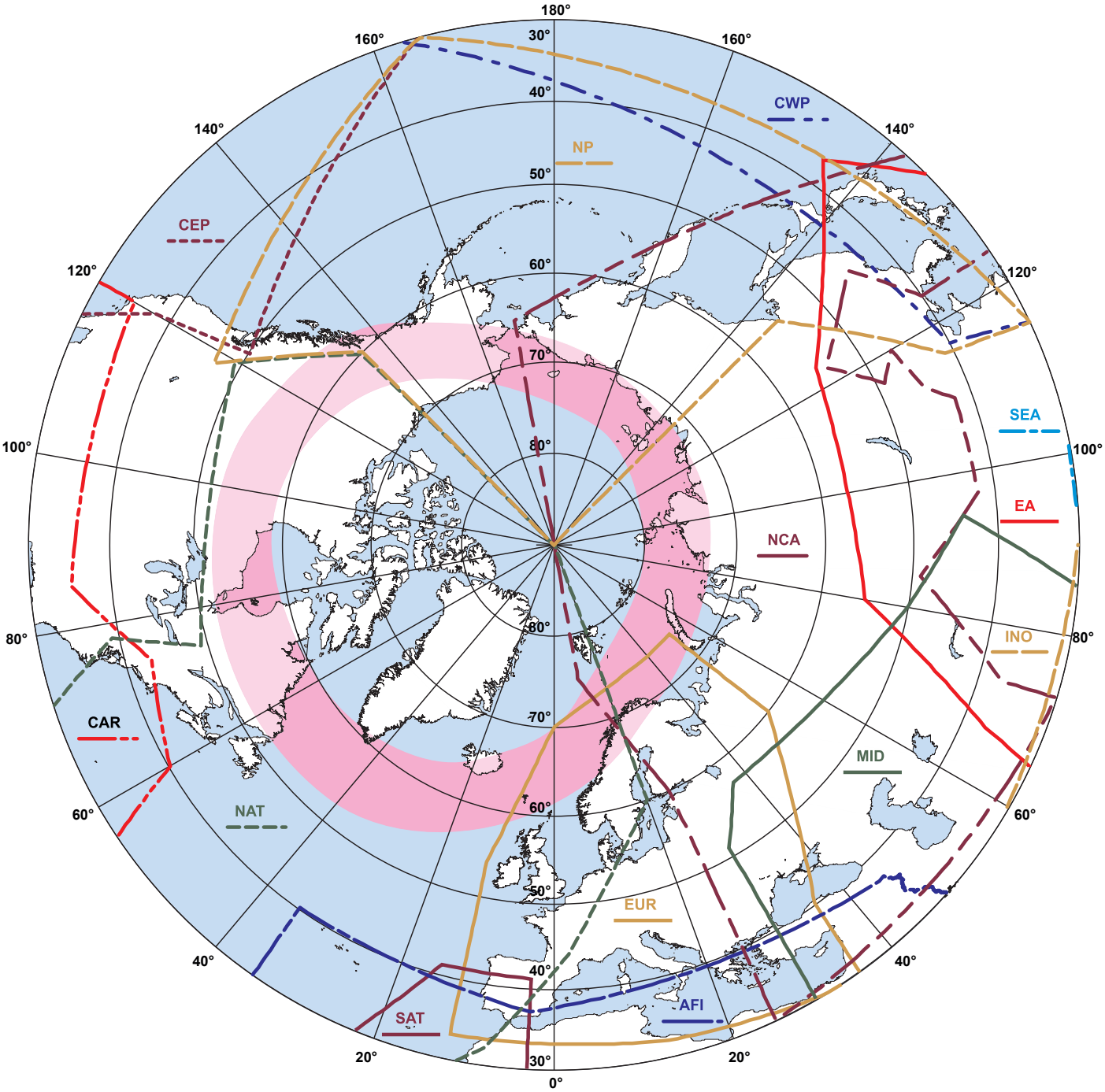
الخريطة 4
مناطق الخطوط الجوية العالمية الرئيسية
إسقاط لامبرت السمتي المكافئ

地图4
主要国际航线区
兰伯特方位等积投影

MAPA 4
Zonas de paso de rutas aéreas
mundiales principales
Proyección acimutal
equivalente de Lambert

CARTE 4
Zones de passage des lignes aériennes
mondiales principales
Projection azimutale
équivalente de Lambert

КАРТА 4
Зоны основных всемирных
воздушных трасс
Ламбертова азимутальная
проекция равных площадей



The map delineates the aeronautical areas only for the purpose of radiocommunications in the aeronautical mobile (R) service.

تبين هذه الخريطة حدود مناطق الطيران فقط لأغراض الاتصالات الراديوية في الخدمة المتنقلة للطيران (R).

本图标出这些航空区域仅出于航空移动(R)业务无线电通信方面的考虑。

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На карте отмечены границы зон воздушной навигации исключительно в целях радиосвязи в воздушной подвижной (R) службе.

Scale valid for latitudes > 60°
مقياس رسم صالح لخطوط عرض > 60°
比例在纬度>60°的范围有效
Escala válida para latitudes > 60°
Echelle valable pour les latitudes > 60°
Шкала применяется для широт > 60°

0 1 000 2 000 3 000 4 000 km

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MAP 5
Regional and domestic air route areas
Lambert azimuthal equal area projection

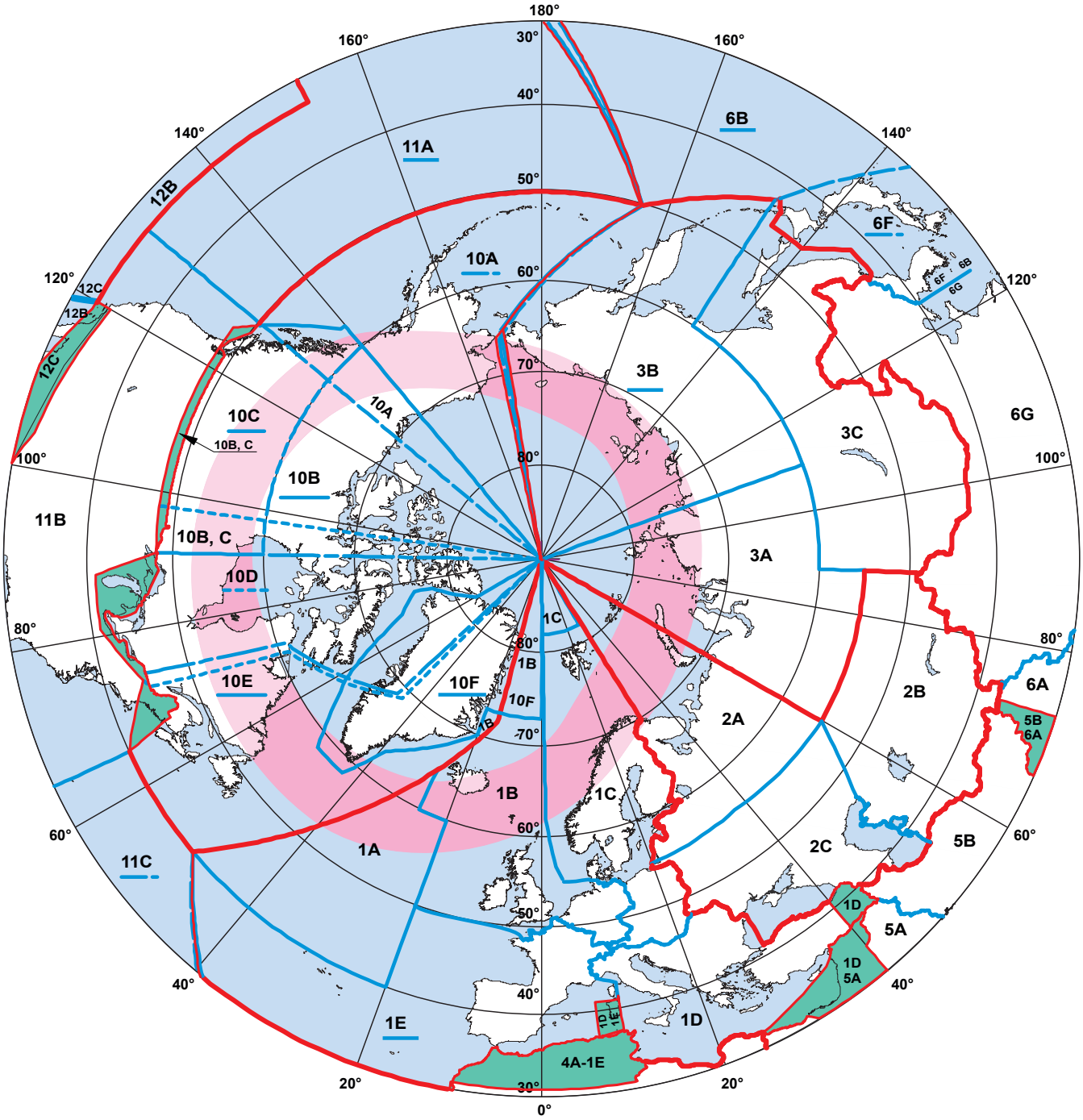
الخريطة 5
مناطق الخطوط الجوية الإقليمية والوطنية
إسقاط لامبرت السمتي المكافئ

地图 5
区域航线区和国内航线区
兰伯特方位等积投影

MAPA 5
Zonas de rutas aéreas regionales y nacionales
Proyección acimutal equivalente de Lambert

CARTE 5
Zones des lignes aériennes régionales et nationales
Projection azimutale équivalente de Lambert

КАРТА 5
Зоны региональных и национальных воздушных трасс
Ламбертова азимутальная проекция равных площадей



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Scale valid for latitudes > 60°
مقياس رسم صالح لخطوط عرض > 60°
比例在纬度>60°的范围有效
Escala válida para latitudes > 60°
Echelle valable pour les latitudes > 60°
Шкала применяется для широт > 60°

0 1 000 2 000 3 000 4 000 km

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MAP 6
Major world air route areas
Lambert azimuthal
equal area projection

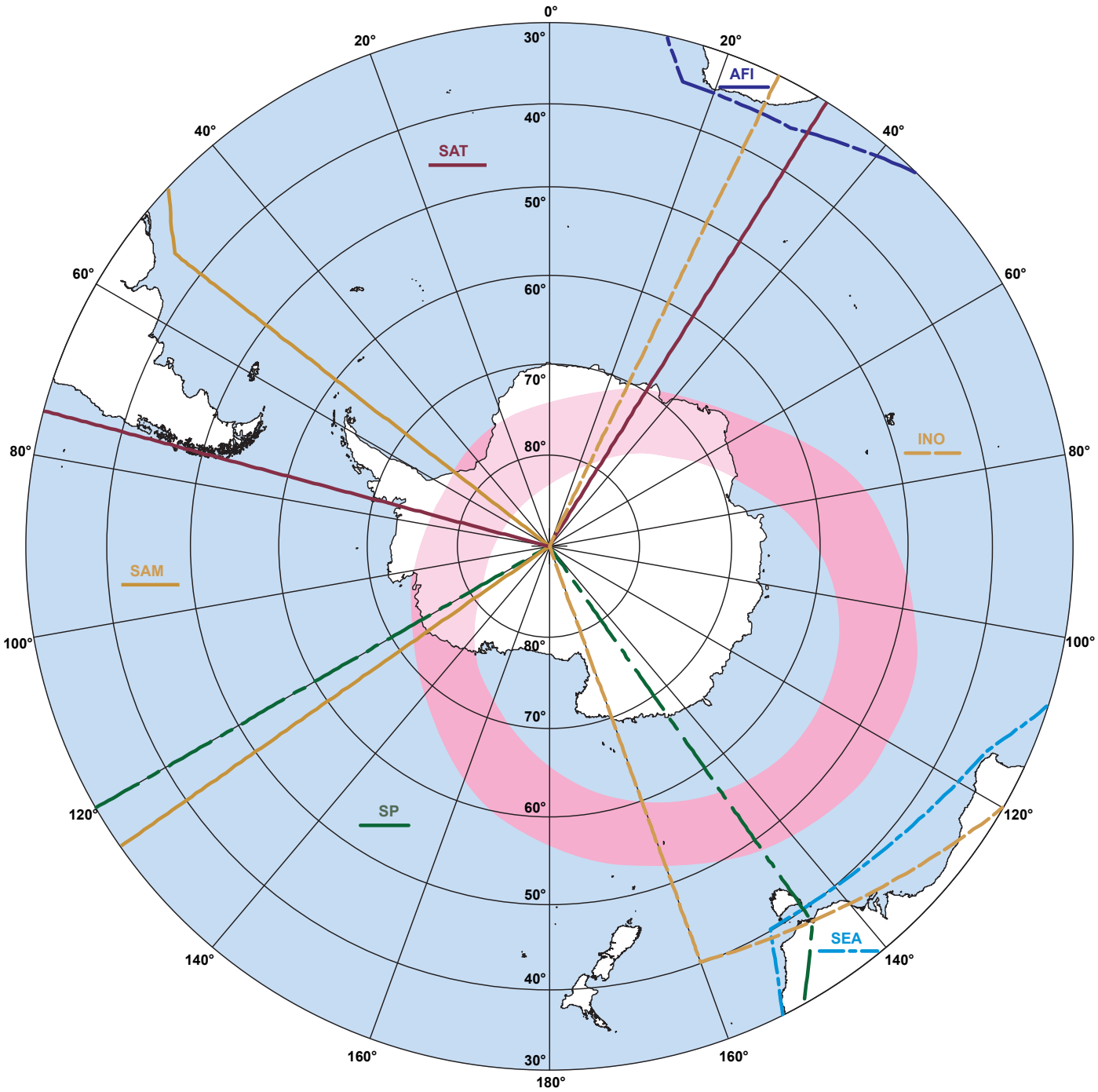
الخريطة 6
مناطق الخطوط الجوية العالمية الرئيسية
إسقاط لامبرت السمتي المكافئ

地图6
主要国际航线区
兰伯特方位等积投影

MAPA 6
Zonas de paso de rutas aéreas
mundiales principales
Proyección acimutal
equivalente de Lambert

CARTE 6
Zones de passage des lignes aériennes
mondiales principales
Projection azimutale
équivalente de Lambert

КАРТА 6
Зоны основных всемирных
воздушных трасс
Ламбертова азимутальная
проекция равных площадей



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На карте отмечены границы зон воздушной навигации исключительно в целях радиосвязи в воздушной подвижной (R) службе.

Scale valid for latitudes > 60°
مقياس رسم صالح لخطوط عرض > 60°
比例在纬度>60°的范围有效
Escala válida para latitudes > 60°
Echelle valable pour les latitudes > 60°
Шкала применяется для широт > 60°

0 1 000 2 000 3 000 4 000 km

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MAP 7
Regional and domestic air route areas

Lambert azimuthal equal area projection

MAPA 7
Zonas de rutas aéreas regionales y nacionales

Proyección acimutal equivalente de Lambert

الخريطة 7
مناطق الخطوط الجوية الإقليمية والوطنية

إسقاط لامبرت السمتي المكافئ

CARTE 7
Zones des lignes aériennes régionales et nationales

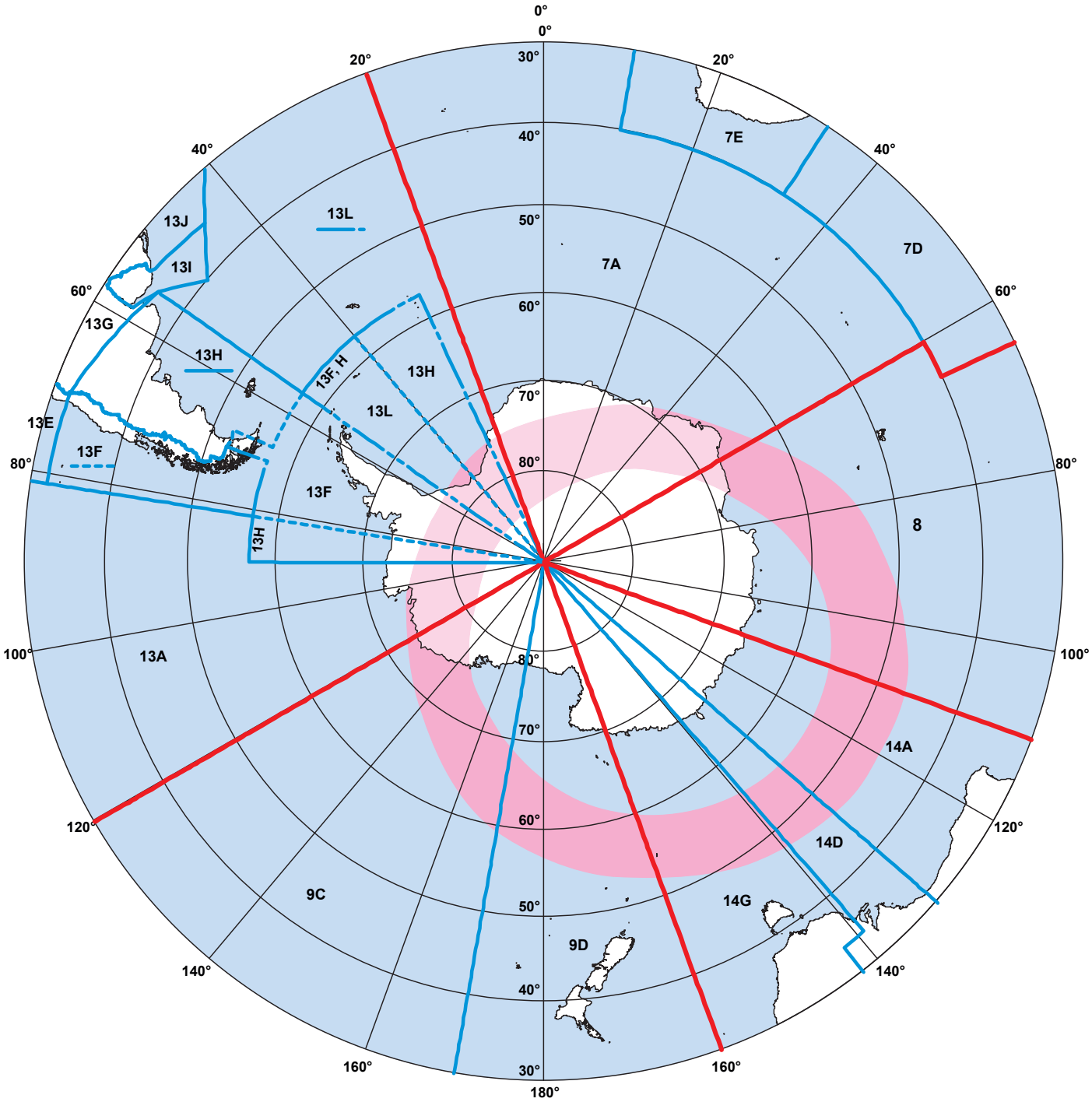
Projection azimutale équivalente de Lambert

地图 7
区域航线区和国内航线区

兰伯特方位等积投影

КАРТА 7
Зоны региональных и национальных воздушных трасс

Ламбертова азимутальная проекция равных площадей



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Scale valid for latitudes > 60°

مقياس رسم صالح لخطوط عرض > 60°

比例在纬度>60°的范围有效

Escala válida para latitudes > 60°

Echelle valable pour les latitudes > 60°

Шкала применяется для широт > 60°

0 1 000 2 000 3 000 4 000 km

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MAP 8
VOLMET allotment
and reception areas
Lambert azimuthal
equal area projection

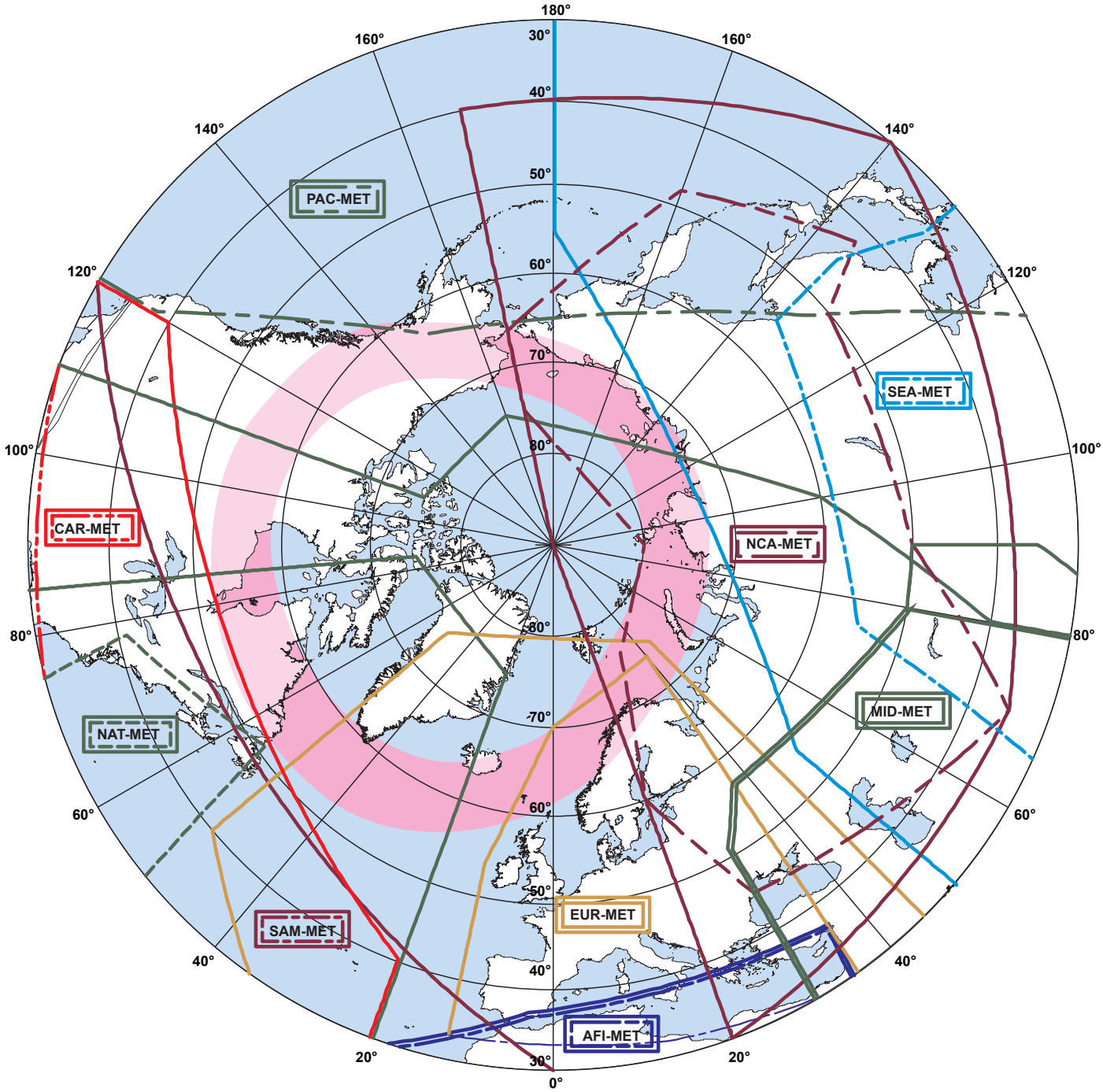
الخريطة 8
مناطق التعيين والاستقبال VOLMET
إسقاط لامبرت السمتي المكافئ

地图 8
飞行气象信息(VOLMET)分配
和接收区
兰伯特方位等积投影

MAPA 8
Zonas de adjudicación
y de recepción VOLMET
Proyección acimutal
equivalente de Lambert

CARTE 8
Zones d'allotissement
et de réception VOLMET
Projection azimutale
équivalente de Lambert

КАРТА 8
Зоны выделения
и приема VOLMET
Ламбертова азимутальная
проекция равных площадей



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Scale valid for latitudes > 60°
مقياس رسم صالح لخطوط عرض > 60°
比例在纬度>60°的范围有效
Escala válida para latitudes > 60°
Echelle valable pour les latitudes > 60°
Шкала применяется для широт > 60°

0 1 000 2 000 3 000 4 000 km

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MAP 9
VOLMET allotment
and reception areas

Lambert azimuthal
equal area projection

MAPA 9
Zonas de adjudicación
y de recepción VOLMET

Proyección acimutal
equivalente de Lambert

الخريطة 9
مناطق التعيين والاستقبال VOLMET

إسقاط لامبرت السمتي المكافئ

CARTE 9
Zones d'allotissement
et de réception VOLMET

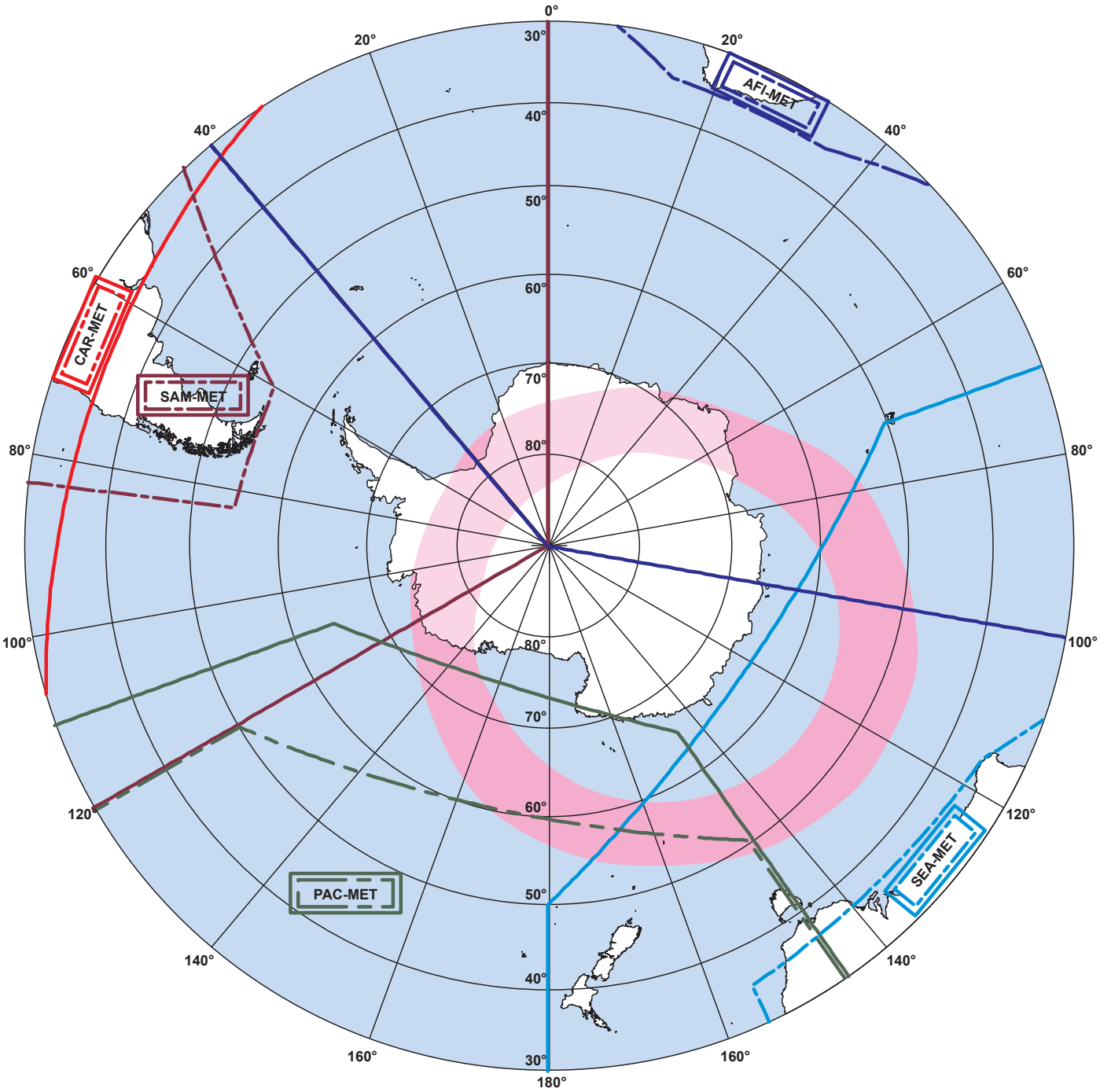
Projection azimutale
équivalente de Lambert

地图 9
飞行气象信息(VOLMET)分配
和接收区

兰伯特方位等积投影

КАРТА 9
Зоны выделения
и приема VOLMET

Ламбертова азимутальная
проекция равных площадей



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Scale valid for latitudes > 60°
مقياس رسم صالح لخطوط عرض > 60°
比例在纬度>60°的范围有效
Escala válida para latitudes > 60°
Echelle valable pour les latitudes > 60°
Шкала применяется для широт > 60°

0 1 000 2 000 3 000 4 000 km

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