Doc 9718

# Handbook on Radio Frequency Spectrum Requirements for Civil Aviation

## Volume I
## ICAO spectrum strategy, policy statements and related information

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# AMENDMENTS

Amendments are announced in the supplements to the *Products and Services Catalogue*; the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such amendments.

## RECORD OF AMENDMENTS AND CORRIGENDA

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# FOREWORD

## Historical background

The International Civil Aviation Organization (ICAO) Special Communications/Operations Divisional Meeting held in 1995 (Special COM/OPS/95) noted that the International Telecommunication Union (ITU) had begun to convene its World Radiocommunication Conferences (WRCs) every three to four years. While divisional-type ICAO meetings had traditionally developed positions on WRC agenda items related to aviation, it was evident that it was not feasible to convene such meetings frequently enough to keep pace with this schedule of WRCs. The Special COM/OPS/95 meeting recognized the importance of keeping up with the rapid development in telecommunications and consequently recommended that a new mechanism be developed to enable civil aviation to record its agreed requirements for aeronautical radio frequency spectrum in an adequate and timely manner.

The meeting accordingly recommended that an ICAO radio frequency (RF) document be developed and maintained (Recommendation 7/1). The Air Navigation Commission, at its meeting on 19 June 1995 (ANC 139-10), approved the recommendation for action. Subsequently, ICAO developed this *Handbook on Radio Frequency Spectrum Requirements for Civil Aviation* and the first edition was published in 1998.

**Recommendation 7/1 — ICAO radio frequency (RF) policy document on the aeronautical utilization of the RF spectrum**

That ICAO develop and maintain a document (rolling plan) containing policy statements and other elements relevant to the utilization of the frequency spectrum with a view to assisting States and ICAO in their preparation for future ITU world radiocommunication conferences.

## Status of the handbook

This handbook contains the ICAO spectrum strategy and policy statements relevant to the aviation requirements for radio frequency spectrum, as approved and amended by the Council of ICAO.

The handbook is intended to assist States and ICAO in preparing for ITU conferences. The ICAO Position on matters of interest to aviation on the agenda of ITU WRC-23 is included in Attachment F. The approach for establishing and

promoting the ICAO Position for future ITU WRCs is in Attachment E.
The material in this handbook is supplementary to the Standards and Recommended Practices (SARPs) contained in Annex 10 to the Convention on International Civil Aviation – *Aeronautical Telecommunications*, which continue to have precedence and applicability for those aspects covered by their provisions.

Amendments to this handbook will be made on a regular basis so that the material will represent the latest position on the spectrum requirements for civil aviation. Towards this end, the recommendations of divisional-type meetings and air navigation conferences as well as the findings and Recommendations of ICAO panels and other (for example, regional) bodies, as approved by the Air Navigation Commission and Council as appropriate, are expected to be among the main sources of information. Changes may also be necessary as a result of decisions taken at ITU WRCs.

Results of ongoing activities in ICAO on spectrum management are available on the website for the Frequency Spectrum Management Panel (FSMP) at https://www.icao.int/safety/FSMP/Pages/default.aspx. FSMP is undertaking the activities on preparation and coordination of material, including the development of the draft ICAO Position, in particular for ITU WRCs, ITU-R study group meetings and meetings of regional telecommunication organizations.

**Organization of the handbook**

The handbook consists of two volumes:

Volume I contains the ICAO spectrum strategy and policy statements. It updates and replaces the material previously contained in the second edition of Doc 9718, Volume I, published in 2018.

Volume II contains technical material on the utilization of radio frequency spectrum by aviation.

Volume I is structured as follows:

– Chapter 1 introduces the subject of radio frequency spectrum management and aspirations.

– Chapter 2 defines the objectives and purpose of the handbook.

– Chapters 3 to 5 describe the institutional aspects and the relationships between the main participants (ITU, ICAO, national authorities, etc.).

– Chapter 6 contains an overview of the spectrum management process.

– Chapter 7, which is divided into four sections, contains the principal elements of the handbook. Each frequency band and its uses are described in detail, together with the approved ICAO policy statements for the civil aviation spectrum requirements in that band. Also included are relevant provisions (Regulations), Resolutions and Recommendations which are contained in the ITU Radio Regulations.

– Chapter 8 contains the ICAO spectrum strategy and vision and addresses future requirements of frequencies for civil aviation.

– Chapter 9 describes the elements of a framework of rules and preventative measures for the regulation and control of interference.

– Attachment A provides a selection of relevant ITU definitions.

– Attachment B contains acronyms and abbreviations used in the handbook.

– Attachment C gives an overview of the regulatory aspects of radio equipment in aircraft.

– Attachment D addresses the processes and sequence of actions for the review and updating of the handbook.

– Attachment E contains the ICAO approach for improving support for the ICAO Position.

– Attachment F contains the ICAO Position for ITU WRC-27, as approved by the Council on 25 June 2025.

– Attachment G contains technical information and frequency-sharing criteria.

– Attachment H references relevant ITU Resolutions and Recommendations which are incorporated in the ITU Radio Regulations.

**Action by Member States and ICAO**

States are requested to use the material in this policy document, as it is necessary and opportune, in their national discussions on matters relating to the use of the radio

frequency spectrum by international civil aviation. In particular, the ICAO spectrum strategy, the ICAO policy statements and the ICAO Position for ITU WRCs should be utilized and incorporated in proposals from States for ITU WRCs, meetings of the ITU-R sector (ITU-R study groups) and meetings of regional telecommunication organizations as the up-to-date agreement within ICAO on the reference subject. ICAO observers at these conferences and meetings may also, as necessary, use the material from the document as the agreed ICAO policy for international civil aviation purposes.

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*Note 1.— Although this handbook includes relevant provisions from the ITU Radio Regulations, these extracts are not complete and the handbook should therefore be used in conjunction with the full text of the ITU Radio Regulations and the relevant ITU-R Recommendations.*

*Note 2.— Throughout this handbook, extracts from the ITU Radio Regulations are presented against a shaded background.*

# CONTENTS


*Page*

Chapter 1. Introduction ..... 1-1

Chapter 2. Objectives and Purpose ..... 2-1

Chapter 3. The International Telecommunication Union ..... 3-1

Chapter 4. The ITU Regulatory Framework for Aeronautical Radio Services ..... 4-1

4.1 The ITU Radio Regulations ..... 4-1
4.2 Communications ..... 4-2
4.3 Navigation and surveillance ..... 4-4
4.4 Relationship between ITU Radio Regulations and other material and ICAO SARPs ..... 4-7
4.5 Frequency coordination and registration ..... 4-8
4.6 ITU standards ..... 4-9
4.7 ITU Resolutions and Recommendations ..... 4-10
4.8 Radio equipment in aircraft ..... 4-10

Chapter 5. ICAO Involvement in Frequency and Spectrum Planning ..... 5-1

Chapter 6. Overview of the Spectrum Management Process ..... 6-1

6.1 General aspects of the process ..... 6-1
6.2 Elements of the technical domain ..... 6-4
6.3 The role of technology in spectrum management ..... 6-7
6.4 Aeronautical services ..... 6-7
6.5 Spectrum management in the future ..... 6-8
6.6 Spectrum management summary ..... 6-10

Chapter 7. Statement of Frequency Allocations, Technical Details and ICAO Policy ..... 7-1

Section 7-I. List of frequency bands ..... 7-2
Section 7-II. Civil aviation frequency allocations — ICAO policy statements and related information ..... 7-17

*Page*

Section 7-III. Radio Regulations and other ITU material of importance to aeronautical services ..... 7-185
Section 7-IV. Review of ITU Resolutions and Recommendations ..... 7-216

Chapter 8. ICAO Spectrum Strategy and Vision ..... 8-1

8.1 Introduction ..... 8-1
8.2 ICAO spectrum strategy ..... 8-1
8.3 Future systems and strategy evolution ..... 8-13
8.4 Challenges ..... 8-14
8.5 The aviation spectrum long-term vision ..... 8-15

Chapter 9. Interference Protection Considerations ..... 9-1

9.1 Introduction ..... 9-1
9.2 Regulatory aspects ..... 9-1
9.3 Management and control of interference ..... 9-11
9.4 Assessment of protection for aeronautical radio services ..... 9-13
9.5 Some special cases ..... 9-19
9.6 General protection limits for aeronautical radio ..... 9-23

Attachment A. Definitions and Terms Used in the ITU Radio Regulations Relevant to Aviation ..... A-1

1. Introduction ..... A-1

Attachment B. Abbreviations and Acronyms ..... B-1

Attachment C. The Regulation of Radio Equipment in Aircraft ..... C-1

1. Introduction ..... C-1
2. Background ..... C-1
3. The regulatory framework ..... C-2
4. Airworthiness approval and the issue of a Certificate of Airworthiness ..... C-3
5. Summary ..... C-4

Attachment D. Review and Update ..... D-1

*Page*

Attachment E. Approach for Establishing and Promoting the ICAO Position for Future ITU World Radiocommunication Conferences ..... E-1

1. Introduction ..... E-1
2. Basis for the ICAO Position ..... E-1
3. Development of the ICAO Position ..... E-1
4. Support for the ICAO Position ..... E-2
5. New trends in spectrum management ..... E-3
6. Assembly Resolution -A42-7 ..... E-4

Attachment F. ICAO Position for the International Telecommunication Union (ITU) World Radiocommunication Conference 2027 (WRC-27) ..... F-1

1. Introduction ..... F-2
2. ICAO and the international regulatory framework ..... F-2
3. Spectrum requirements for international civil aviation ..... F-3
4. Aeronautical aspects on the agenda for WRC-27 ..... F-5

Appendix to Attachment F. Agenda for the ITU 2027 WRC ..... F-44

Attachment G. Technical Information and Frequency-sharing Criteria .. G-1

1. Introduction ..... G-1

Attachment H. ITU Resolutions and Recommendations ..... H-1

1. Introduction ..... H-1

---

# Chapter 1

# INTRODUCTION

1.1 The radio frequency spectrum is a scarce natural resource with finite capacity limits and for which demand is constantly increasing. Predictions of future demand for spectrum indicate a continuing rate of increase for all users and radio services and facilities that utilize radio waves as the world economies progressively expand. The competition among all users for the spectrum available is hence expected to intensify in the years ahead. In this competitive situation, even a user holding a spectrum allocation will not have an automatic right to retain that radio frequency spectrum, as a decision by an International Telecommunication Union (ITU) conference may require that spectrum be removed from any radio service to meet a superior justified demand for other radio services. Aviation is only one of many such competitors, albeit with the significant benefit of a worldwide cooperative forum, namely the International Civil Aviation Organization (ICAO), to coordinate and support its case.

1.2 Aeronautical services are recognized internationally to be prime users of radio frequencies, without which aircraft operations would not be capable of meeting the global demand for safe, efficient and cost-effective transport. The prominent safety-of-life element, present during all phases of an aircraft's flight, is accorded special treatment internationally and is granted protection from harmful interference through agreed measures. Spectrum allocated to aeronautical services in the main frequency bands is divided into two main functions: air-ground communications and radionavigation. The gradual introduction of satellite-based services in accordance with the communications, navigation and surveillance/air traffic management (CNS/ATM) policies agreed at the Tenth Air Navigation Conference (1991) and approved by the Council of ICAO, is progressing.

1.3 Radio frequency spectrum congestion imposes on all users the duty of spectrum-efficient operation. The process of channel splitting, as employed in some aeronautical communication and navigation frequency bands, is an example of technological development helping to achieve spectrum-efficient operation and meeting future requirements without requiring additional spectrum. Modern sophisticated systems employing complex modulation techniques are another facet of efficient spectrum use when transmitting more information within the same bandwidth. Extending radio services and systems into higher frequency bands is yet another. These measures need to continue for the foreseeable future.

1.4 The process of international competition between expanding radio services obliges all existing users (i.e. aeronautical and non-aeronautical) to continually defend and justify the retention of frequency bands or the addition of new bands to those already allocated to their service, subject to the same conditions as apply in other services. Civil aviation operations are expanding globally, requiring more navigation and communication facilities and thus creating additional pressures on the already stressed and limited spectrum availability. The civil aviation community must accordingly develop and present, as necessary, its agreed policies and its quantified and qualified statements of requirement for radio frequency spectrum so as to ensure the continuing availability of adequate radio spectrum and, ultimately, the ongoing viability of air navigation services throughout the world.

1.5 Aeronautical systems utilize frequency bands that are attractive to many users due to their propagation characteristics, their generally worldwide allocations and resultant benefits in equipment design. Many of these users are global industries delivering significant economic benefits that are well understood by governments. The potential revenues for such sectors are often directly quantifiable in terms of their overall spectrum bandwidth allocation. However, unlike other spectrum users, the amount of spectrum used by aeronautical safety systems is not directly related to revenue and thus the quantification of the cost benefit of aviation spectrum bandwidth can become challenging.

1.6 Competition among spectrum users is becoming more severe and each ITU/WRC cycle sees increasing demand for new allocations to meet industry and societal demands for improved communications and new applications. Spectrum availability is now a key issue, and potentially a critical constraint, to delivering innovation and growth in all sectors. This has resulted in significant economic pressure on radio regulators and governments to ensure spectrum can be managed in a way that can adapt to meeting these changing needs.

1.7 This document contains a balanced and justified presentation of aviation needs, and it will be made available to all aviation interests involved in the frequency management process. It will be updated through regular amendments based on technological developments in communication, navigation and surveillance systems for aviation and changing operational requirements on the utilization of these systems. These updates also consider the decisions in the ITU, including amendments to the ITU Radio Regulations and the development of relevant ITU-R Recommendations and reports.

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# Chapter 2

# OBJECTIVES AND PURPOSE

2.1 The ITU is the specialized agency of the United Nations for telecommunication matters where international agreements are made on the use of the radio frequency spectrum. At World Radiocommunication Conferences (WRCs), convened about every four years, changes are made to the ITU Radio Regulations, including the Table of Frequency Allocations (Article 5 of the ITU Radio Regulations), on the basis of proposals made by States. This mechanism was introduced in 1992 in order to better adapt the Table of Frequency Allocations to rapid technological developments and spectrum requirements for all users of the radio frequency spectrum.

2.2 A consequence of this process is that a coordinated aeronautical position (the ICAO Position) must be established for every ITU WRC and finalized well in advance of the ITU conference itself, in order to be of maximum use to aviation authorities. The ICAO Position is intended for use by Civil Aviation Authorities (CAAs) in their national discussions with the radio regulatory authorities when developing proposals for submission by their administrations to meetings of regional telecommunication organizations which prepare regional positions for ITU conferences, as well as to the ITU conferences themselves, and to brief the delegations at these meetings. In addition, it is to be used by aviation experts at these conferences and is submitted by ICAO to the ITU conferences in the form of an information paper. The ICAO Position contains the agreed radio frequency allocation requirements for aeronautical radio services, including the necessary protection from harmful interference, that are provided to support safety-critical aeronautical communication, navigation and surveillance systems. The ICAO Position, the ICAO spectrum strategy and the ICAO policy statements in this handbook are developed by the Air Navigation Commission, with the assistance of the Frequency Spectrum Management Panel (FSMP), and approved by the Council of ICAO. In developing the ICAO Position, all ICAO Member States and relevant international organizations are consulted.

2.3 With this background, the prime objectives of this document are:

a) to provide a consolidated and up-to-date statement of agreed spectrum requirements for aeronautical services and the ICAO policy in the frequency bands used by international civil aviation for the communication, navigation and surveillance systems that are to be provided for air traffic purposes, taking into account all future needs;

b) to provide a source of reference for relevant ITU regulations, resolutions, recommendations and associated ITU-Radiocommunication Sector (ITU-R) material;

c) to provide a convenient record for important frequency management material, such as the criteria applied in the planning of radio frequency assignments, and the protection from interference; and

d) to provide background information on the international spectrum management institutional framework and the main ITU elements.

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# Chapter 3

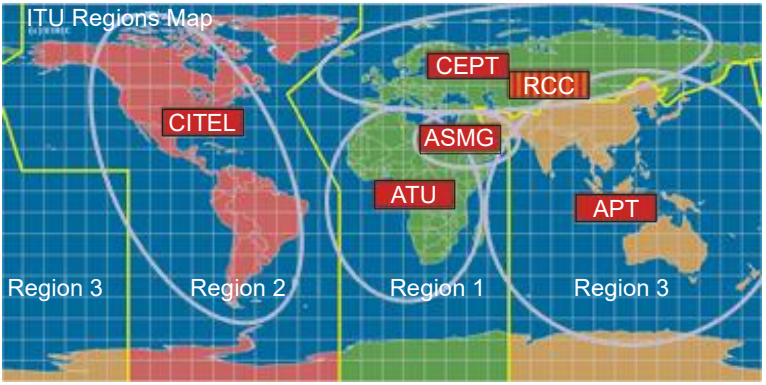
# THE INTERNATIONAL TELECOMMUNICATION UNION

3.1 The ITU was founded in Paris on 17 May 1865 as the International Telegraph Union and took its present name in 1934 at the International Telegraph Conference in Madrid. In August 1947, the United Nations recognized the ITU as a specialized agency in the field of telecommunications, while acknowledging also that other specialized agencies, such as ICAO, would not be barred from any kind of work touching upon aeronautical telecommunications including standardization activities. The recognized competence of the ITU embraces all aspects of telecommunications, whether by line or by radio transmission, for which it has authority to set standards for systems, technical parameters and procedures. A prime and highly important area for aviation concerns the regulation and use of the radio frequency spectrum for which ITU is the recognized international body. The agreements made under its auspices for these matters and incorporated in the Final Acts of World Radiocommunication Conferences (which prior to 1993 were known as World Administrative Radio Conferences) are accorded treaty status and have full mandatory force without any possibility for variation in regard to their scope or their substance except by agreement at a further conference.

3.2 The basic treaty documents of the ITU (the ITU Constitution and the ITU Convention) may be amended at Plenipotentiary Conferences which are held every four years. Between these conferences, the Council, with a membership not exceeding 25 per cent of the total number of members of the Union, performs a policy and management function. The Council normally meets once per year for a duration of two weeks. The representation from member administrations to ITU conferences and meetings is drawn from national telecommunication authorities representing all the radio services and users in their State. Consequently, policy and decisions at a national level are matters for these authorities.

3.3 The internationally agreed regulation of the radio frequency spectrum is provided through the ITU Radio Regulations, parts of which are reviewed at WRCs. Within the Radio Regulations, the finite useable radio spectrum, from approximately 8.3 kHz to 275 GHz, is allocated to user services (see Figure 3-3) in response to their recognized demands, and among three ITU world Regions (see Figure 3-1) in accordance with the major regional spectrum requirements for these services in the relevant region. The allocations are contained in Article 5 of the Radio Regulations; together with other provisions on licensing, interference resolution, safety and

distress procedures and other aspects, the Radio Regulations are the treaty requirements to be observed at all times by all radio services.




Approximate coverage of ITU Regions
by regional telecommunication organizations

**Figure 3-1. Map of ITU world Regions**

3.4 Within ITU Member States, the telecommunication authorities (or telecommunication administrations) normally control and operate the mechanism which develops the national proposals for amending the Radio Regulations for submission to the ITU WRCs. National and international (regional) preparatory committees function as the coordination medium to which the aviation requirements, either ICAO coordinated or nationally derived, are presented by the national aviation authorities for consideration. National policies take into account all of the competing interests of radio frequency spectrum users to determine the States' proposals to the conference. It is essential that aeronautical participation in these national and regional activities be ensured in order to support and defend aviation requirements.

3.5 Aviation services are recognized important users of radio spectrum to create safe and expeditious conditions to support air operations. The aeronautical mobile (route) service (AM(R)S), the aeronautical radionavigation service (ARNS) and their satellite service counterparts are important components in the mobile and radiodetermination families of users (see Figure 3-3) made on a worldwide basis to ensure global harmonization. The aeronautical allocations are mainly exclusive or

with a priority over other services sharing the same frequency band. A summary overview of the use of spectrum by aviation is in Figure 3-2. Worldwide allocations enable international standardization of equipment and systems to support safe and global air traffic. The Radio Regulations are used as the framework for the relevant Annexes and the Standards and Recommended Practices (SARPs) contained therein.

3.6 The Radio Regulations also regulate the prevention and removal of interference, whether between services, countries or regions, between frequency assignments, or from other sources of radiation such as industrial or medical equipment. Particular attention is accorded to services that have a predominant critical safety-of-life function, such as aeronautical and radionavigation services. This is reflected in special measures for rapid elimination of interference by national telecommunication authorities or, in case interference is affecting two or more States, through bilateral negotiations with authorities in these States. Other special measures such as the use of radio in distress and emergency situations or for search and rescue operations, in collaboration with maritime and land services as necessary, are also given prominent treatment.

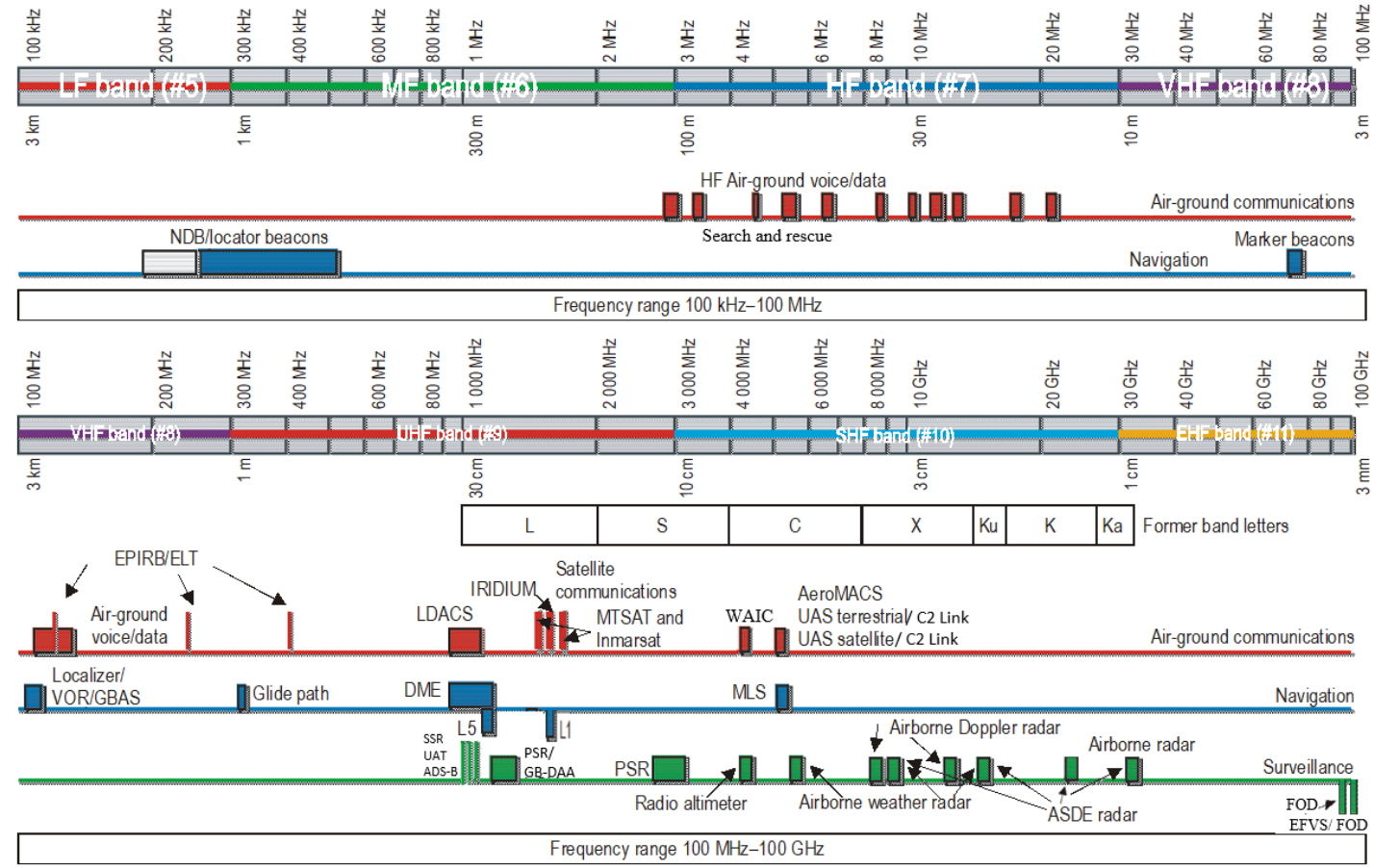
3.7 In the radio field, the technical work of the ITU is performed on an ongoing basis by the ITU Radiocommunication Sector (ITU-R) and the ITU Radiocommunication study groups (ITU-R SG). The ITU-R study groups support this technical work through the development of relevant ITU-R Recommendations, or reports and handbooks. Most aviation related issues are addressed in ITU-R Study Group 5, which deals with terrestrial services including mobile and radiodetermination. ITU-R Study Group 4 deals with satellite services, including those used for aeronautical purposes. This work is important to aviation, particularly in relation to the development of ITU-R Recommendations addressing compatibility between aeronautical and non-aeronautical services with the view to preventing harmful interference to aeronautical use of radio frequency spectrum. In addition, the detailed technical preparations for the WRCs which are undertaken under the auspices of the Radiocommunication Bureau by the Conference Preparatory Meeting (CPM) are delegated to these STUDY Groups. The CPM functions as a permanent body using material developed by the ITU-R study groups and presented by administrations in developing the CPM Report to the WRC. The CPM Report provides information on the technical, operational and regulatory/procedural issues relevant to the WRC agenda items.

3.8 In response to its specialized responsibility and competence in civil aviation, ICAO has been accorded observer status (*"Observer in an advisory capacity"*, see Section 7-III.2) at all conferences and meetings held under ITU auspices, including ITU-R meetings. This enables ICAO to submit its internationally agreed statements on telecommunication policies and frequency use and ensures that the ICAO Position and policy is propagated at these conferences and meetings and, to the maximum extent possible, to ensure that aeronautical allocations and frequency use, including future

requirements, are safeguarded.

3.9 In order to coordinate frequency use and spectrum requirements within specific regions of the world, a number of regional bodies have been set up in a cooperative arrangement between telecommunication administrations. These are: the European Conference of Postal and Telecommunications Administrations (CEPT) for Europe, the Asia Pacific Telecommunity (APT) for the Asia Pacific region, the Comisión Interamericana de Telecomunicaciones (CITEL) for the Americas region, the African Telecommunications Union (ATU) for Africa, the Regional Commonwealth in the Field of Communications (RCC) for Eastern Europe and Asian countries belonging to ITU Region 1, and the Arab Spectrum Management Group (ASMG) for the countries in the Middle East and North Africa. These regional bodies have the capability, where agreed and necessary, to present common proposals to ITU conferences, which would include, where appropriate, proposals addressing aeronautical allocations. A trend is appearing also where these bodies exercise joint influence on policies to promote their regional interest, often with a strong commercial motivation.

3.10 The ITU forum is of great importance to civil aviation interests and is increasing in importance with the emergence of new philosophies on spectrum sharing between different services and on jointly operated services, such as mobile-satellite services. In order to secure adequate spectrum for aviation, it is essential that the aviation position be rational, well considered and well presented in discussions that are becoming increasingly diverse, complex and commercial in their character and scope. The ITU, for its part, is expected to give due consideration to the globally coordinated civil aviation requirements and positions submitted by ICAO and to act accordingly in order to ensure the continued safety of the air transport operations worldwide.




Notes:
1. Drawing not to scale.
2. Not all regional or sub-regional allocations are shown.
3. Band identification (e.g. VHF) and band # per Radio Regulations.
4. The satellite communication bands used by MTSAT and Inmarsat are not allocated to the aeronautical mobile satellite (R) service.

Figure 3-2. Overview of spectrum allocation to aeronautical services

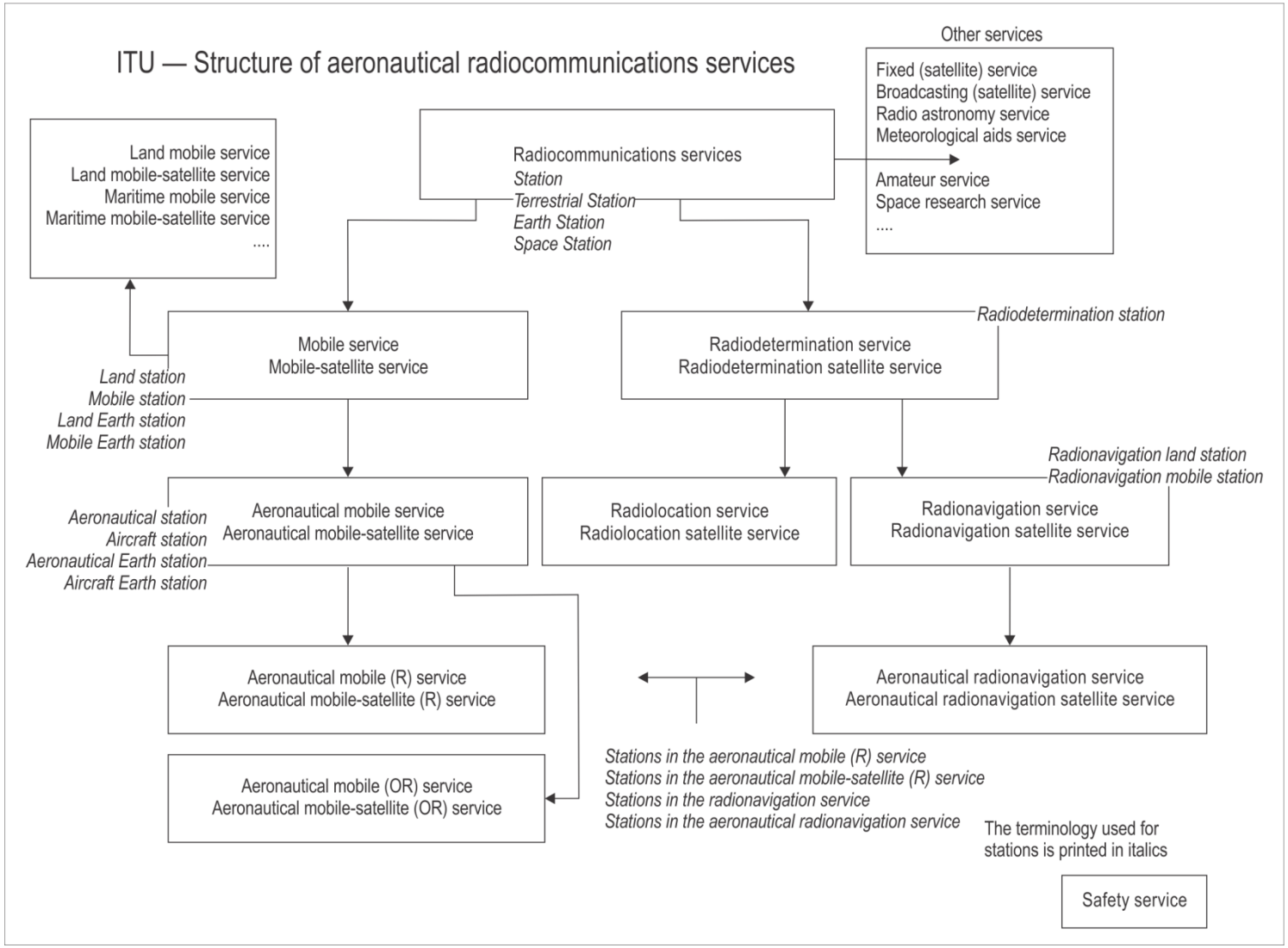



**Figure 3-3. Radio services**

*Note.— Allocations are made to services; frequency assignments are made to stations.*

# Chapter 4

# THE ITU REGULATORY FRAMEWORK FOR AERONAUTICAL RADIO SERVICES

## 4.1 THE ITU RADIO REGULATIONS

4.1.1 The ITU Radio Regulations recognize aeronautical mobile and radionavigation services as separate services within the mobile services family and the radiodetermination family, respectively (see Figure 3-3). The distress and safety provisions in Chapter VII (Article 30) and the regulatory and operational aspects of the aeronautical mobile service in Chapter VIII (dealing with aeronautical services), as well as various other regulations of the Radio Regulations, establish aeronautical services as a distinct and important component within the radio service hierarchy with a high importance being placed on safety aspects.

4.1.2 For the purpose of allocating spectrum, three regions are defined in the Radio Regulations as in Figure 3-1. Allocations in the Table of Frequency Allocations (Article 5 of the Radio Regulations) can be made on a worldwide or regional basis. Sub-regional or country allocations are normally made through footnotes to this table. These "footnote" allocations have the same status as allocations appearing in the Table of Frequency Allocations.

4.1.3 A distinctive designation has been created between aeronautical mobile services provided for safety and regularity of flight (aeronautical mobile route (R) services) and those for other (non-safety) purposes (aeronautical mobile off-route (OR) services) to ensure the necessary protection of air traffic operations (safety and regularity). The convention employed in the Radio Regulations of according worldwide exclusive allocations to these services facilitates and promotes the development of globally agreed system specifications and interoperability as required in Article 37 of the Convention on International Civil Aviation (Chicago Convention). The ICAO SARPs, notably those in Annex 10, are the practical realization of this requirement.

4.1.4 This section of the handbook identifies elements of the Radio Regulations which define the context and status of aeronautical services incorporated in the Radio Regulations. Reference should be made, as appropriate, to the hierarchical organization of radio services at Figure 3-3 and to the extracts in Attachment A (definitions and terms used in the Radio Regulations).

## 4.2 COMMUNICATIONS

4.2.1 Aeronautical communications services, according to Article 44 of the Radio Regulations, are classified into 1 of 10 orders of priority where those in priority order 1 to 6 are regarded as safety and the remaining 4 non-safety. In practical terms, this relates to the following:

a) safety communications requiring high integrity and rapid response:

   1) safety-related communications carried out by the air traffic services (ATS) for air traffic control (ATC), flight information and alerting; and

   2) communications carried out by aircraft operators, which also affect air transport safety, regularity and efficiency (aeronautical operational control (AOC)); and

b) non-safety related communications:

   1) private correspondence of aeronautical operators (aeronautical administrative communications (AAC)); and

   2) public correspondence (aeronautical passenger communications (APC)).

4.2.2 Allocations in the Table of Frequency Allocations (Article 5 of the Radio Regulations) are made to the:

a) aeronautical mobile service (AMS) defined in RR 1.32 – this service is not appropriate for safety-of-life operations and is not considered further in this handbook;

b) aeronautical mobile (route) service (AM(R)S) defined in RR 1.33 – with allocated band segments in the frequency range 2 850–22 000 kHz, and the frequency bands 108–117.975 MHz, 117.975–137 MHz, 960–1 164 MHz, 5 030–5 091 MHz and 5 091–5 150 MHz;

c) aeronautical mobile (off-route) service (AM(OR)S) defined in RR 1.34 – this service is not appropriate for safety-of-life operations and is not considered further in this handbook;

d) no allocations have been made to the aeronautical mobile-satellite service (AMSS) defined in RR 1.32 — this service is not appropriate for safety-of-life operations and is not considered further in this handbook; instead, the AMSS may operate under the (generic) mobile-satellite service;

e) aeronautical mobile-satellite (route) service (AMS(R)S) defined in RR 1.36 in the frequency bands 1 610–1 626.5 MHz and 5 000–5 150 MHz;

f) aeronautical mobile-satellite (off-route) service (AMS(OR)S) defined in RR 1.37 – this service is not appropriate for safety-of-life operations and is not considered further in this handbook.

*Note.— For further information see Section 7-II, mobile-satellite bands 1 525–1 559 MHz and 1 626.5–1 660.5 MHz.*

4.2.3 All voice and data communications between aircraft and ground stations, with priority 1 to 6 as defined in RR 44.1, use frequencies from the bands under b) and e) above. The (R) designation (see RR 43.1) signifies the use along national and international civil air routes. The (OR) designation (RR 43.2) signifies uses other than along national or international civil air routes and typically includes national defence. Public correspondence is not permitted in bands allocated exclusively to the aeronautical mobile service or the aeronautical mobile-satellite service.

4.2.4 In the 1 545–1 555 MHz and 1 646.5–1 656.5 MHz bands, the spectrum requirements of the AMS(R)S (i.e. all aeronautical communications with priorities between 1 and 6 in Article 44 of the Radio Regulations) shall be given priority. These categories of messages are the same as those in Annex 10, Volume II, Chapter 5, 5.1.8 a) to f). These AMS(R)S communications also have priority and immediate access over any other mobile-satellite communication operating within a network in these bands (see RR 5.357A and RR 5.362A, as well as Chapter 7-II (1 525–1 559 MHz and 1 626.5–1 660.5 MHz) on mobile-satellite bands).

4.2.5 Chapter VIII of the Radio Regulations deals with certain licensing, regulatory and service operation aspects of the aeronautical mobile service and applies to all of the aeronautical mobile-satellite services, including the (R) and the (OR) components. A special mention at RR 35.1 and RR 35.1.1 recognizes the role which ICAO carries out through the SARPs in Annex 10 by according these superior status to that of the regulations mentioned in RR 35.1 which they may replace.

4.2.6 Appendix 27 to the Radio Regulations contains the frequency allotment plan for the AM(R)S in the HF bands between 2 850 kHz and 22 000 kHz. This

appendix contains the plan for HF frequency allotments to major world air route areas and to regional and domestic air route areas as well as meteorological information for aircraft in flight (VOLMET) areas. It also includes worldwide frequency allotments, which are for the use of aircraft operating agencies for AOC, to be assigned in accordance with RR 27/217.

4.2.7 Article 39 of the Radio Regulations requires the operators of aircraft to produce, on request, the radio licence for the installations on board an aircraft and the operator's certificate. These regulations are in line with Article 30 of the Chicago Convention.

## 4.3 NAVIGATION AND SURVEILLANCE

4.3.1 Allocations in the Table of Frequency Allocations (Article 5 of the Radio Regulations) for navigation and surveillance purposes are made to the:

– radiodetermination-satellite service: defined in RR 1.41. This service is not appropriate for safety-of-life operations and hence is not considered further in this handbook;

– radionavigation service: defined in RR 1.42;

– aeronautical radionavigation service: defined in RR 1.46;

– radionavigation-satellite service: defined in RR 1.43;

– aeronautical radionavigation-satellite service: defined in RR 1.47.

4.3.2 The definition for radionavigation services also includes those systems, such as radar, which contribute to the navigation of aircraft for ATC or which support other air navigation functions, such as radio altimeters and airborne weather radar.

4.3.3 Consideration for detect and avoid (DAA) system

4.3.3.1 In addition to existing aviation applications, radionavigation is of high interest for ICAO to support emerging technologies such as remotely piloted aircraft systems (RPAS). The safe operation of RPAS in civil airspace requires addressing the same issues as manned aircraft, namely integration into the ATC system. Because the pilot is no longer onboard, DAA system enables the capability to see, sense or detect conflicting traffic or other hazards and take the appropriate action. DAA Radar is one component of the wider DAA system which objective is to allow the remote pilots to exercise their responsibilities with regards to see and

avoid. DAA radars aim at detecting non-cooperative targets around the RPA.

4.3.3.2 Types of DAA

4.3.3.2.1 In line with the following requirement addressed in Annex 6 Part IV, RPAS are equipped with an automated collision system, for which DAA radar is a key input sensor.

The relevant requrement extracted from Annex 6 Part IV.

"*6.20.2.1 The RPA shall be equipped with an automated system that performs appropriate collision avoidance manoeuvres, except when the collision avoidance responsibilities of the remote pilot can be adequately exercised using other means.*"

4.3.3.2.2 The airborne based DAA, where the DAA radar is installed on-board the RPA, is the preferred way to meet the above requirement. However, it also gives some flexibility, under the responsibility of the State of the RPAS Operator, to exercise collision avoidance through other means, such as ground based DAA.

4.3.3.2.3 Ground based DAA consists of a ground based primary radar, and the information are transmitted to the RPA through the C2 Link. As a consequence, a C2 Link disruption would also induce a loss of the DAA and collision avoidance capability. To overcome this concern, the following requirement is also included in Annex 6 Part IV.

The relevant requrement extracted from Annex 6 Part IV.

"*6.20.2.2 Notwithstanding the provisions in 6.20.2.1, the State of the Operator may approve RPAS operations without automated collision avoidance, based on the results of a specific safety risk assessment conducted by the operator which demonstrates how an equivalent level of safety will be maintained. The specific safety risk assessment shall include at least the:*

*a) integrity and performance of the C2 Link;*
*b) diversity of multiple C2 Links, if installed; and*
*c) reliability of other systems that are required to allow the remote pilot to exercise control of the RPA flight trajectory.*"

4.3.3.3 Spectrum requirements for DAA radar

4.3.3.3.1 Spectrum requirements for DAA radars include:

- Since the objective of the RPAS is to perform international IFR flights in

non-segregated airspace, DAA solution should be global. As a consequence, in order to ensure that RPA can operate globally, the RPAS air-to-air DAA frequency bands should be harmonized on a worldwide basis.

- Due to the inherent safety nature of DAA system, the DAA frequency band should have an aeronautical radionavigation service (ARNS) allocation and appropriate protection must be provided against harmful interference.

4.3.3.4 Choice of the DAA frequency band

4.3.3.4.1 WRC-12 Agenda Item 1.3 examined the availability of Aeronautical Radionavigation spectrum to support RPAS operations. Based on the results of studies, it was determined that the existing Aeronautical Radionavigation spectrum was sufficient and no new aeronautical radionavigation spectrum was needed. ITU-R Report M.2204-0 identifies different ARNS frequency bands without analyzing their suitability to support DAA.

4.3.3.4.2 It is anticipated that ground-based DAA would rely on primary radars and can share "usual" civil aviation radar frequency bands (for example, 1240 – 1370 MHz, 2.7 – 2.9 GHz, 9 – 9.2 GHz) if compatibility is ensured. The coexistence between ground-based radars sharing the same band can be ensured through frequency coordination process and separation distance.

4.3.3.4.3 This identification of a frequency band to fulfill RPAS DAA spectrum needs seems more difficult for on-board DAA than for ground-based DAA, in particular regarding the requirement to have a global solution. This question will be addressed within the FSMP.

4.3.4 Radionavigation services receive specific mention in the definition of harmful interference at RR 1.169, and in that of a safety service at RR 1.59. Radio Regulation 4.10 ensures that such harmful interference to radionavigation services receives the highest priority in measures to control and clear its effects.

4.3.5 Radiodetermination services, the generic service which includes radionavigation, are the subject of Article 28 of the Radio Regulations. Protection requirements for the planning of aeronautical radio beacons operating in the low frequency (LF) and medium frequency (MF) bands are contained in Appendix 12 of the Radio Regulations.

4.3.6 The practice in the aeronautical service of removal of the station identification to indicate a failure of service is expressly provided for in RR 19.10,

and the requirements for call signs, including the formation of call signs, are contained in Article 19, Sections III and IV of the Radio Regulations. These call signs are also used in aviation for the registration of aircraft.

## 4.4 RELATIONSHIP BETWEEN ITU RADIO REGULATIONS AND OTHER MATERIAL AND ICAO SARPS

4.4.1 Under its Constitution and Convention, the ITU is recognized as the authoritative international body for telecommunications. The Radio Regulations are the instrument through which this specialization is expressed in internationally agreed terms for radio matters. These Radio Regulations, as presently constituted, lay down the agreed apportionment of the radio frequency spectrum to the various user services, including the aeronautical services. The Radio Regulations also define maximum radiation limits (e.g. for spurious or unwanted emissions) to support an interference-free radio environment. When necessary, this material is supplemented by ITU-R Recommendations. These, together with a broad regulatory framework covering, in particular, licensing of radio stations, personnel, provisions for inspection on demand, and procedures for safety, distress, resolving harmful interference, coordination and notification of frequency assignments, create the basis for a universal system of order in the use of radio frequencies.

4.4.2 The Radio Regulations have treaty status, and there is an inherent obligation on States to comply, unless an exception is stated and embodied in the Final Acts of the Conference which created the regulation. Such statements appear in the published version of the Final Acts. Aeronautical services are obliged to operate within the framework established by the Radio Regulations.

4.4.3 The ICAO SARPs in Annex 10 are developed in accordance with Article 37 of the Chicago Convention for the purpose of ensuring the safety and regularity of air navigation. In addition to the Radio Regulations, the SARPs specify interface and performance standards for internationally agreed aeronautical systems which have been developed by aviation to meet the specific operational requirements of aeronautical services. ICAO is recognized internationally as the competent international body to carry out this work and to coordinate a worldwide policy for the operational use of the specified systems. Furthermore, the Annexes contain procedures for regular and emergency communications that are specifically developed for aviation purposes, taking account of the operational conditions. These procedures supplement the basic requirements of the Radio Regulations for procedures in aeronautical communications.

4.4.4 The Radio Regulations and ICAO SARPs together thus form a complementary set of regulatory provisions without any overlap. The Radio Regulations must evolve within the general telecommunications environment with its many and diverse users of the radio frequency spectrum, while the ICAO SARPs respond to the operational safety aspects of air navigation and are developed and agreed by aviation within the ICAO organizational framework.

## 4.5 FREQUENCY COORDINATION AND REGISTRATION

4.5.1 The coordination and registration of frequency assignments is the prerogative of the ITU and must be performed in accordance with procedures laid down in the Radio Regulations. Frequencies are registered in the Master International Frequency Register (MIFR) maintained at ITU Headquarters in Geneva. With the increasing practice of the sharing of frequency bands by more than one service, coordination assumes an increasing importance in ensuring compatible use.

4.5.2 In exclusive aeronautical bands, actual (day-to-day) coordination of frequency assignments is being undertaken by ICAO, through the ICAO Regional Offices. To support this coordination, the ICAO Regional Offices have developed the necessary procedures, including the relevant frequency assignment planning criteria. A global frequency assignment plan, based on the frequency assignment planning in the ICAO Regional Offices, is being developed. Coordination of frequency assignments is taking place (in most cases) with the national CAAs.

4.5.3 This procedure, however, does not dispense with the more general requirement for the coordination of a frequency assignment within the ITU and the registration of this frequency assignment in the MIFR, if international protection of that assignment is necessary. Such coordination and registration needs to take place through the radio regulator authorities in each country. Although in some cases aeronautical frequency assignments, notably those in HF and LF/MF bands, are registered by the countries operating these services, other frequency assignments, particularly those in bands above 100 MHz, tend to be recorded only in national registers or in the ICAO Regional Air Navigation Plans. Because of this, de facto, the ICAO frequency register is the authoritative internationally agreed (within ICAO) list of coordinated frequency assignments for aviation in the following frequency bands:

| | |
|---|---|
| 190–535 kHz | NDB, locator |
| 108–117.975 MHz | ILS localizer, VOR, GBAS, VDL Mode 4 |

| | |
|---|---|
| 117.975–137 MHz | Air-ground voice (DSB/AM), VDL Mode 2 and 4 |
| 960–1 215 MHz | DME (SSR) |
| 5 030–5 091 MHz | MLS |

Nevertheless, even for the exclusive aeronautical bands it is considered beneficial to register the relevant frequency assignments within the ITU in order to obtain the status of international recognition and assist in protection of aeronautical applications from other services at future WRCs by declaring actual usage of these frequency bands. To this end, countries could use the system parameters recorded in the ICAO frequency register to update the ITU MIFR, as it was encouraged by the World Radiocommunication Conference, Geneva, 2012 (WRC-12).

4.5.4 Coordination and registration of frequency assignments in the HF bands (between 2 850 kHz and 22 000 kHz) is only taking place through the ITU. However, ICAO is considering developing, in parallel, a relevant ICAO list of HF frequency assignments.

4.5.5 Coordination and registration of frequency assignments for radar stations and on-board autonomous radionavigation systems are however NOT being coordinated through ICAO.

*Note.— See also Chapter 5.*

## 4.6 ITU STANDARDS

In the case of system and equipment standards, those contained in Annexes are obligatory (although a difference is allowable in matters of non-major detail). On the other hand, ITU standards, as published in ITU-R or ITU-T specification documents, exist as recommendations only, except for the very few instances where an ITU-R Recommendation is incorporated in the Radio Regulations, included in Volume 4 of the Radio Regulations and compliance is mandatory. The technical characteristics for HF aviation equipment in Appendix 27 of the Radio Regulations, since they form part of the Radio Regulations, enjoy the same status as compulsory treaty obligations.

## 4.7 ITU RESOLUTIONS AND RECOMMENDATIONS

ITU WRC Resolutions, included in Volume 3 and referenced in Volumes 1 (Articles) and 2 (Appendices) of the Radio Regulations using mandatory language, form part of the Radio Regulations and express a mandatory agreement among all of the ITU members to follow a particular course of action. ITU Recommendations, which are also part of the Radio Regulations, have no mandatory force and usually address matters of limited concern.

## 4.8 RADIO EQUIPMENT IN AIRCRAFT

Proper regulation and control of the use of radio equipment is important for the safe operation of the aircraft. Correct operation of equipment in approved frequency bands and on assigned, operational frequencies must be assured throughout an aircraft's flight on national or international journeys. Performance standards for both telecommunication and air safety requirements are the means used to achieve conformity with international rules. The processes to achieve this are explained in detail in Attachment C.

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# Chapter 5

# ICAO INVOLVEMENT IN FREQUENCY AND SPECTRUM PLANNING

5.1 ICAO is the United Nations specialized agency with recognized competence in matters related to aviation safety. Under Article 37 of the Convention on International Civil Aviation, ICAO is empowered to adopt and amend international SARPs for all aviation matters including aeronautical communications systems and air navigation aids. Under Article 37, the highest practicable degree of uniformity is seen as essential to facilitate and improve the safety of air navigation. Characteristics for aeronautical radio communication and navigation systems are laid down in Annex 10 to the Chicago Convention, and the requirement for interoperability of systems on a global basis demands that frequency allocations be available worldwide and, preferably, also exclusive.

5.2 ICAO coordinates the input to ITU discussions on aeronautical radio frequency spectrum matters. In pursuance of this role, ICAO is accorded observer status at relevant ITU WRCs and also participates at meetings of the ITU-R study groups, including the Conference Preparatory Meetings (CPMs) which prepare the technical and regulatory basis for WRCs. The range of this involvement includes aspects of common system technical standards, maximum levels of tolerable interference and measures to control and resolve interference incidents, frequency planning criteria, the preparation of frequency plans, and distress and safety procedures. The outcome of these discussions normally results in material being incorporated in the ITU Radio Regulations or in ITU-R Recommendations and subsequently being applied through national regulation by national telecommunication authorities.

5.3 Within ICAO, the necessary activity to support these ITU-generated functions exists at two levels:

a) at the worldwide level, through the work of the Air Navigation Commission, with the assistance of the FSMP (and communication divisional meetings or air navigation conferences, as required), to prepare the coordinated ICAO policies, spectrum estimates and technical inputs for ITU conferences and ITU-R study groups. The ICAO spectrum strategy, policy statements and the ICAO Position for WRCs are approved by the Council; and

b) at the regional level, by the ICAO Regional Offices, through coordination of frequency assignment plans with States, using agreed ICAO planning criteria. This activity is supported by the Regional Planning and Implementation Groups (PIRGs).

5.4 Aviation representatives are generally included in States' delegations to ITU conferences where they have the important role of safeguarding the aviation position during the conference discussions. States' cooperation in this supporting role is an essential factor in securing the aviation requirements.

5.5 The repetitive (now three to four-year) cycle for ITU WRCs means that the ICAO Position on the conference agenda must be prepared within the same time frame as national/regional inputs to the conference. This process is described in Attachment D to this handbook.

5.6 This handbook, which is updated through a rolling system of amendment action, provides the record of agreed ICAO policies, including the ICAO spectrum strategy and the ICAO policy statements.

5.7 The relationship between the radio regulatory activities and those of ICAO and CAAs is given in Figure 5-1.

5.8 The approach to improve States' support of the ICAO Position at WRCs has been approved by the Council of ICAO. This approach is in Attachment E.

5.9 The ICAO Position for WRC-27, as approved by the Council, is in Attachment F.

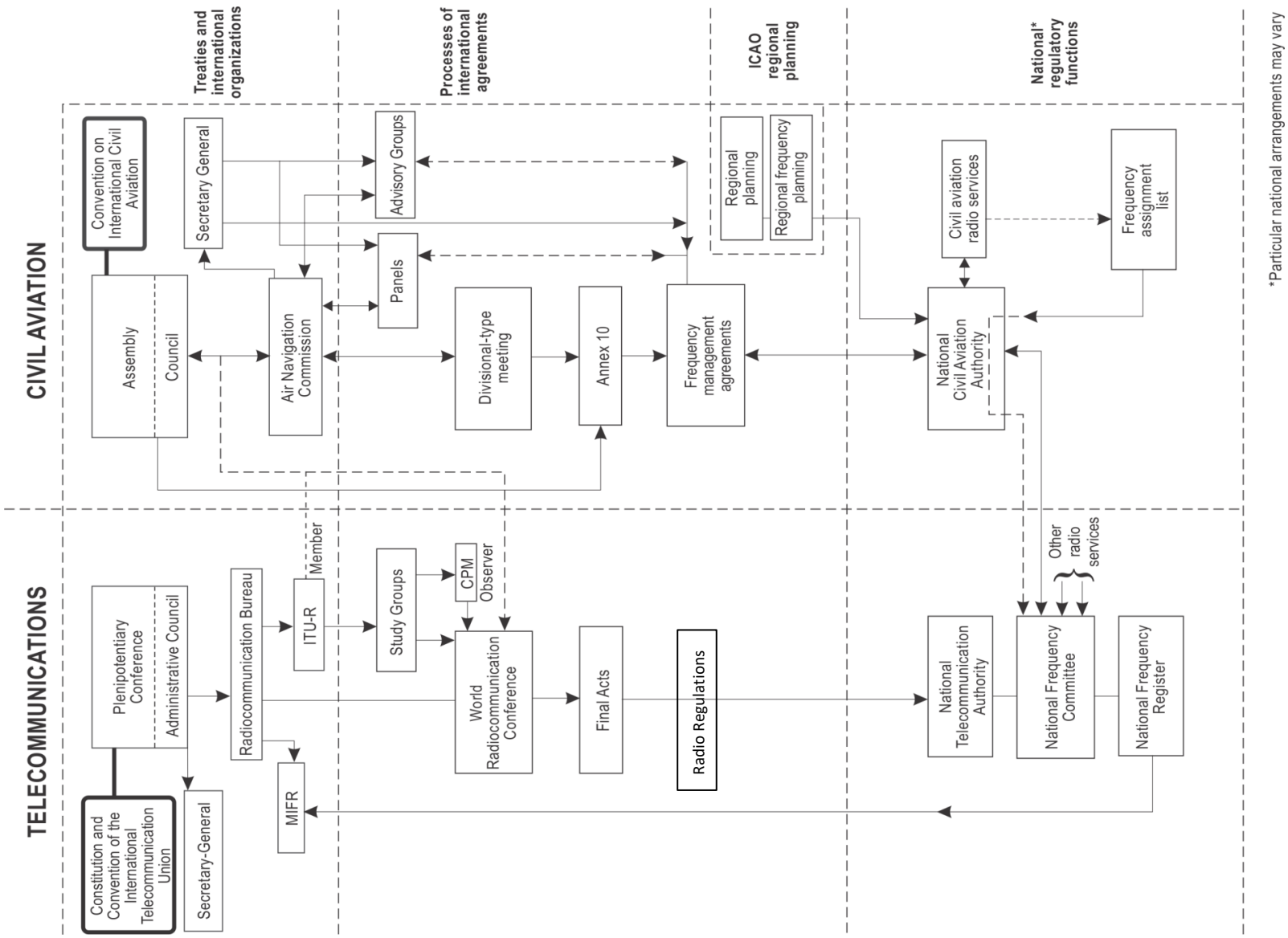


**Figure 5-1. Frequency management institutional relationships**

# Chapter 6

# OVERVIEW OF THE SPECTRUM MANAGEMENT PROCESS

## 6.1 GENERAL ASPECTS OF THE PROCESS

6.1.1 Civil aviation use of the radio frequency spectrum accounts for less than 14 per cent of the total, comparable to maritime use, but considerably less than other uses such as broadcast or national defence. The spectrum management process is designed to make the optimum use of this scarce spectrum resource. One of its main objectives is to create a universally agreed framework in which the demands for radio frequencies from individual countries are balanced with the interests of different service users to produce a planned radio environment incorporating an effective and efficient spectrum use. It has a necessary international dimension, which must be flexible and responsive to changing patterns of demand or to new technology, having scope for additional forms of transmissions and modulation methods.

6.1.2 With new technology, the useable spectrum expands over time, particularly in the higher frequency region, creating new possibilities and options. Spectrum expansion has limitations of scale and scope, however. Demand for spectrum continues to increase at a much faster rate than the frequency availability created from either extended spectrum boundaries or improved efficient use of the spectrum that is available (e.g. through reduced channel spacing). In its essentials, spectrum management combines separate disciplines, such as regulatory and control measures and technical (frequency assignment) planning, to achieve a reasonable compromise in dealing with the increasing demand for more spectrum. The current decade is expected to see this increase in demand rise sharply, particularly for broadband mobile applications and spectrum management problems will hence increase in complexity and scale.

6.1.3 In the context of this handbook, the management of the spectrum may be characterized by four main domains or areas of activity: the regulatory domain, the technical domain, the licensing domain and the registration domain, which are described below.

**The regulatory domain**

6.1.4 In this domain, the international agreements made within the ITU lay down a set of principles, rights and procedures, together with an institutional framework for their effective operation, which create the basis for an orderly international use of radio frequencies. The mechanism of the ITU (periodic radiocommunication conferences, the Radio Regulations Board and the Radiocommunication Bureau) maintains the permanent documents responsive to, and in line with, modern conditions.

6.1.5 The Radio Regulations, which have treaty status, are the cornerstone of the process. They contain the internationally agreed Table of Frequency Allocations and the agreed rules for its implementation, as well as the important international obligations for the operation of radio stations, licensing and other control measures for ensuring an effective regime of operation within the framework of the Radio Regulations.

6.1.6 The Radio Regulations primarily address regulatory aspects; technical material, usually of a more volatile character, is relegated to the Appendices to the Radio Regulations or to ITU-R Recommendations. Amendments to the Radio Regulations can only be made through a WRC, the Final Acts of which are agreed and signed at the conference, with the instrument of ratification to be deposited within the given time as specified in the Final Acts themselves. This regulatory basis, as contained in the ITU Constitution, Convention and Radio Regulations, is the starting point for the existence of a framework of stable international order and practical utility which is adhered to by all countries of the world.

**The technical domain**

6.1.7 In the final analysis, the effective use of the radio frequency spectrum is dependent on the expert technical planning of the frequency assignments used by the various services and systems. The main technical tools at the disposal of the spectrum manager are those in the hierarchical order of allocation planning, service sharing planning and, at the station level, the planning of assignments to particular locations.

6.1.8 The processes here are quantitative and exact, requiring careful examination and agreement between countries and service users. The concepts of acceptable interference and harmful interference, as contained in the regulatory rules, must be translated into practical limits and applied to achieve a service which meets all of its operational requirements. Different services require different amounts of bandwidth and can tolerate different levels of interference. Also, propagation

conditions vary widely throughout the useable spectrum. Careful assessment and balancing of these degrees of freedom have to be applied to achieve optimum results. The ITU-R is the focus for the studies which lead to refined and workable criteria for sharing among services and for the development of international and national frequency plans.

6.1.9 Due to safety implications, however, civil aviation is, through ICAO, developing and planning most of the use of worldwide exclusive aeronautical frequency bands within its organizational structures, utilizing technical standards that have been adopted or approved within ICAO.

**The licensing domain**

6.1.10 Implementation of the basic ITU obligations for certification of system and personnel, licensing of stations, monitoring the observance of licence conditions and clearing interference are functions carried out at the national level under national law. These duties are normally exercised by national telecommunication administrations, which also provide the spectrum management expertise for national frequency planning and participate in international discussions on spectrum matters. Coordination among administrations is the usual mechanism for bilateral and multilateral discussions. The licensing actions generally also include equipment type approval against national or other specifications. The parameters checked include those having an effect on other users, such as frequency stability and spurious emissions, and system interoperability features. In the case of aviation equipment, conformity with Annex 10 may also be a licensing condition.

6.1.11 The licensing process is the controlling mechanism for the use and change of use of frequency bands, or for the exercise of sanctions in the case of licence infringements. It also provides the opportunity to levy such charges as are necessary to support the spectrum management and regulation activity or to control demand.

6.1.12 Article 18 of the Radio Regulations requires that all stations be licensed by the government having authority over their operations. For aircraft, dispensations are granted in 18.8 for the specific instance of first delivery, and in 18.11 for wet and dry lease. Article 39 requires the station licence to be available for inspection on demand at any time. Article 37 addresses operators' certificates for personnel in the aeronautical services. These basic telecommunications requirements have been included in Articles 29, 30 and 32 of the Chicago Convention.

**The registration domain**

6.1.13 The registration by countries of their assignments in an internationally agreed database is fundamental to the ITU principle of prior rights gained by earlier registration (first come, first served), and the important obligation not to derogate the protection of existing registered assignments of other countries. The procedural rules are laid down in the Radio Regulations and the process of consultation and recording in the Master International Frequency Register (MIFR) is administered by the Radiocommunication Bureau. A comprehensive procedure for coordination, especially for space services, is a particular feature of these important provisions which have been developed and refined over many years.

6.1.14 The MIFR thus serves the dual purpose of a formal record and a planning guide for new assignments.

6.1.15 The predominant emphasis in all of these processes is that of the freedom of countries to use frequencies as they wish, provided they do not affect other existing services and uses of other countries, which have been established in accordance with the Radio Regulations and registered in the MIFR. In keeping with these liberal principles, the ITU Convention contains no provisions for arbitration or for the referral of disputes to international adjudication. The settling of problems is hence treated as a matter for bilateral or multilateral resolution in the first instance, calling on informal assistance from the permanent organs of the ITU should this fail. Cases of failure, however, remain an insignificant proportion of the millions of operating radio services.

6.1.16 For the role of ICAO in frequency coordination and registration (in ICAO) see Chapter 4, 4.5, and Chapter 5.

## 6.2 ELEMENTS OF THE TECHNICAL DOMAIN

6.2.1 The technical planning of frequency assignments is the single most important element in the use of the spectrum. Advances in technology supporting more efficient use of the available radio frequency spectrum and in planning methods enable a more effective and efficient use of radio frequencies. Frequencies are technically managed and planned in accordance with a hierarchical process that involves the planning of allocations to radio services, the determination of sharing conditions (with other services operating in the same or adjacent frequency bands) co-frequency and the actual frequency assignment planning.

**Planning of frequency allocations**

6.2.2 At the highest level is the planning of allocations of frequency bands to radio services, which are agreed internationally within ITU at WRCs and incorporated in the Table of Frequency Allocations (Article 5 of the Radio Regulations (RR); see also Section 7-II). Allocations in the form of frequency bands are made to "services", with the choice of grouping of services adopted in ITU (see Figure 3-3). Allocations are classified as primary or secondary, with the primary allocation taking precedence at all times over a secondary allocation should a conflict arise in registration or in implementation (see Section 7-II).

6.2.3 Allocations may be worldwide, as is the case with the majority of aeronautical services, or made to one or two of the three ITU regions (see Figure 3-1). Countries may make specific requests for sub-regional or country allocations, usually coordinated in advance with their neighbours. These allocations are normally incorporated in footnotes to the Table of Frequency Allocations.

6.2.4 In addition to the allocations concept, in which frequency bands are allocated to different radio services, specific ITU WRCs may distribute frequencies to geographical areas or radio stations, thus establishing frequency allotment or assignment plans, respectively, and incorporating them in ITU documents. Examples of such ITU documents are Appendix 27 to the RR containing a frequency allotment plan for the AM(R)S in HF bands, Appendix 30 to the RR containing a frequency assignment plan for broadcasting-satellite service or ITU Regional Agreement GE85 containing a frequency assignment plan for stations of the aeronautical radionavigation service in the MF bands in Region 1. It is more usual, however, for allocations to provide the basis for regional, area (sub-regional) or national frequency assignment planning.

6.2.5 Frequency assignment plans for aeronautical communications and navigation systems (with the exception of the HF bands) are usually developed and agreed regionally within ICAO, through the ICAO Regional Offices, using the planning criteria contained in the attachments to ICAO Regional Air Navigation Plans (see also Chapter 4, 4.5).

**Service sharing**

6.2.6 Increasing pressure on the spectrum has led to an increased sharing of frequency bands by compatible primary services to the extent that sharing has become commonly used. ITU-R studies, which determine the sharing conditions between different services, may include technical and operational limitations or procedures for coordination purposes. Sharing between low-signal-level space

services and other services, including on occasion aeronautical services, is often proposed. The results of the ITU-R studies are normally published in ITU-R Recommendations or ITU-R Reports.

**Planning of frequency assignments**

6.2.7 This activity follows on from allocation planning or sharing studies. Its purpose is to prepare frequency assignment plans between cooperating countries for their region or area, or by countries for application within national boundaries, or to identify individual assignments on a case-by-case basis. For terrestrial services, it employs the dimensions of frequency, distance and time separation in calculations which would use some or all of the following parameters:

– location of required service;

– frequency of operation and transmission bandwidth;

– power and directive gain of antenna;

– propagation characteristics;

– protection required by proposed service;

– protection required by other existing services on same or adjacent frequencies;

– time of day, season or year of operation.

A frequency assignment can be made when each new (or modified) frequency assignment simultaneously satisfies the protection requirement for each direction of transmission (the new/modified frequency assignment will not cause harmful interference to existing frequency assignments and in turn, existing frequency assignments shall not cause harmful interference to the new/modified frequency assignment). The task of creating and maintaining a frequency assignment plan for a region is usually extensive, requiring computer-based tools. Assignments are made to transmitting stations subject to the requirement to protect the received signal in a given area (designated operational coverage) from harmful interference.

6.2.8 For space services, Article 9 of the Radio Regulations lays down comprehensive coordination procedures operated by the Radiocommunication Bureau. Acceptability is assessed using calculation methods and criteria contained in agreed ITU-R Recommendations. ICAO is normally not involved in the coordination of frequency assignments for space services.

6.2.9 Further guidance on frequency assignment planning and other technical material is in Volume II of this handbook.

## 6.3 THE ROLE OF TECHNOLOGY IN SPECTRUM MANAGEMENT

6.3.1 Technology plays a vital role in spectrum management in two ways:

a) it provides automated (computer-based) assistance to the frequency assignment planning process, facilitating better analysis, performing more complex or repetitive calculations, maintenance and access to information and data on frequency use, and many other applications; and

b) through system improvements, it leads to improved utilization of radio frequency (RF) spectrum.

6.3.2 Modern communication and navigation systems, employing sophisticated RF modulation techniques, tighter system design parameters and improved interference rejection circuitry, promote more efficient frequency use and are now commercially available at economical prices. For example, the actual spectral occupancy of a single VHF communication channel in the AM(R)S band has been significantly improved by channel splitting on four occasions in the past fifty years, which has resulted in the availability of many extra channels in that band. The use of digital modulation techniques to replace analogue modulations may provide for another practical system improvement measure which, coincidentally, may lead to more efficient spectrum use.

6.3.3 Technology improvements remain the best possibility for meeting the anticipated demand for frequencies in the future.

## 6.4 AERONAUTICAL SERVICES

6.4.1 Aeronautical services are subject to all of the processes described above in the same general way as any other radio service. The allocations to the aeronautical mobile and aeronautical radionavigation services are part of the common spectrum resource for aviation and are required to be justified on a continuous basis, requesting additions when necessary and releasing frequencies which are no longer required.

6.4.2 The areas where the special role of radio in air operations is fully recognized, as noted above, are:

a) the technical control and management of the exclusive allocations to aeronautical services is carried out by aeronautical experts, both internationally and nationally, in a majority of countries. In these activities, ICAO performs a central coordinating function, providing the international forum for the review of needs for spectrum, the development of technical planning standards and the registration of global use. National aviation experts participate fully in these activities;

b) equipment and system approval by aviation authorities, recognizing that ground systems must meet operational standards based on safety, and aircraft equipment must obtain type approval and airworthiness certification also based on safety requirements under national responsibilities emanating from the Chicago Convention; and

c) cases of interference to aeronautical radio services are treated in the Radio Regulations as requiring special measures. National telecommunications administrations are required to take particular care in the licensing and operation of other services and industrial processes using radio waves which have the potential to endanger safety-of-life functions. In cases where harmful interference is experienced, ICAO can offer assistance in eliminating the interference.

## 6.5 SPECTRUM MANAGEMENT IN THE FUTURE

6.5.1 The worldwide demand for frequencies continues to increase, placing considerable pressures on the spectrum management process. Growth patterns vary between world regions, with developed economies experiencing expansion in (generic) mobile communications, both terrestrial and satellite, and in sound and television broadcasting. Elsewhere, fixed links for point-to-point communications are important in areas without an extensive ground-based (cable) infrastructure, or where radio services in large areas with difficult terrain have to be developed. Bandwidth efficient technologies can provide substantial gains in the amount of information processed per unit of bandwidth. Attention is also strongly focused on the release of spectrum no longer needed, or inefficiently used, or where the service concerned fails to argue the case for retention.

6.5.2 A result of this new trend is that spectrum earmarked for use at some point in the future, or where no plans exist for use, can no longer be retained, effectively creating a situation in which it may never be possible to successfully reinstate a claim. In this process, the aeronautical industry, with its long timescales for international agreement and coordination, is at a serious disadvantage compared to other users, particularly to those users where commercial considerations are prime. Instances of arbitrary forcible release of spectrum to such commercial services are expected to increase.

6.5.3 Demand is unlikely to be satisfied solely by the application of the procedures of administrative negotiation and agreement used in the past, in which majority support at ITU conferences has been the criterion for change. Further, there are practical limits to the technical sharing of frequencies between services (i.e. shared allocations) which in the final analysis often merely advances eventual saturation. Spectrum managers are therefore seeking fresh initiatives to provide more effective ways of awarding and recovering frequencies.

6.5.4 In some countries, procedures are being introduced in which the recognition of economic forces would play a controlling role. Spectrum award to the highest bidder and licensing costs are the parameters in which market forces will be applied to restrict demand, ration allocations, and affect the speedy return of frequencies no longer needed. While this is initially applicable to high-profile services, such as land mobile and broadcasting, and in congested areas, it will in the longer term affect aeronautical allocations, increasing the cost of licences and applying pressure to release underused frequencies. Although there is some recognition that for any methodology to be completely viable it must take into account essential social and community services and protect their interests, this reasoning has not yet been extended to include aviation, which spectrum managers are coming to regard as just another type of commercial operation, albeit with some special safety connotations. Spectrum pricing, which is a levy on the use of radio frequency spectrum, is in some countries being extended to spectrum allocated to aeronautical services.

6.5.5 Future aeronautical radio services are anticipated to make much greater use of bandwidth efficient systems through the application of modern technology for reduction of channel spacing, and increased channel capacity and digital technology. The overall effect of these technological improvements is to meet the expected increase in air traffic around the world in the years ahead, which in some areas is expected to double, and perhaps up to and beyond the year 2030 without any significant increase in spectrum. Introduction of new aeronautical systems or services may require additional frequency bands to be made available for aviation.

## 6.6 SPECTRUM MANAGEMENT SUMMARY

The objective of radio frequency spectrum management is to create a rational, controlled regime whereby the scarce radio frequency resource is planned in such a manner as to meet the competing and conflicting demands of all of the radio services intending to make use of it. It is characterized by an international treaty agreement within the ITU on the principles and objectives to be adhered to in pursuance of agreed international policies, which include, in particular, the following:

a) a complementary set of domains addressing the separate aspects of allocations, supporting regulations, technical planning, service licensing and frequency registration, embodied within an enabling set of agreed Radio Regulations;

b) the application of these agreed principles and measures within national territories by national telecommunication authorities. This process also includes the national coordination role for both implementation of international agreements and for the development of coordinated national proposals for the purpose of international negotiation and agreement;

c) the recognition that radio plays a vital role in the safe operation of aircraft, and the acceptance that aviation, through ICAO, may create standards for equipment and for frequency plans; and

d) the realization that technical and regulatory measures alone cannot meet all future demands of radio services for access to scarce frequencies. Present trends are leading to consideration of other means, including in particular the restriction of demand through the application of economic measures, such as administrative pricing and auction of frequency bands to the highest bidder.

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# Chapter 7

# STATEMENT OF FREQUENCY ALLOCATIONS, TECHNICAL DETAILS AND ICAO POLICY

This chapter addresses the main subject matter in detail, structured as follows:

**Section 7-I.** List of frequency bands.

**Section 7-II.** Civil aviation frequency allocations – ICAO policy statements and related information (including a composite statement for each frequency band):

- allocation table;
- footnotes;
- ICAO policy;
- aviation use; and
- commentary.

**Section 7-III.** Radio Regulations and other ITU material of importance to aeronautical services including:

- identification of Regulations of importance to civil aviation; and
- ICAO policy.

**Section 7-IV.** Review of ITU Resolutions and Recommendations.

## SECTION 7-I. LIST OF FREQUENCY BANDS

| *Band* | *Service* | *Aviation use* | *Section 7-II page no.* |
|---|---|---|---|
| *130–535 kHz | ARNS | NDB | 7-23 |
| *2 850–22 000 kHz | AM(R)S | Air-ground communications (HF voice and data) | 7-33 |
| 3 023 and 5 680 kHz | AM(R)S | Search and rescue | 7-45 |
| 74.8–75.2 MHz | ARNS | Marker beacon | 7-47 |
| *108–117.975 MHz | ARNS<br>AM(R)S | VOR/ILS localizer/ GBAS/VDL Mode 4 | 7-49 |
| *117.975–137 MHz | AM(R)S<br>AMS(R)S | Air-ground and air-air communications (VHF voice and data) | 7-59 |
| 121.5, 123.1 and 243 MHz | AM(R)S<br>AMS(R)S | Emergency frequencies (EPIRB & ELT) | 7-66 |
| 328.6–335.4 MHz | ARNS | ILS glide path | 7-68 |
| 406–406.1 MHz | MSS | Search and rescue | 7-70 |
| *960–1 164 MHz | ARNS/<br>AM(R)S | Air-ground communications/ DME/UAT/ LDACS | 7-68 |
| 1 030 and 1 090 MHz | ARNS<br>AMS(R)S | SSR/ACAS/ADS-B/MLAT | 7-68 |
| *1 164–1 215 MHz | ARNS/RNSS | DME/GNSS | 7-68 |
| *1 215–1 400 MHz | RLS/<br>RNSS<br>ARNS | GNSS<br>Primary surveillance radar | 7-87 |
| *1 525–1 559 MHz | MSS (s-E)** | Satellite communications | 7-96 |
| *1 610–1 626.5 MHz | AMS(R)S (s-E, E-s) | Satellite communications | 7-99 |
| *1 626.5–1 660.5 MHz | MSS (E-s)** | Satellite communications | 7-89 |
| *1 559–1 626.5 MHz | ARNS/RNSS/ MSS | GNSS | 7-99 |
| *2 700–3 300 MHz | ARNS/RNS/ RLS | Primary surveillance radar | 7-112 |

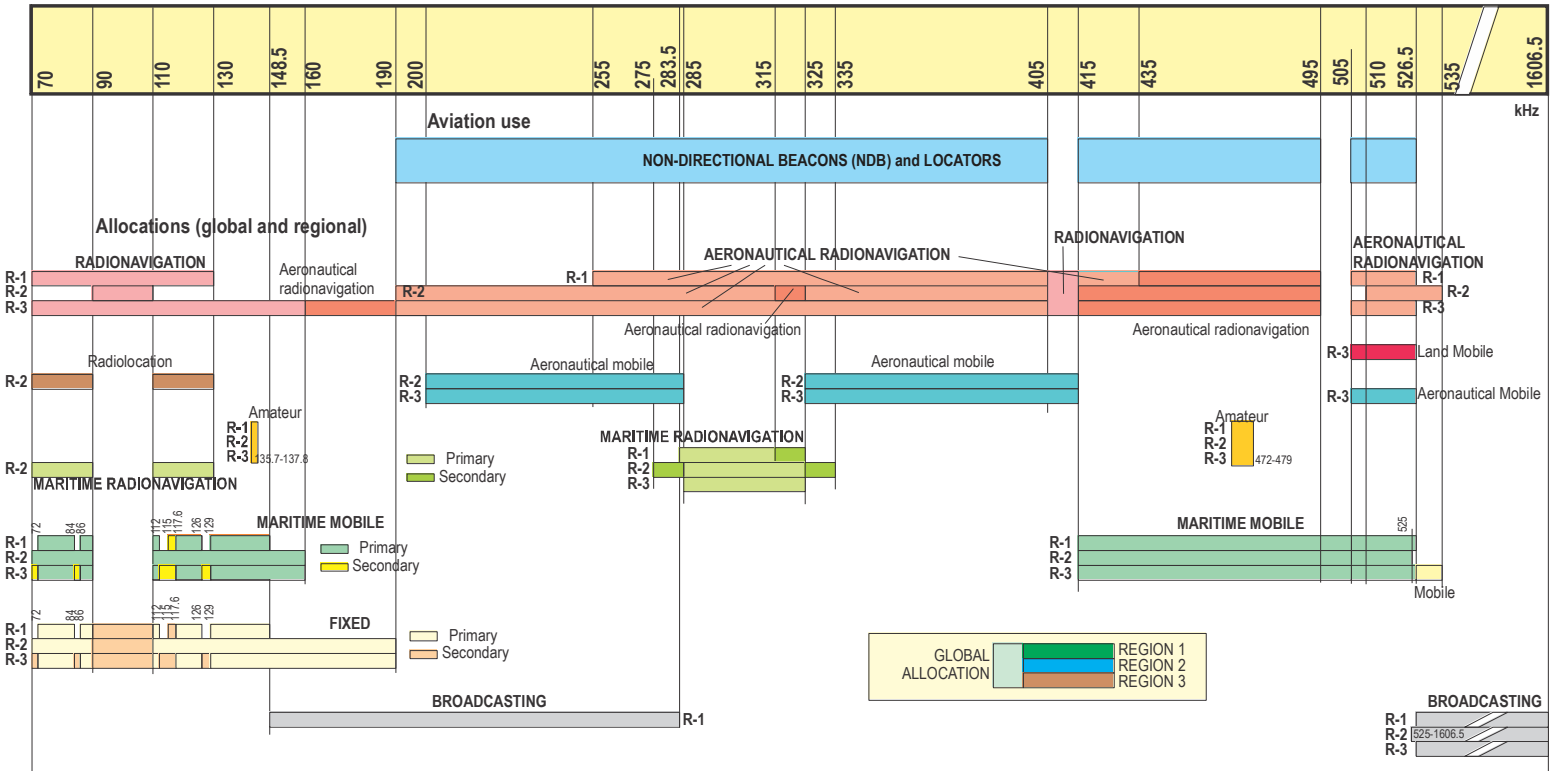
| *Band* | *Service* | *Aviation use* | *Section 7-II page no.* |
|---|---|---|---|
| *4 200–4 400 MHz | ARNS/ AM(R)S | Radio altimeter WAIC | 7-118 |
| *5 000–5 250 MHz | ARNS AM(R)S AMS(R)S | MLS/UAS command and non-payload communication/airport surface communication | 7-121 |
| *5 350–5 470 MHz | ARNS | Airborne weather radar | 7-129 |
| 8 750–8 850 MHz | ARNS/RLS | Airborne Doppler radar | 7-131 |
| 9 000–9 500 MHz | ARNS/RNS | Precision approach radar/ airborne weather radar/ ASDE | 7-133 |
| 13.25–13.4 GHz | ARNS | Airborne Doppler radar | 7-145 |
| 15.4–15.7 GHz | ARNS/RLS | ASDE/other systems | 7-151 |
| 24.25–24.65 GHz | RNS | ASDE | 7-161 |
| 31.8–33.4 GHz | RNS | ASDE/ enhanced flight vision system (EFVS) | 7-167 |
| 92–95 GHz | RLS | Foreign Object Debris (FOD) Detection | 7-171 |
| 95–100 GHz | RNS RLS | enhanced flight vision system (EFVS) Foreign Object Debris (FOD) Detection | 7- 173 |

AM(R)S: Aeronautical mobile (route) service
AMS(R)S: Aeronautical mobile-satellite (route) service
ARNS: Aeronautical radionavigation service
MSS: Mobile-satellite service
RLS: Radiolocation service
RNS: Radionavigation service
RNSS: Radionavigation-satellite service

*Note.— The identification of specific frequency bands to support DAA systems is still under discussion within ICAO. It is expected that DAA frequency bands will be identified in the next update to this document.*

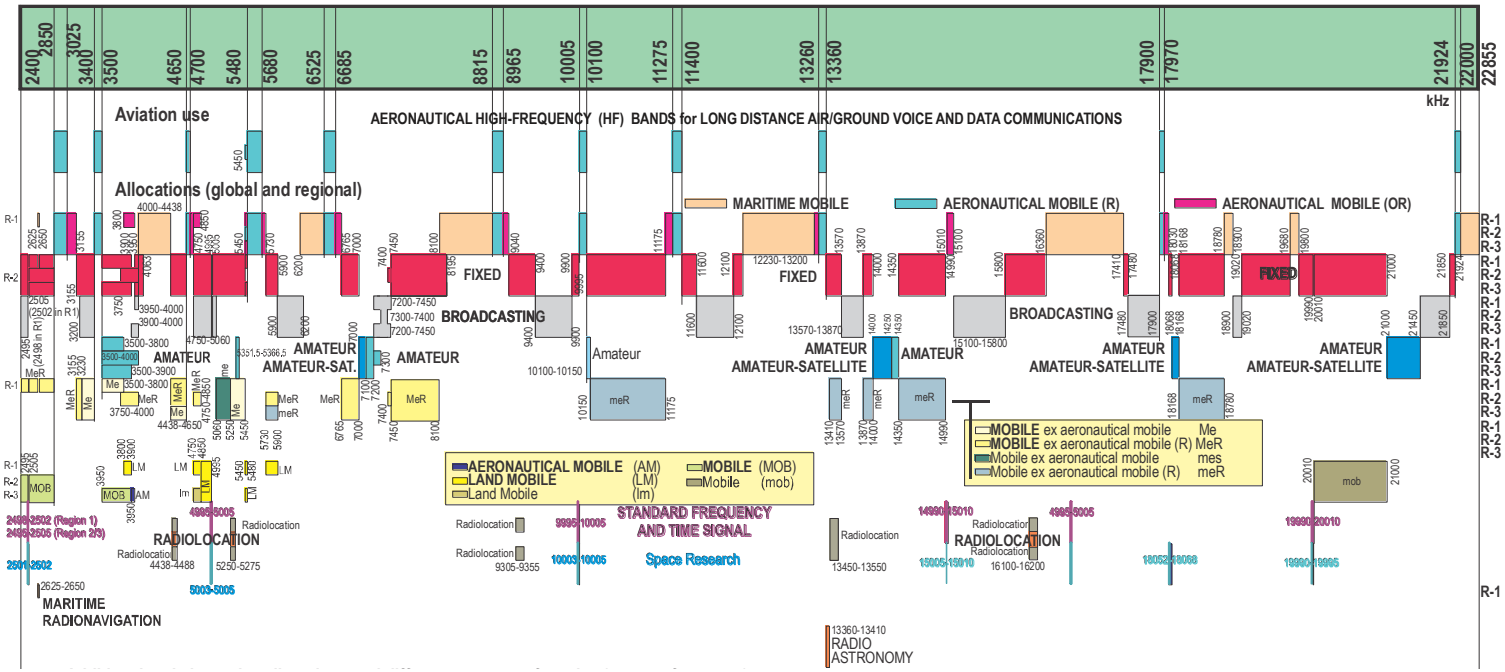
* A graphical presentation of the allocations of the aeronautical services, together with other services and relevant footnotes to which these bands are also allocated, is in Figures 7-1 to 7-7.

** In the frequency bands 1 545–1 555 MHz and 1 646.5–1 656.5 MHz under RR 5.357A (and also in the band 1 555-1 559 MHz and 1 656.5-1 660.5 MHz in the United States under RR 5.362A), priority is to be given to accommodating the spectrum requirements of the aeronautical mobile-satellite (R) service providing transmission of messages with priority 1 to 6, as defined in Article 44 of the Radio Regulations.



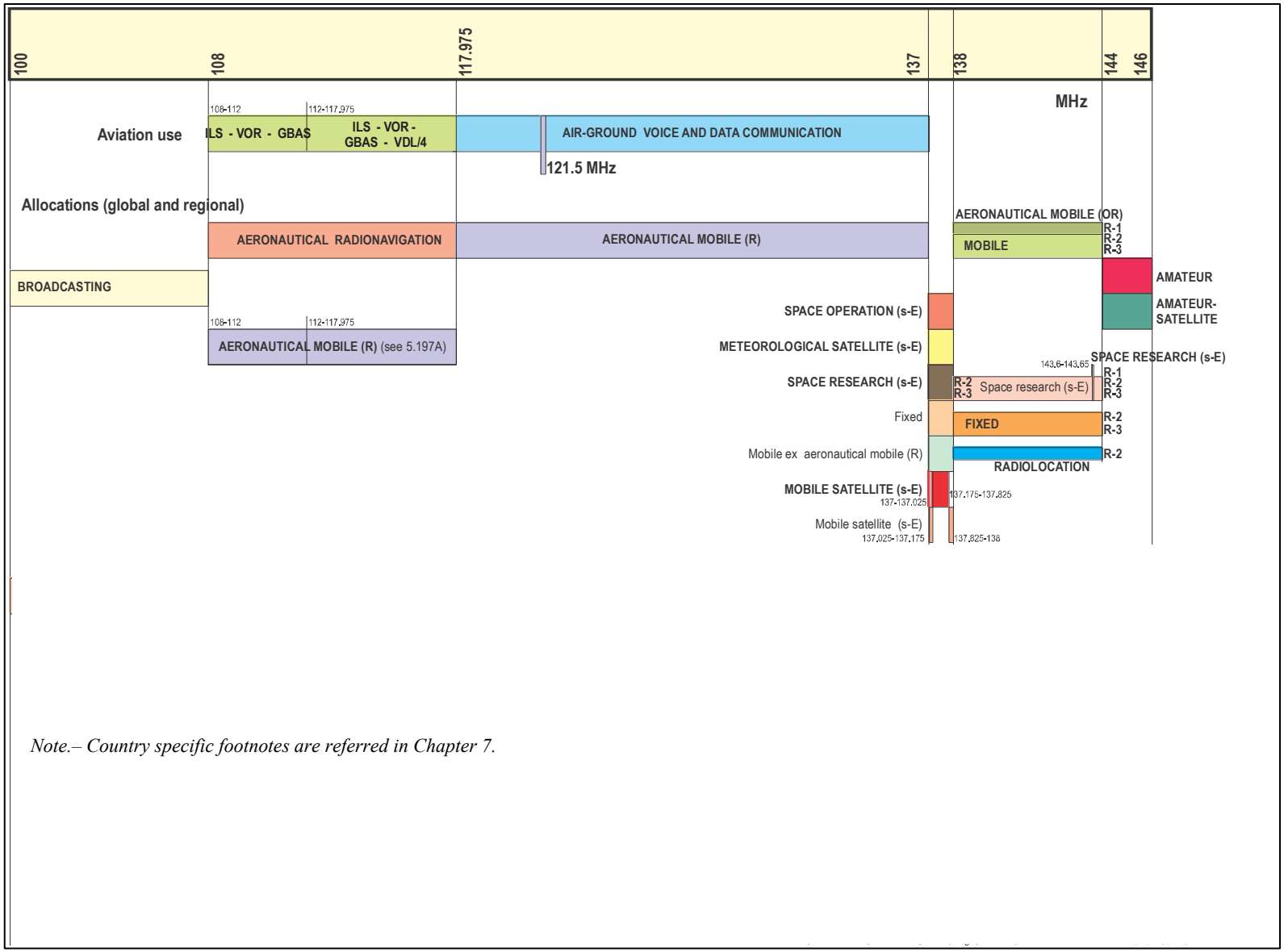

*Note– Country specific footnotes are referred in Chapter 7.*

**Figure 7-1. 70 – 1 606.5 kHz**



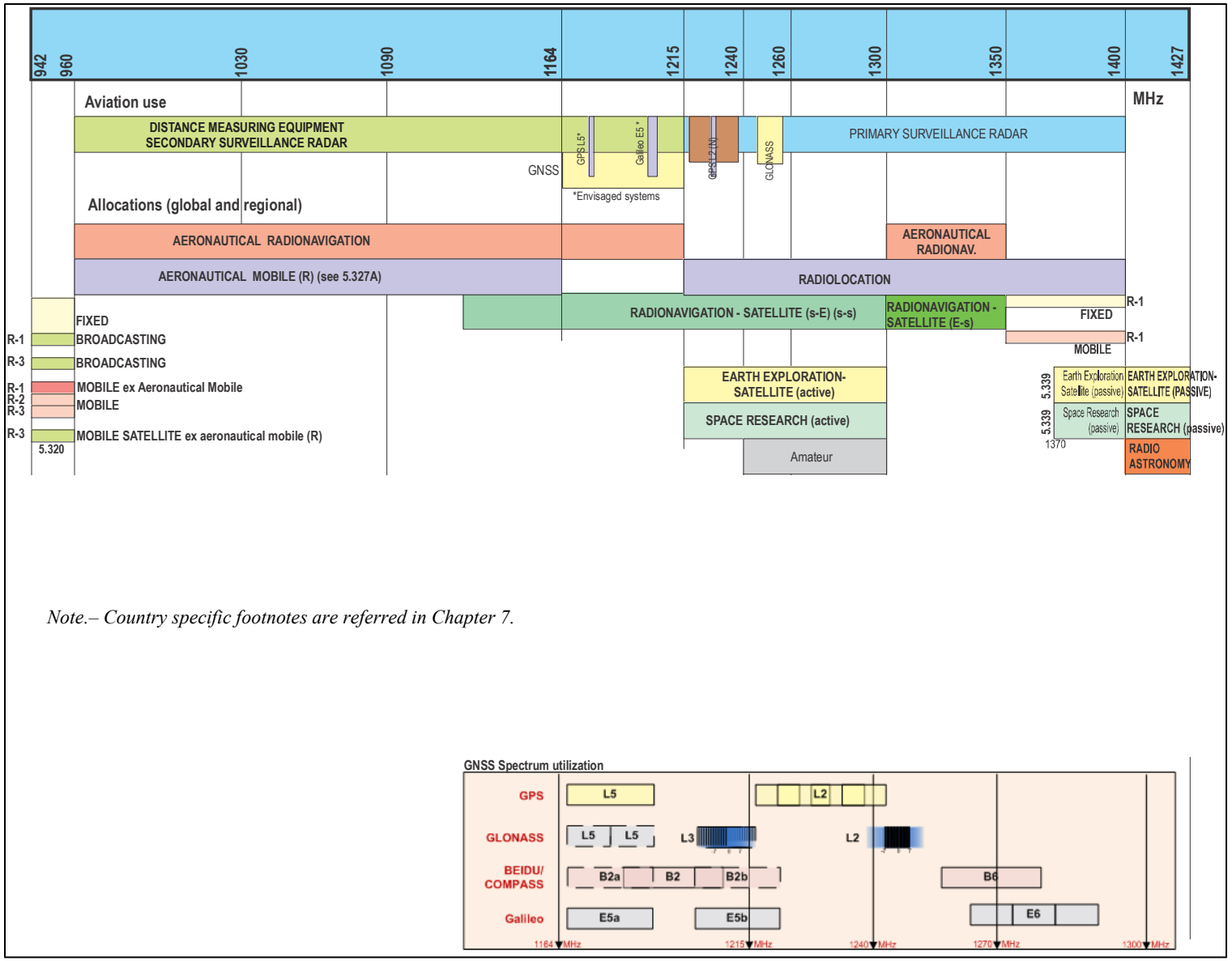

*Note.– Country specific footnotes are referred in Chapter 7.*

**Figure 7-2. 2 400 – 22 250 kHz**



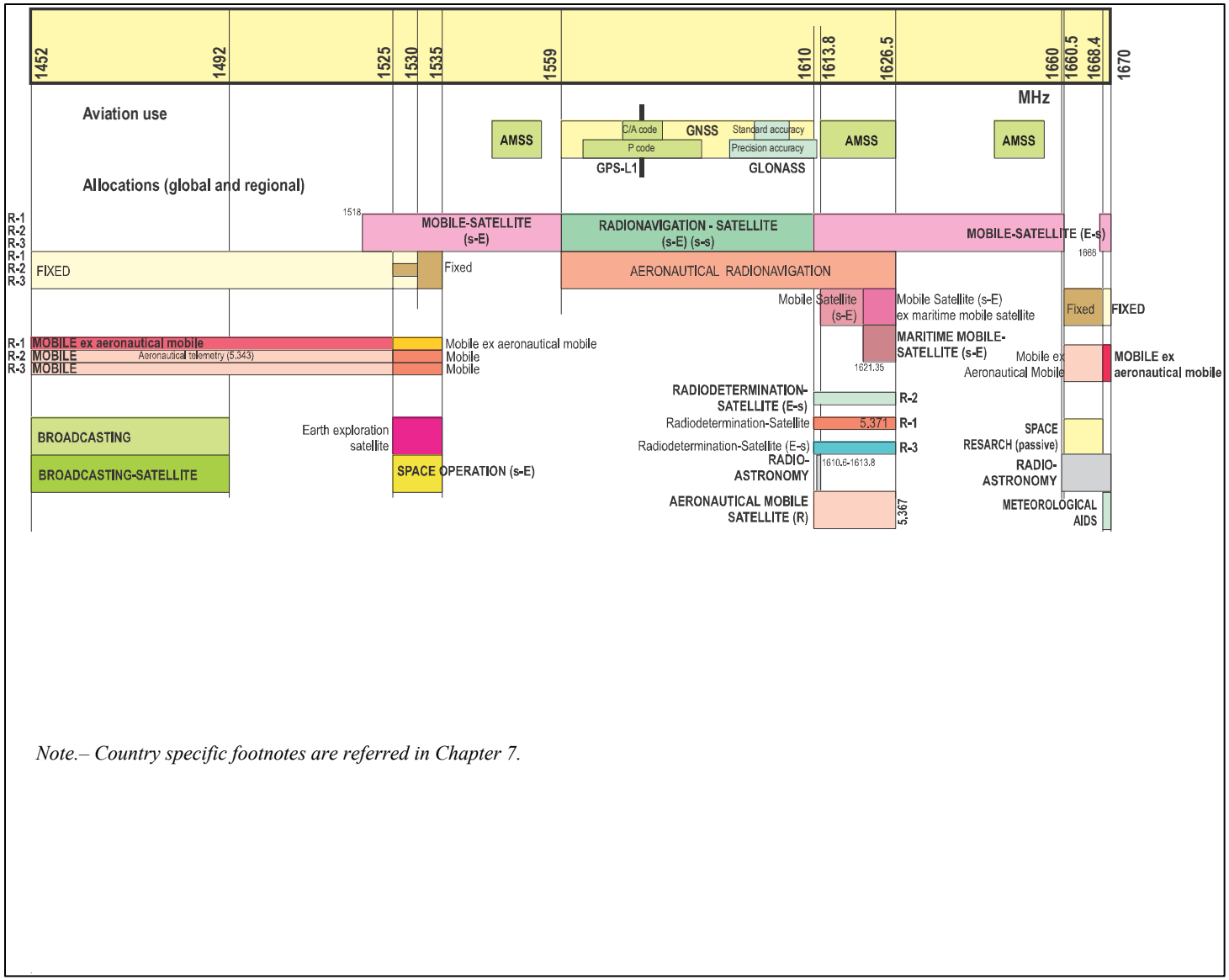

*Note.– Country specific footnotes are referred in Chapter 7.*

**Figure 7-3. 100 – 146 MHz**



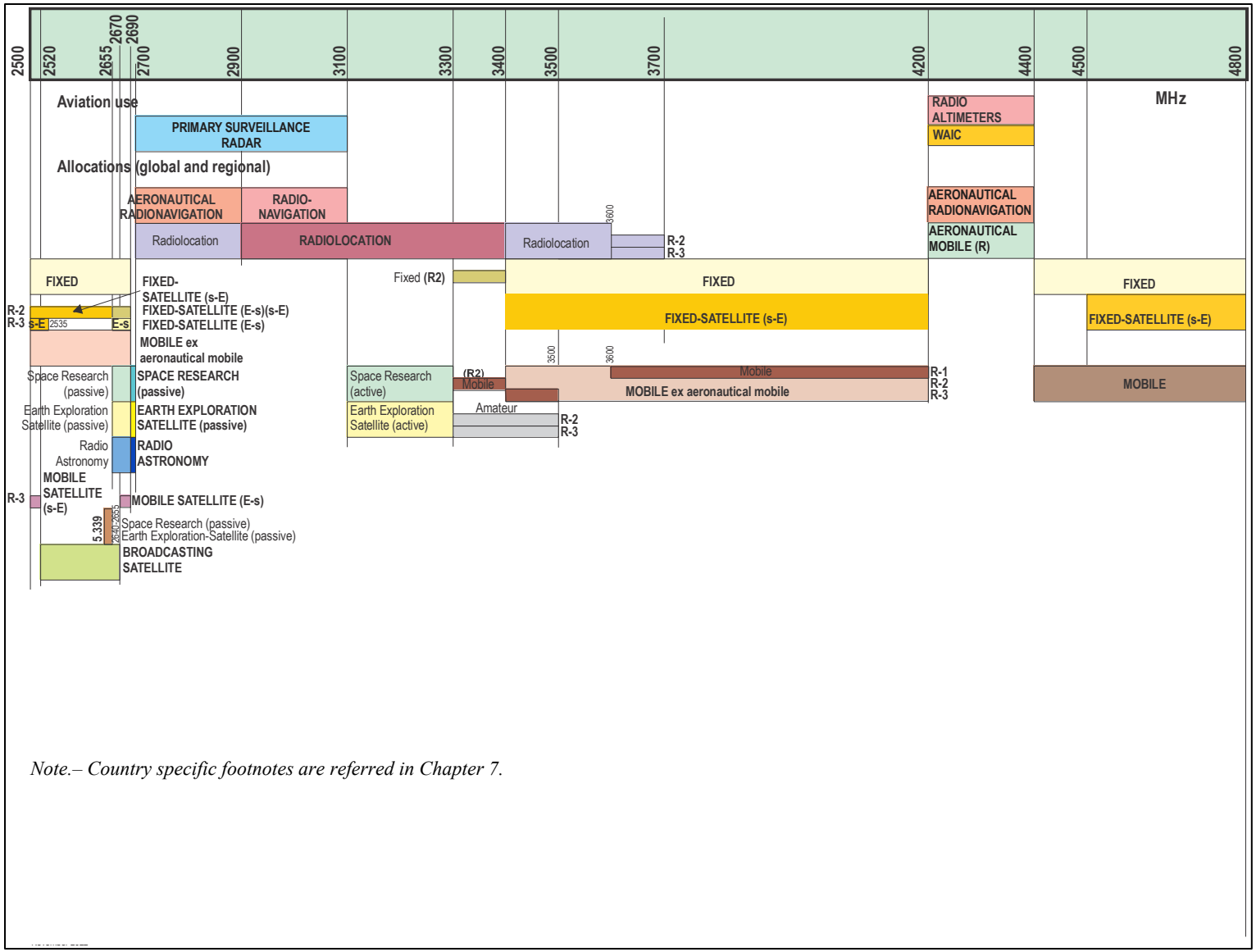

*Note.– Country specific footnotes are referred in Chapter 7.*

**Figure 7-4. 942 – 1 427 MHz**



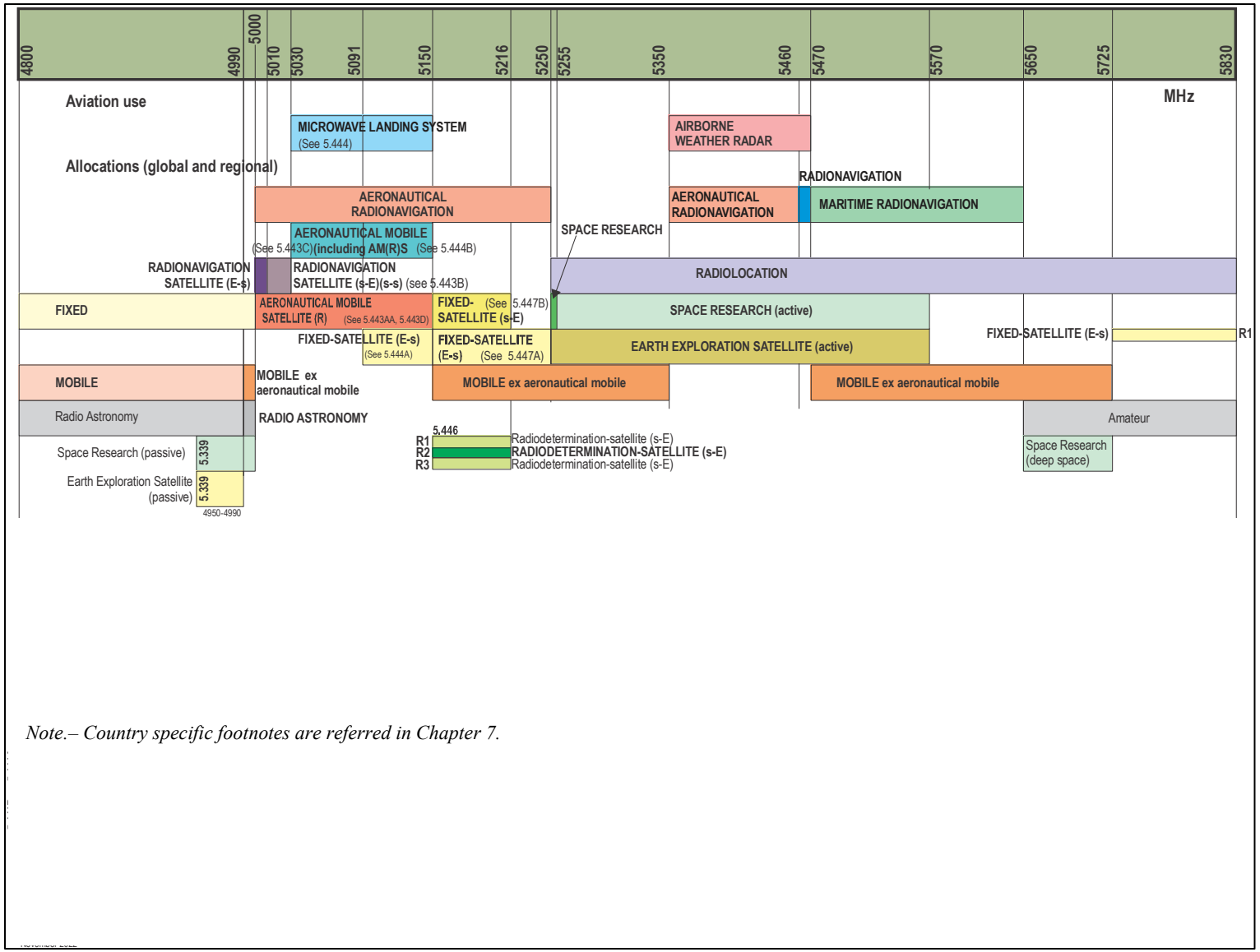

*Note.– Country specific footnotes are referred in Chapter 7.*

**Figure 7-5. 1 452 – 1 670 MHz**




*Note.– Country specific footnotes are referred in Chapter 7.*

**Figure 7-6. 2 500 – 4 800 MHz**




*Note.– Country specific footnotes are referred in Chapter 7.*

**Figure 7-7. 4 800–5 830 MHz**

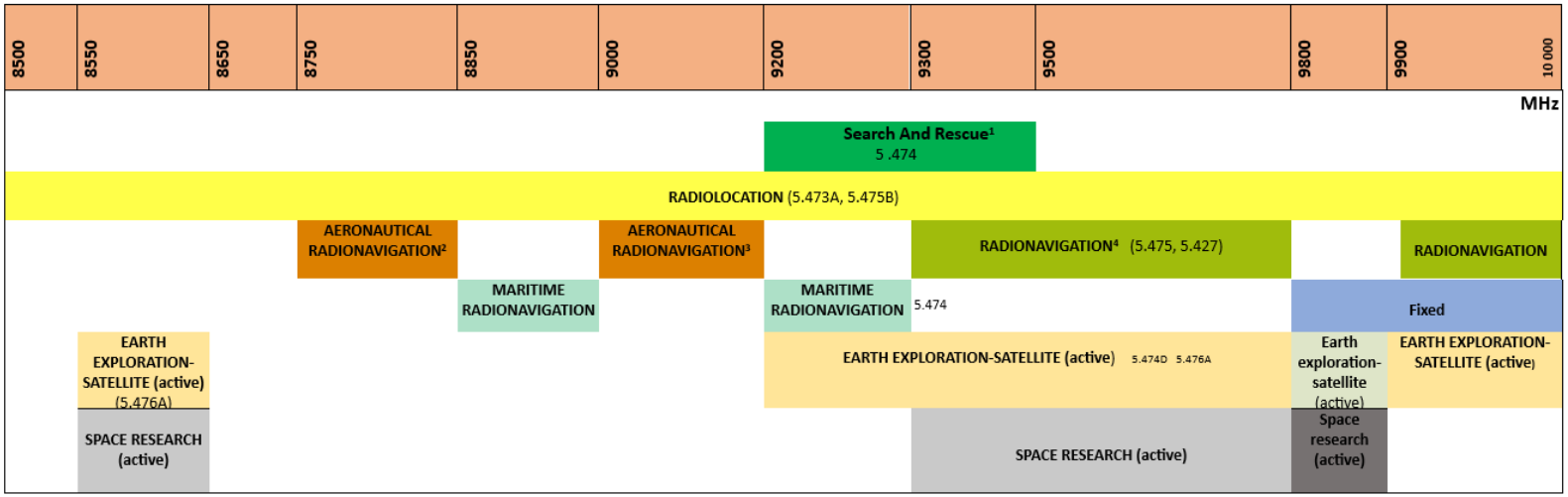



**Figure 7-8. 8 500-10 000 MHz**

[1] Search and rescue transponders.

[2] Airborne Doppler radar and ground mapping radar.

[3] Ground-based radars and their associated airborne transponders, approach radar (PAR), and airport surveillance detection equipment (ASDE).

[4] Ground-based radar beacons used in 9 300-9 320 MHz, and
Airborne weather radars and ground-based radars used in 9 300-9 500 MHz.

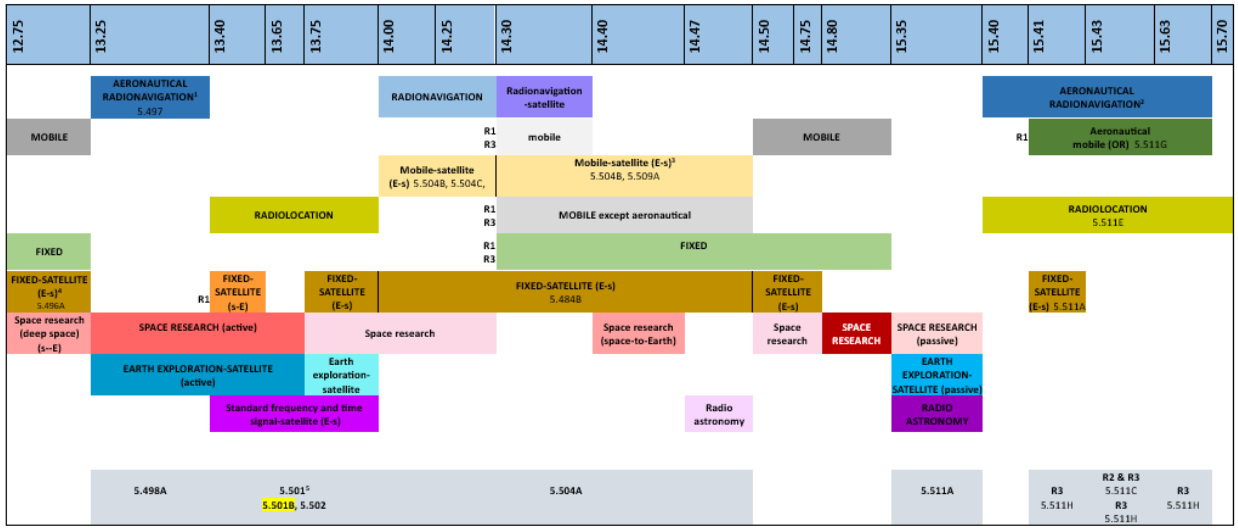



**Figure 7-9. 12.75 –15.70 GHz**

[1] Airborne Doppler radar, ground mapping radar

[2] Ground-based primary surveillance radar systems including precision approach radar (PAR), airport surveillance detection equipment (ASDE), and can also be used for RPAS Detect And Avoid systems (DAA).

[3] Command and Non-Payload Communications (CNPC) of UAS (termed RPAS C2 link in ICAO) in 14–14.5 GHz.

[4] Limited to earth stations on aircraft and vessels, communicating with geostationary space stations in the fixed-satellite service.

5 airborne and ground-based radars.

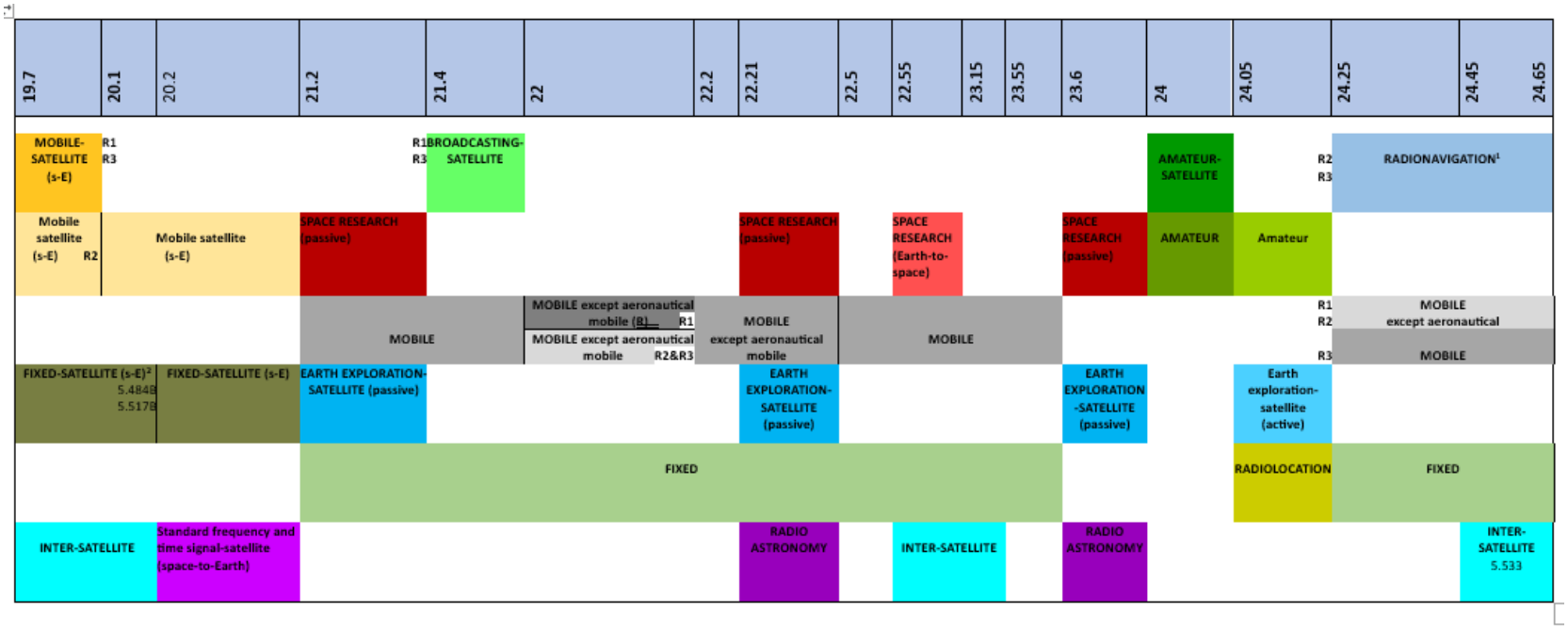



**Figure 7-10. 19.7 –24.65 GHz**

[1] Airport Surface Detection Equipment (ASDE), and a component of Detect and Avoid (DAA) system to detect non-cooperative aircraft (Remotely Piloted Aircraft (RPA)).

[2] Command And Non-Payload Communications (CNPC) of UAS (termed RPAS C2 link in ICAO).

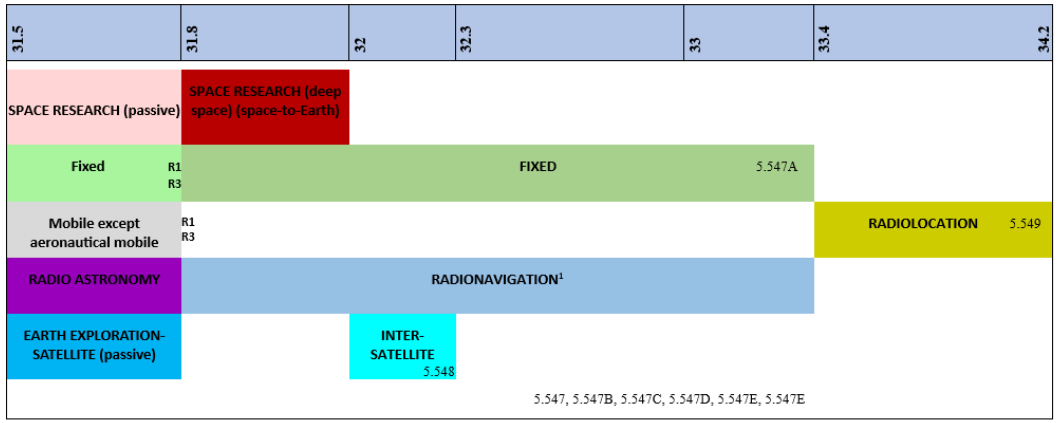



**Figure 7-11. 31.5–34.2GHz**

[1] ASDE /enhanced flight vision system (EFVS) / possible use also of RPAS detect and avoid systems.

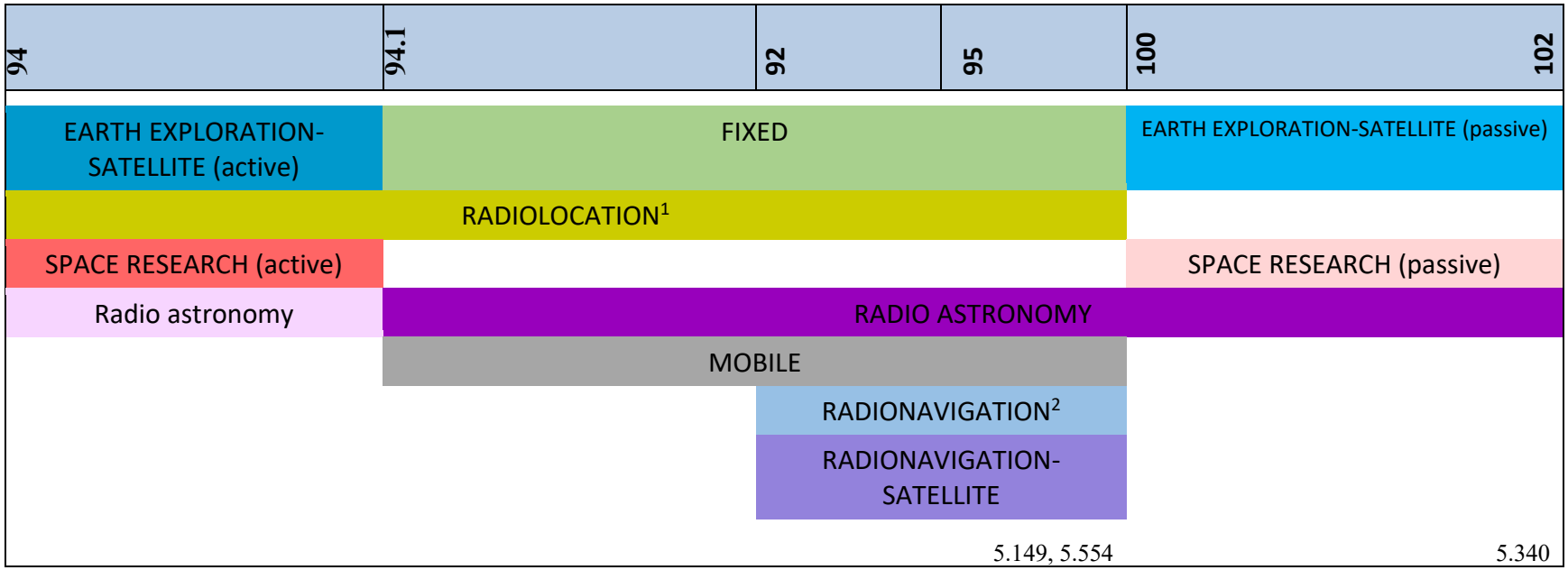



**Figure 7-12. 94 – 102 GHz**

[1] Use of Ground based foreign object debris (FOD) Detection systems in 92-100 GHz band.
[2] Use of EFVS embedded radar systems in 95-100 GHz band.

## SECTION 7-II. CIVIL AVIATION FREQUENCY ALLOCATIONS – ICAO POLICY STATEMENTS AND RELATED INFORMATION

(including a composite statement for each frequency band)

The following material is reproduced from Article 5 of the ITU Radio Regulations to provide necessary information on the regulatory basis of the Table of Frequency Allocations.

*Note 1.— Extracts from the ITU Radio Regulations are presented against a shaded background.*

*Note 2.— This edition incorporates the changes to the Radio Regulations adopted at WRC-23.*

### ARTICLE 5
### FREQUENCY ALLOCATIONS

**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**.

*Note 1.— The map is reproduced in Figure 3-1 of this handbook.*

*Note 2.— RR Nos. **5.3** to **5.22** are not included in this handbook.*

[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.

. . .

**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.

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**Band:** 130–535 kHz
**Service:** Aeronautical radionavigation (NDB)
**Allocation:**

<table>
<tr><th colspan="3">kHz<br>130–255</th></tr>
<tr><td colspan="3">Allocation to services</td></tr>
<tr><td>Region 1</td><td>Region 2</td><td>Region 3</td></tr>
<tr><td>130–135.7<br>FIXED<br>MARITIME MOBILE<br><br>5.64 5.67</td><td>130–135.7<br>FIXED<br>MARITIME MOBILE<br><br>5.64</td><td>130–135.7<br>FIXED<br>MARITIME MOBILE<br>RADIONAVIGATION<br>5.64</td></tr>
<tr><td>135.7–137.8<br>FIXED<br>MARITIME MOBILE<br>Amateur 5.67A<br><br>5.64 5.67 5.67B</td><td>135.7–137.8<br>FIXED<br>MARITIME MOBILE<br>Amateur 5.67A<br><br>5.64</td><td>135.7–137.8<br>FIXED<br>MARITIME MOBILE<br>RADIONAVIGATION<br>Amateur 5.67A<br>5.64 5.67B</td></tr>
<tr><td>137.8–148.5<br>FIXED<br>MARITIME MOBILE<br><br>5.64 5.67</td><td rowspan="2">137.8–160<br>FIXED<br>MARITIME MOBILE<br><br>5.64</td><td rowspan="2">137.8–160<br>FIXED<br>MARITIME MOBILE<br>RADIONAVIGATION<br><br>5.64</td></tr>
<tr><td rowspan="3">148.5–255<br>BROADCASTING<br><br>5.68 5.69 5.70</td></tr>
<tr><td>160–190<br>FIXED</td><td>160–190<br>FIXED<br>Aeronautical radionavigation</td></tr>
<tr><td colspan="2">190–200<br>AERONAUTICAL RADIONAVIGATION</td></tr>
</table>

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

| **kHz**<br>**405–495**<br>Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **405–415**<br>RADIONAVIGATION<br>5.76 | **405–415**<br>RADIONAVIGATION 5.76<br>Aeronautical mobile | |
| **415–435**<br>MARITIME MOBILE<br>5.79<br>AERONAUTICAL<br>RADIONAVIGATION<br><br>**435–472**<br>MARITIME MOBILE<br>5.79<br>Aeronautical<br>radionavigation 5.77<br><br>5.82 | **415–472**<br>MARITIME MOBILE 5.79<br>Aeronautical radionavigation 5.77 5.80<br><br>5.78 5.82 | |
| **472-479**<br>MARITIME MOBILE 5.79<br>Amateur 5.80A<br>Aeronautical radionavigation 5.77 5.80<br><br>5.80B 5.82 | | |
| **479–495**<br>MARITIME MOBILE<br>5.79 5.79A<br>Aeronautical<br>radionavigation 5.77<br><br>5.82 | **479–495**<br>MARITIME MOBILE 5.79 5.79A<br>Aeronautical radionavigation 5.77 5.80<br><br>5.82 | |

<table>
<tr><th colspan="3">kHz<br>505–535</th></tr>
<tr><td colspan="3">Allocation to Services</td></tr>
<tr><td>Region 1</td><td>Region 2</td><td>Region 3</td></tr>
<tr><td rowspan="3">505–526.5<br>MARITIME MOBILE<br>5.79 5.79A 5.84<br>AERONAUTICAL<br>RADIONAVIGATION</td><td>505–510<br>MARITIME MOBILE<br>5.79</td><td rowspan="2">505–526.5<br>MARITIME MOBILE<br>5.79 5.79A 5.84<br>AERONAUTICAL<br>RADIONAVIGATION<br>Aeronautical Mobile<br>Land Mobile</td></tr>
<tr><td>510–525<br>MARITIME MOBILE<br>5.79A 5.84<br>AERONAUTICAL<br>RADIONAVIGATION</td></tr>
<tr><td>525–535<br>BROADCASTING<br>5.86<br>AERONAUTICAL<br>RADIONAVIGATION</td><td>526.5–535<br>BROADCASTING<br>Mobile<br>5.88</td></tr>
</table>

**Footnotes:**

**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.

…

**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)

…

**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.

**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)

**5.82** 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)

**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)

**5.86** 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.

**ICAO POLICY**

- No change to RR Nos. **5.70**, **5.80** and **5.86**.
- In regions where the global navigation satellite system (GNSS) is implemented and non-directional radio beacon (NDB) assignments are withdrawn from international and national usage, aviation requirements for spectrum in these bands may be reduced.
- Until NDBs have been phased out, the current allocations to the aeronautical radionavigation service must be safeguarded.

On a global basis, the use of NDB beacons is expected to continue in the medium term and the long term, subject to regional or sub-regional requirements. The use in general is stabilized and may be reduced over time as a result of ongoing GNSS and RNAV implementation. However, the use of NDB and locator beacons will continue subject to regional requirements (e.g. to provide a backup network to GNSS). No (significant) increase in frequency requirements for NDB and locator beacons is expected; the aeronautical requirements can be met in the currently available frequency bands. Outer locators which are used in conjunction with the instrument landing system (ILS) and marker beacons are, in a number of cases, being replaced with DME. Parts of the bands used for NDB/locator systems are shared with amateur, broadcasting, maritime radionavigation and maritime mobile services.

**AVIATION USE:** These bands support NDBs for short- and medium-range navigation. NDBs transmit non-directional signals in the low and medium frequency (LF/MF) bands, normally between 190 kHz and 535 kHz. With appropriate automatic direction-finding (ADF) equipment on board an aircraft, the pilot can determine the bearing of the station or can "home" on the station. The ADF receiver tuning range is normally between 190 kHz and 1 750 kHz. NDBs are mainly used as a non-precision instrument approach aid, either in conjunction with an ILS (then

designated as a "locator"), or to define air routes/airways. NDBs are extensively deployed at aerodromes for general aviation. Although NDBs are comparatively inexpensive navigation aids and relatively simple to install and maintain, bearing information derived from NDBs is not very precise and lightning, precipitation static, etc., cause intermittent or unreliable signals resulting in erroneous bearing information and/or large oscillations of the radio compass needle. NDBs are assigned frequencies on the basis of daytime propagation conditions. Frequencies used for NDB are prone to night effects, whereby, due to ionosphere propagation (reflection), significant errors due to the reception of signals from distant NDBs may occur. This night effect increases with assigned frequency of operation.

Aeronautical NDBs at coastal locations are also used by the maritime service, and in the reverse sense, beacons provided for maritime purposes are potentially usable by aviation.

Frequency scarcity in ITU Region 1 (Europe and Africa) has been a cause for concern in the past. The 1979 ITU World Administrative Radio Conference (WARC-79) hence recognized a demand in Europe and Africa and allocated in ITU Region 1 the frequency band 415–435 kHz to the aeronautical radionavigation service, shared with the maritime mobile service, at that time on a permitted basis. An ITU frequency assignment plan for Region 1 was prepared for this band in 1985, giving priority access to the aeronautical radionavigation service (*Final Acts of the Regional Administrative Radio Conference for the planning of the MF Maritime Mobile and Aeronautical Radionavigation Services (Region 1)*, Geneva, 1985 refers). At present, the need for NDBs has stabilized and aviation can meet its requirement from the current allocations. Allocations made on a permitted basis were removed from the Radio Regulations in WRC-95 and replaced with an allocation on a primary basis.

Interference from broadcasting in the band 255–283.5 kHz has been reported, which renders parts of this band unusable in much of Region 1. (This band is not allocated to the broadcasting service in Regions 2 and 3.)

**COMMENTARY:** For international purposes, the future air navigation systems (FANS) scenario foresaw a reduction in the role of NDBs in the future due to, inter alia, the emergence of GNSS as the future system for a range of navigation services, including those for oceanic and low-density continental airspace.

At a national level where the majority of NDB services are provided, frequency demand for NDBs will depend to a large extent on national policies. The last worldwide ICAO review in 1985 (held at the *Communications/Operations (COM/OPS) Divisional Meeting*) considered the retention of NDB allocations essential, including the need for assignments for national purposes. General aviation use of NDBs is expected for at least the medium term (2035).

Recent developments include the need to retain NDB systems on a larger scale to provide backup for GNSS failures in areas where alternative backup systems, such as VOR/DME or DME-DME navigation, are technically or economically not practicable.

**Footnotes:**

Footnotes to the Table of Frequency Allocations of particular importance are:

**5.76**: Designation of 410 kHz for radio direction finding.
**5.80**: The prohibition of the use of voice on NDB frequencies in Region 2 in the band 435–495 kHz.
**5.84**: Designation of 518 kHz for special use in the maritime mobile service.

More information on the use of spectrum for NDB as well as frequency assignment planning of these beacons relating to the provisions of Article **28** and Appendix **12** of the Radio Regulations is in paragraphs 7-III.3.6 and 7-III.4.2 of this handbook. Attachment G contains technical information and frequency-sharing criteria for NDB.

**Band:** 2 850–22 000 kHz
**Service:** AM(R)S (air-ground communications (HF voice and data))
**Allocation:** In several sub-bands

| **kHz**<br>**2 850–22 000** | | |
|---|---|---|
| Allocation to Services | | |
| Region 1 | Region 2 | Region 3 |
| **2 850–3 025** | AERONAUTICAL MOBILE (R)<br>5.111 5.115 | |
| **3 400–3 500** | AERONAUTICAL MOBILE (R) | |
| **4 650–4 700** | AERONAUTICAL MOBILE (R) | |
| **5 450–5 480**<br>FIXED<br>AERONAUTICAL MOBILE (OR)<br>LAND MOBILE | **5 450–5 480**<br>AERONAUTICAL MOBILE (R) | **5 450–5 480**<br>FIXED<br>AERONAUTICAL MOBILE (OR)<br>LAND MOBILE |
| **5 480–5 680** | AERONAUTICAL MOBILE (R)<br>5.111 5.115 | |
| **6 525–6 685** | AERONAUTICAL MOBILE (R) | |
| **8 815–8 965** | AERONAUTICAL MOBILE (R) | |
| **10 005–10 100** | AERONAUTICAL MOBILE (R)<br>5.111 | |
| **11 275–11 400** | AERONAUTICAL MOBILE (R) | |
| **13 260–13 360** | AERONAUTICAL MOBILE (R) | |
| **17 900–17 970** | AERONAUTICAL MOBILE (R) | |
| **21 850–21 870** | FIXED 5.155A<br>5.155 | |
| **21 924–22 000** | AERONAUTICAL MOBILE (R) | |

**Footnotes:**

**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)

**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)

**5.155** *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)

**ICAO POLICY**

- Retain the current allocations in the HF bands to the aeronautical mobile (route) service (AM(R)S) bands and the provisions of Appendix **27** to the Radio Regulations for the foreseeable future for HF voice and data.
- Protect the use of the aeronautical HF bands in accordance with the provisions of Appendix **27**.
- No change to RR Nos. **5.111** and **5.115**.
- Support the measures and participate in the technical studies addressed in Resolution **207 (Rev. WRC-15)** concerning the unauthorized use of and interference to frequencies in the bands allocated to the AM(R)S.
- Consider technical solutions which can be implemented efficiently without changes to aircraft equipment or disruption of aeronautical services.

The global aviation HF frequency bands between 2 850 kHz and 22 000 kHz provide aviation with a means for long-distance (beyond the radio horizon) communications. HF communications consist of both air-ground voice, and HF data link (HFDL) communications. Both voice and HFDL enable aircraft to still communicate when moving outside of VHF coverage (e.g. oceanic, polar or remote areas) or during loss of satellite communications. Effective HF communication can be maintained up to thousands of kilometres between a ground station and the aircraft.

The extended range of HF operations is achieved through sky wave propagation, which uses the ionosphere and the Earth's surface to effectively "bounce" the signal beyond normal radio line of sight. As the ionosphere varies depending on the time of day and solar activity, a single HF ground station may cycle through multiple aeronautical frequencies from 2 MHz up to 22 MHz throughout the day to ensure communications.

HF is still required as a means for long-range communications for all aircraft operating in oceanic or remote regions, and is an integral part of the associated safety case. HFDL has continued to evolve to support more aeronautical operational control (AOC) and ATS applications, such as controller-pilot data link communication (CPDLC) and ADS-C reporting and as of 2017 over 3 000 aircraft are equipped with HFDL. Consequently, the HF channel capacity required for contingency planning continues to grow, though future requirements are expected to be met in the currently available frequency bands.

**AVIATION USE:** HF voice, HFDL.

HF voice is used for both ATS and AOC communications worldwide. Using an upper single sideband (suppressed carrier) amplitude modulation (USB) for 3 kHz channels, HF ground stations transmit up to 6 kW of power. Use of the selective calling (SELCAL) notification system by ground stations reinserts the carrier for the duration of the SELCAL message to ensure reception by the aircraft.

HFDL also uses 3 kHz USB upper sideband channels, using a half-duplex digital transmission to communicate between the HF ground station and the aircraft on the same frequency. Its adaptive modulation rate provides resilience to interference, while also regularly scanning the other HF frequencies to select the most efficient channel as the ionosphere conditions change.

Appendix **27** to the Radio Regulations contains the Frequency Allotment Plan and system parameters and was agreed at the ITU WARC-Aer2 (1978). The ICAO Communications Divisional Meeting (1976) carried out the ICAO coordination prior to the ITU conference. The ICAO Communications Divisional Meeting (1981) agreed to the necessary amendments to Annex 10, which included the change of modulation specification from double sideband (DSB) to single sideband (SSB) upper sideband.

The registration of assignments in the ITU Master International Frequency Register (MIFR) is a mandatory requirement covered by the Radio Regulations and effected through ITU member administrations (national telecommunication administrations). Due to the provisions of the Radio Regulations, ICAO cannot play any role in this registration (see *Ref. 27/19* in the section below titled *Use of HF datalink in the HF AM(R)S*). However, ICAO encourages all administrations to maintain accurate and current information in the ITU MIFR to ensure additional frequency assignments are not constrained by legacy assignments no longer in use.

HF voice frequencies are used for international and domestic services:

- Allotments in the Appendix **27** Plan are made to major world air route areas (MWARA) for long-distance international services where more than one country is affected. Regional and domestic air route areas (RDARA) allotments are made in other cases. Both MWARA and RDARA voice services provide ATC and other ATS messages within the relevant flight information region (FIR). The structure of Appendix **27** conforms to the operational requirement for aeronautical HF voice communication for the foreseeable future.

- A number of frequencies in the HF bands have been allotted on a worldwide basis for AOC messages. Known as long-distance operational control (LDOC), many aircraft operating agencies use these frequencies intensively and, in many cases, operate their own HF networks to support LDOC for regularity of flight and aircraft safety purposes. (RR 27/217).

**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.

Appendix **27** designates the carrier frequencies 3 023 kHz and 5 650 kHz (RR 27/232 to RR 27/238) for common use on a worldwide basis. RR 27/236 permits these frequencies to be used by other mobile services for air-surface search and rescue operations. RR Nos. **5.111** and **5.115 (WRC-07)** and Appendix **15** of the Radio Regulations also specify these frequencies for specific distress and safety purposes (coordinated search and rescue operations). The relevant provisions of Appendix **27** of the Radio Regulations are reproduced in *Section 7-II – Band 3 023 kHz and 5 680 kHz* of this handbook.

Appendix **27** RR 27/19 specifically recognizes the coordination role of ICAO, with reference to the operational use of frequencies in the Allotment Plan. This activity is coordinated at regional air navigation meetings where regional requirements and frequencies for long-range communications are agreed. Such agreements need to be registered with the ITU MIFR through the national telecommunication administrations.

Appendix **27** contains provisions for adaptation of the allotment and frequency assignment procedures. These provisions allow administrations to assign frequencies which are not identified in the Allotment Plan under the condition that such frequency assignments will not reduce the protection of frequencies which are in the Allotment Plan. After proper coordination by the national telecommunication authorities of such frequency assignments with other administrations, these frequency assignments can be recorded in the ITU MIFR with the same international protection as other frequencies.

These provisions provide for adequate flexibility in the regulatory procedures to implement changes in the use of the HF frequency bands by aviation, including the accommodation of new frequency assignments.

**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.

**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.

**COMMENTARY:**

The present policy, in line with the findings of the ICAO Communications/ Meteorology/Operations (COM/MET/OPS) Divisional Meeting (1990), is that no change be made to the allocation of the bands between 2 MHz and 22 MHz allocated to the AM(R)S (Appendix A to the report of COM/MET/OPS/90 on Agenda Item 3, paragraph 2.3 – Future aviation use – refers). Although this policy recognized that requirements for HF frequency assignments were increasing, over the years few new frequency assignments have been made. The coverage of polar regions which cannot be accommodated by satellite systems utilizing geostationary satellites is a requirement for continued use of HF spectrum even after full implementation of satellite communication. Additionally, implementation of non-geostationary satellite systems (e.g. IRIDIUM) may also provide for the missing coverage over polar areas.

***Use of HFDL in the HF AM(R)S***

Data link on HF frequencies was considered by the Aeronautical Mobile Communications Panel (AMCP) and the Automatic Dependent Surveillance Panel (ADSP). A study on this matter, including the development of SARPs for Annex 10, was completed and relevant SARPs incorporated in Annex 10, Volume III.

SARPs for HFDL were incorporated in Annex 10, Volume III, in 1999 and updated to technical specifications to align them with relevant provisions of ITU RR. A global HFDL network/system (ARINC Global Link) for aviation, operating in accordance with ICAO SARPs, is currently in operation. HFDL is approved for full Future Air Navigation Systems (FANS) capability at RCP400.

The existing technical provisions in Appendix **27** permit data modulations, and the Rules of Procedure relating to this were approved by the ITU Radio Regulations Board. The relevant rules are referenced below:

**Ref. 27/15:**
This provision specifies that 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 this connection, the Board considers as a valid “special arrangement by the administrations concerned” any formal action by the International Civil Aviation Organization (ICAO) which results in Standards and Recommended Practices (SARPs), which are approved by the ICAO in accordance with its procedures and which are communicated to the ITU accordingly.

**Ref. 27/19:**
This provision specifies the role of ICAO in performing voluntary coordination (“should”) in the operational use of the frequencies. The Board considers such a coordination as an internal ICAO activity, intended to concluding operational agreements between the international operators (e.g. timesharing arrangements). Therefore the Bureau will not take into account such agreements between operators, unless they are communicated to the Bureau by their national telecommunications administration.

**Ref. 27/58:**
This provision lists the permissible classes of emission on the channels of Appendix 27 and stipulates, amongst other emissions, the possibility of using “other transmissions such as data transmission, single sideband, suppressed

carrier". The class of transmission listed against this latter description is JXX (former designation A9J). In this respect, the Board considers that any SSB (suppressed carrier) class of emission is authorized on the channels in Appendix 27 (e.g. J2B, J2D, J7B, J7D, J9B, J9D, etc.), provided that the following conditions are satisfied:

- the reference frequency of the concerned transmission coincides with a reference frequency listed in the list of carrier (reference) frequencies (27/18);
- the occupied bandwidth of other authorized emissions does not exceed the upper limit of J3E emissions (No. 27/12), i.e. 2 700 Hz;
- the assigned frequency is at a value 1 400 Hz above the carrier (reference) frequency (27/75).

In frequency assignment planning, it is important to realize that the geographical disposition of allotments to MWARA and RDARA needs to be adjusted to accommodate the area of application of the new data services. In accordance with Appendix **27**, RR 27/56, the frequency assignments for data must be made so as not to cause harmful interference to the allotments in Appendix **27**. While some assignments may be identified using the possibilities covered by RR 27/20 (see above), the additional requirements for dedicated families for data, as specified by the AMCP, cannot be met from the present Appendix **27** Allotment Plan without affecting the provisions (allotments) for HF voice.

On the use of HF data link and to assist in the coordination and registration of frequency assignments by the ITU, Recommendation ITU-R M.1458 on the *Use of the frequency bands between 2.8 MHz and 22 MHz by the AM(R)S for data transmission using class of emission J2D* provides additional information.

***Harmful interference to HF services in certain areas***

The increase in harmful interference to air-ground communications (and to maritime communications) in the HF bands was discussed at ITU World Radiocommunication Conferences in 1997 and 2000. This problem is prevalent in some areas in the western part of the South Pacific and is believed to arise from the use of non-licensed, non-authorized equipment often installed on marine craft. The ITU discussions have encompassed both administrative measures, i.e. better control and regulation, and technical measures, which can reduce the effect. The latter are only regarded with favour in aviation if they can be implemented without changes to current operational aircraft equipment. Resolution **207 (Rev. WRC-15)** was

amended at WRC-03 to draw attention to this threat and to ensure that studies by ITU-R continue.

Additionally, increasing environmental noise is being seen from unintentional and intentional radiators in the HF spectrum. New technologies such as Broadband over Power Lines (BPL) and Wireless Power Transmission (WPT) are being deployed worldwide into the consumer market with little control over the area of use, and have a high potential for raising the noise floor of aviation HF ground receivers. Furthermore, over the horizon HF radars are also a known source of interference when such use has not been fully coordinated internationally.

**Appendix 27 provisions:** Appendix **27** can only be amended by a competent ITU-R WRC where this subject is placed on the agenda. There are currently no requirements for a review of the Allotment Plan.

Some of the definitions relevant to the use of frequencies from the aeronautical HF bands, as given in Appendix **27**, are presented in the shaded box below.

**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 | 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) |

**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 Routes* 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.

**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.

***Current and future use of HF frequency bands***

Current use of the HF frequency bands is still very significant. In the North Atlantic area, due to air traffic growth, use of HF communications is still a major component for adequate air traffic control. The NAT SPG (North Atlantic Systems Planning Group) has taken steps to increase the number of HF frequencies for use in the NAT region. It is expected that the necessary frequency assignments can be found within the current HF frequency bands and within the procedures as specified in Appendix **27** to the Radio Regulations. Similar steps (to increase the use of HF

frequencies) are also being considered in other regions. No amendments to the Radio Regulations are necessary as the current procedures include some flexibility for making new assignments and seeking their registration and protection within the ITU.

It should be noted that SATCOM voice trials conducted in 2007 showed, inter alia, that it could not be concluded if the existing satellite infrastructure, networks and telephone links to the radio stations have sufficient capacity to handle the volume of traffic currently supported by the NAT HF/VHF network. Since then, some countries have conducted additional studies to allow one HF communication system to be permanently replaced with a SATVOICE system, with several trials being implemented in certain FIRs.

Based on the ICAO Global Air Navigation Plan (GANP) fifth edition, the already employed HF systems are expected to continue operation beyond 2030.

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**Band:** 3 023 kHz and 5 680 kHz
**Service:** AM(R)S (search and rescue)
**Aviation use:** The frequencies 3 023 kHz and 5 680 kHz are intended for common use on a worldwide basis as indicated in Appendix **27**.

**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 worldwide 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.

*Note.— See also RR Nos.* ***5.111*** *and* ***5.115*** *under band 2 850–22 000 kHz.*

**Band:** 74.8–75.2 MHz
**Service:** Aeronautical radionavigation (marker beacon)
**Allocation:**

| **MHz**<br>**74.8–75.2** | | |
|---|---|---|
| Allocation to Services | | |
| Region 1 | Region 2 | Region 3 |
| **74.8–75.2** | AERONAUTICAL RADIONAVIGATION<br>5.180 5.181 | |

**Footnotes:**

**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)

**ICAO POLICY**

- No change to the current allocations.
- No change to RR No. **5.180**.
- Deletion of RR No. **5.181**.

Marker beacons are used in conjunction with ILS. On a global basis, the frequency band available for marker beacons satisfies the aeronautical requirements. In a number of cases, marker beacons (and outer locators) are being replaced with DME. As long as marker beacons are in operation, the band 74.8–75.2 MHz needs to be available for these systems.

**AVIATION USE:** The frequency of 75 MHz is assigned to marker beacons for use with ILS to define specific points on the approach path. The outer marker is nominally at 7.5 km from the runway threshold, the middle marker at 1 050 m from the threshold and, where installed, the inner marker is located just prior to the threshold. In addition, markers may also be used to mark significant points on air routes.

**COMMENTARY:** There is a continuing and essential requirement for this allocation (see also ILS localizer in band 108–111.975 MHz and ILS glide path in the band 328.6–335.4 MHz).

ILS will continue to be used for the foreseeable future. Marker beacons are normally an element of the ILS system.

RR No. **5.181** relating to the future use of this band by the mobile service was introduced at WARC Mob-87, primarily at the initiative of the European Conference of Postal and Telecommunications Administrations (CEPT) in the expectation that from 1995 onwards the ILS system, including the marker beacons, would be withdrawn from use by international civil aviation due to the firm plans in ICAO to transfer from ILS to MLS. Eventually, this transition did not take place and the need for continuing ILS operations (including the marker beacons) was re-established by ICAO. At WRC-2000, the aviation community was successful in removing fifteen European and Middle Eastern country names from this footnote. With the continuing use of ILS systems and markers, this footnote is not only ineffective but carries the risk of addition of new names at future conferences and should be deleted in its entirety. Any use of this band by the mobile service is incompatible with the allocation to the aeronautical radionavigation service.

The names of many countries, initially included in this footnote, have been deleted, leaving the concerns regarding compatibility and protection of marker beacons ILS/VOR limited to the three countries currently mentioned in this footnote.

**Band:** 108–117.975 MHz
**Service:** Aeronautical radionavigation (VOR/ILS localizer)
and AM(R)S (GBAS/VDL Mode 4)
**Allocation:**

| **MHz**<br>**108–117.975** | | |
|---|---|---|
| Allocation to Services | | |
| Region 1 | Region 2 | Region 3 |
| **108–117.975** | AERONAUTICAL RADIONAVIGATION<br>5.197 5.197A | |

**Footnotes:**

**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)

**ICAO POLICY**

- No change to the current allocation to the aeronautical radionavigation service and the aeronautical mobile (route) service (AM(R)S).
- Deletion of RR No. **5.197**.
- Ensure conformity with Recommendation ITU-R SM.1009-1 regarding compatibility with FM broadcast services in the band 87.5–108 MHz and ILS/VOR as well as with ITU-R Recommendation M.1841 for GBAS.

On a global basis, the frequency band 108–117.975 MHz is used for ILS (localizer) and VHF omnidirectional radio range (VOR). Implementation of the ground-based augmentation system (GBAS) under an allocation to the AM(R)S in this band is underway. Such implementation is subject to a satisfactory safety case with specific attention to interference into GNSS signals. In the longer term, GBAS may replace ILS in some areas. The spectrum vacated by future ILS decommissioning, if any, will be reused for GBAS systems. Some use of ILS is expected to continue for the foreseeable future.

On a global basis, the future use of VOR systems is expected to decline due to implementation of GNSS and RNAV. However, a residual number of VOR systems will continue to be in operation to meet specific requirements beyond 2030. The vacated spectrum, if any, will be reused for AM(R)S.

The frequency band 108–117.975 MHz is expected to meet the aeronautical requirements for ILS, VOR and GBAS until 2030 and beyond. Rationalization of GBAS technical characteristics (and frequency assignment planning criteria) may be necessary, in particular when being implemented in areas where VOR and ILS operations continue.

The allocation to the AM(R)S in the 112–117.975 MHz band can also be used for VDL Mode 4. The spectrum requirements for VDL Mode 4 are expected to be minimal (up to a maximum of 2 to 4 channels) and can easily be implemented in most areas. This frequency band is also considered to accommodate VHF air-ground voice and data link systems, subject to spectrum availability.

**AVIATION USE:** ILS localizer, VOR, GBAS and VDL Mode 4.

ILS is one of the ICAO standard, non-visual aids to final approach and landing. The localizer transmitter, operating on one of the 40 ILS channels within the sub-band 108–111.975 MHz, emits signals which provide course guidance throughout the descent path to the runway threshold.

The VOR is the short/medium range navigation aid. The basic navigation guidance derived from a VOR is a radial line of position (magnetic) with respect to a known geographic point (the VOR site). The radial line is read in degrees of azimuth from magnetic North and is technically accurate to within approximately ±3.0 degrees. The overall system accuracy is approximately ±5.0 degrees. Bearing information may be used by aircraft to fly toward or away from the station at any azimuth selected by the pilot. The 180 degrees ambiguity in this indication is resolved by the provision of a "to/from" indicator in the aircraft avionics. A DME is a useful adjunct to, and is normally co-located with, a VOR. In such cases, the VOR is referred to as "VOR/DME". A DME provides a continuous digital readout of the slant range distance, in nautical miles, between the aircraft and the DME site. Because of the defined channel pairing scheme in Annex 10, when using a VOR/DME, the tuning of the airborne receiver to the VOR will automatically couple the DME receiver to the associated DME ground station. The VOR/DME is used to provide navigation guidance on ATS routes and specified tracks. Its accuracy allows ATS routes to be kept at reasonable widths and permits the application of comparatively small lateral separation minima between routes, resulting in a more efficient use of the airspace. The VOR/DME route structure is normally established so as to make it possible for aircraft to fly from one VOR direct to the next, or along intersecting radials of two adjacent VORs. Reporting points and/or other significant points are normally established along radials, either together with a given DME distance from an associated VOR, or by an intersection of radials from two different VORs. The VOR can also serve as a landing aid at locations where no precision approach facility is available.

The GBAS monitors GNSS signals at an aerodrome and broadcasts locally relevant integrity messages, pseudo-range corrections and approach data via a VHF data broadcast to aircraft within the range depending upon intended operations.

The frequency band 112–117.975 MHz is also planned for use by VDL Mode 4, in accordance with the provisions of the Radio Regulations and Annex 10. Frequency assignment planning criteria for VDL Mode 4 in this band have been developed in ICAO.

***Use of the frequency band 108–117.975 MHz by the aeronautical radionavigation service***

*Note.— Technical details on the use of the frequency band 108–117.975 MHz by systems operating in the aeronautical radionavigation service (ILS, VOR) and the aeronautical mobile (R) service (GBAS, VDL Mode 4) is in Volume II of this handbook, which also includes provisions relating to harmful interference from FM broadcasting stations.*

Figure 7-13 presents an overview of the channelling arrangements and use of the various aeronautical radionavigation and communication systems in the frequency band 108–117.975 MHz.

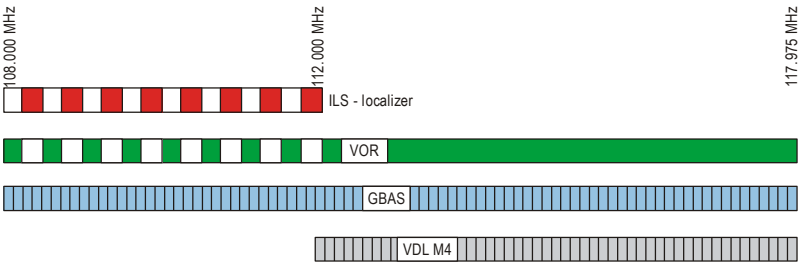


**Figure 7-13. Channelling arrangements and use of systems in the frequency band 108–117.975 MHz**

The sub-band 108–111.975 MHz is shared between ILS localizer and VOR in an interleaved frequency arrangement (108.1 and 108.15 MHz for ILS, 108, 108.05, 108.2 and 108.25 MHz for VOR, etc.). The channel spacing is either 50 kHz or 100 kHz, depending on regional agreements and requirements.

The sub-band 112–117.975 MHz is used for VOR, with 50 kHz or 100 kHz channel spacing, depending on regional agreements and requirements.

GBAS is standardized to operate in the band 108–117.975 MHz. GBAS/ILS and GBAS/VHF COM frequency planning criteria are currently under development. Until these criteria are defined and included in SARPs, GBAS frequencies should be selected from the band 112.050–117.900 MHz. The channel spacing for GBAS is 25 kHz.

VDL Mode 4 is standardized to operate also in the frequency band 112–117.975 MHz. The channel spacing for VDL Mode 4 is 25 kHz. The expected use of this band by VDL Mode 4 is limited to a few frequency assignments.

The ILS localizer is frequency paired with the glide path frequencies from the band 328.6–335.4 MHz (see Figure 7-14) and, where possible, with the microwave landing system (MLS) from the band 5 030–5 150 MHz. The ILS localizer is also paired with DME; implementation of DME associated with the ILS is increasingly replacing the use of marker beacons and the outer locater, mainly for economic reasons.

VOR is normally associated with DME and is frequency paired. Short-range airport VOR frequencies are usually taken from the sub-band 108–111.975 MHz.

*Note.— The pairing of frequencies for the ILS localizer and the ILS glide path, as well as for the ILS/VOR with DME, is contained in Annex 10, Volume I.*

***Interference from FM broadcasting***

ILS localizer, VOR, GBAS and VDL Mode 4 receivers are vulnerable to intermodulation and saturation effects from FM broadcast transmissions from the band 87–108 MHz. Guidelines for States, when assessing compatibility between assignments for FM broadcasting and aeronautical radionavigation (ILS/VOR), have been agreed in the ITU-R (Recommendation ITU-R SM.1009-1 refers). Recommendation ITU-R M.1841 addresses the issue of the compatibility between GBAS and FM sound broadcasting. Report ITU-R M.2147 addresses issues relevant to the compatibility between the ICAO standard VDL Mode 4 air-ground data link and FM sound broadcasting. The need to secure compatibility from the introduction of digital sound broadcasting in the frequency band 87–108 MHz has been addressed in Resolution **413 (**which was amended at WRC-07, at WRC-12 and at WRC-23**)**.

*Note.— Additional information related to the effects of interference from FM broadcasting on aeronautical use of the band 108–117.975 MHz is contained in Attachment G and in Volume II of this handbook.*

***Use of the band 108–117.975 MHz by the aeronautical mobile (R) service***

WRC-03 adopted Resolution **413** (which was amended at WRC-07, at WRC-12 and at WRC-23) to reflect the additional allocation to the AM(R)S as per RR No. **5.197A** (WRC-07) in the band 108–117.975 MHz and to provide for the conditions of using this band by the AM(R)S.

Resolution **413 (**which was amended at WRC-07, at WRC-12 and at WRC-23**)** invites ITU-R to study any compatibility issues between the broadcasting service and GBAS/VDL Mode 4 that may arise from the introduction of appropriate digital sound broadcasting systems.

Frequency congestion for ILS and VOR exists in some high-density areas, such as Western Europe and North America. This applies to ILS and VOR and arises, partially, from the frequency pairing and the frequency assignment planning constraints in the DME band (960–1 215 MHz).

The band has been used by aviation since 1947. The channel spacing was reduced from 200 kHz to 100 kHz in 1963 and from 100 kHz to 50 kHz in 1972 (at the Seventh Air Navigation Conference).

RR No. **5.197 (WRC-12)** was introduced at WARC-87 in anticipation that ILS would be withdrawn from international service in 1998 and the use of the ILS localizer would be terminated. At WRC-03 most countries removed their names from this footnote since ILS will continue operation for the foreseeable future.

**COMMENTARY (ILS):** The ICAO Special Communications/Operations Divisional Meeting held in 1995 (Special COM/OPS/95) examined the future of ILS in the context of transition to MLS and to GNSS as envisaged in the FANS scenarios. The transition to MLS has effectively been cancelled and the transition to GNSS/GBAS approach and landing has been much slower than predicted.

Most States indicated an intention to retain ILS in service (report of the Special COM/OPS/95 meeting on Agenda Item 1, paragraph 1.3.4 refers) for the foreseeable future. In this regard, it is noted that Annex 10 requires all ILS and VOR receivers (globally) to comply with the (improved) immunity standards against interference from FM broadcasts as from 1998.

ILS sustainability was addressed at the Special COM/OPS/95 meeting which agreed to review the ILS SARPs and guidance material to ensure adequate provision for ILS beyond the year 2000. Other recommendations have called for studies and examinations of various scenarios for transition from ILS to either MLS or GNSS, with important emphasis on the economics of operation.

The introduction of the mobile service, in accordance with the provision of RR No. **5.197 (WRC-12)**, is not possible in the foreseeable future. In light of the above, it is clear that the ILS allocation will be needed for the long term – until well beyond 2035.

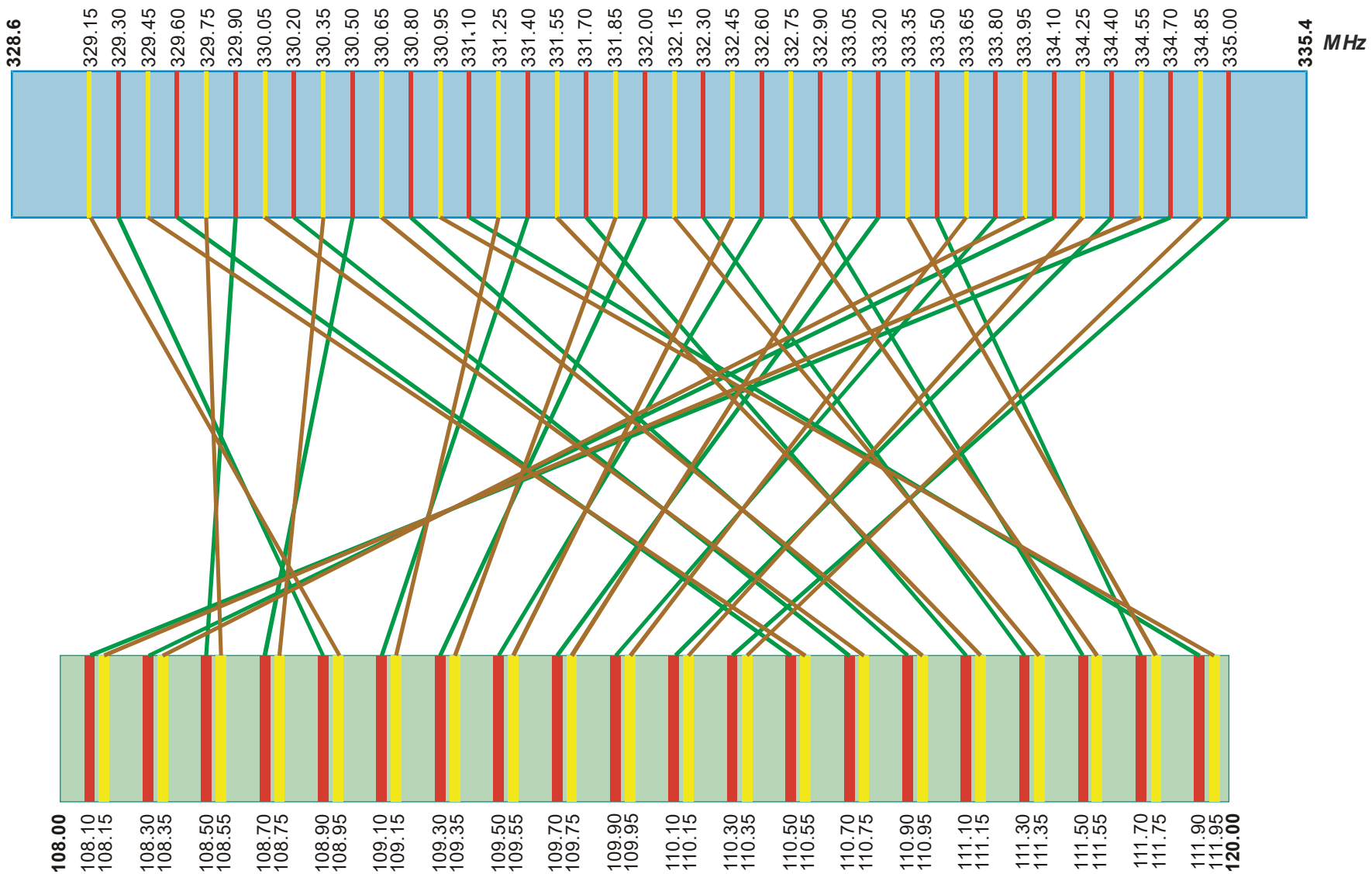


**Figure 7-14. Channel pairing between ILS localizer and ILS glide path**

**COMMENTARY (VOR):** The continuing deployment of VOR is dependent on the progress, development and implementation of GNSS; the aviation community may continue to require VOR for some time after implementing GNSS. ICAO has adopted SARPs for GNSS, and will continue, through the NSP, to develop the measures and principles necessary to evolve towards the use of GNSS as a means of en route navigation.

Different world regions will have different emphasis on their need for GNSS in the near and medium terms, and decisions will be taken at a regional level.

No definite or tentative dates have been agreed for the GNSS programmes. In addition, safety requires a backup means of en route navigation if all GNSS service is temporarily lost. Such backup facilities may include continued use of VOR/DME, DME/DME or NDB.

**COMMENTARY (GBAS):** ICAO has identified the band 108–117.975 MHz to support ground-based augmentation system/VHF data broadcast (GBAS/VDB) operations. WRC-03 and WRC-07 reviewed this band and introduced an allocation to the AM(R)S, which in the frequency band 108–112 MHz is limited to ground-based systems that transmit navigational information in support of air navigation and surveillance functions. This restriction was introduced to prevent aircraft systems using this frequency band which may cause interference to FM broadcast receivers. These systems shall not cause harmful interference to nor claim protection from international standardized systems operating in the aeronautical radionavigation service (RR No. **5.197A (WRC-23)** refers). This provision authorizes the operation of, in accordance with ICAO SARPs, GBAS/VDB systems in the frequency band 108–117.975 MHz.

**COMMENTARY (VDL Mode 4):** SARPs have also been developed for VDL Mode 4 which supports surveillance (e.g. ADS-B) and point-to-point communication applications. This system can also operate in the band 112–117.975 MHz. Provisions have been made for such use in Annex 10 and the Radio Regulations (RR No. **5.197A (WRC-23)** and Resolution **413 (**which was amended at WRC-07, at WRC-12 and at WRC-23**)** refer). The development of frequency assignment planning criteria for VDL Mode 4 to secure compatibility with the localizer, VOR and GBAS when operating in the frequency band 112–117.975 MHz has been completed.

***Allocations to other services***

RR No. **5.197 (WRC-12)** was added by the ITU WARC-87 for mobile services. The footnote introduced the mobile service in the band 108–111.975 MHz in a number of countries. Based on present expectations for the use of the band, it is improbable

that this footnote can be considered for implementation for many years in the country mentioned in the footnote. The footnote is not meaningful in practical terms and carries the risk that more country names will be added at future conferences. Hence, it should be deleted in its entirety. Furthermore, it should be noted that no guidance exists on how RR No. **5.197 (WRC-12)** would be applied, or what essential prior agreements are necessary within aviation for mobile service operations to commence on any single frequency or within particular sub-bands. This inexactness compounds the problem, as it leaves room for undesirable interpretations that could be used to allow entry of the mobile service in the band. The names of many countries initially included in this footnote have been deleted, leaving the concerns on compatibility and protection of ILS/VOR limited to the country that currently remains mentioned in the footnote.

At WRC-12, it was confirmed that all compatibility studies between AM(R)S systems and analogue broadcasting operating below 108 MHz had been completed. On the basis of this confirmation, Resolution **413 (**which was amended at WRC-07, at WRC-12 and at WRC-23**)** was amended to recognize access to the frequency band 108–117.975 MHz by AM(R)S systems under conditions laid out in Resolution **413 (**which was amended at WRC-07, at WRC-12 and at WRC-23**)**. In summary, these conditions stipulate:

- AM(R)S systems shall not cause harmful interference to the aeronautical radionavigation service.
- AM(R)S systems shall meet the FM broadcasting immunity requirements as per Annex 10 SARPs.
- GBAS is the only AM(R)S system that may operate in the band 108–112 MHz.
- Any AM(R)S system operating in the band 108–117.975 MHz shall meet ICAO SARPs.

Resolution **413 (**which was amended at WRC-07, at WRC-12 and at WRC-23**)** continues to call for studies to be undertaken to assess any compatibility issues with aeronautical radionavigation and communication systems operating in the band 108–117.975 MHz which are relevant to the introduction of digital broadcasting below 108 MHz.

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**Band:** 117.975–137 MHz
**Service:** AM(R)S (air-ground and air-air communications
(VHF voice and data), AMS(R)S (air-ground and air-air communications (VHF voice and data))
**Allocation:**

| **MHz**<br>**117.975–137** | | |
|---|---|---|
| Allocation to Services | | |
| Region 1 | Region 2 | Region 3 |
| **117.975–137** | AERONAUTICAL MOBILE (R)<br>AERONAUTICAL MOBILE SATELLITE (R)<br>5.198A 5.198B<br>5.111 5.200 5.201 5.202 | |

**Footnotes:**

**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)

**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)

**5.200** 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, BelarusBahrain, Bulgaria, 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 and Ukraine, 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)

**ICAO POLICY**

- No change to the allocations to the aeronautical mobile (route) service and the aeronautical mobile satellite (route) service (AMS(R)S) in this band.
- No changes to RR No. **5.200**.
- No changes to the provisions relating to the use of the emergency channels 121.5 and 123.1 MHz.
- Promote measures for the deletion of RR Nos. **5.201** and **5.202**.

The band 117.975–137 MHz is extensively used for VHF air-ground and air-air voice/data communications, and since 2023, is planned to be augmented by VHF earth-space and space-earth voice/data communications. On a global basis, this band is expected to satisfy the aeronautical communication requirements due to full terrestrial implementation of 25 kHz and/or 8.33 kHz channel spacing, where required.

**AVIATION USE:** The band 117.975–137 MHz is the main communications band for radio line-of-sight air-ground voice and data communications and is used at all airports, for en route, approach and landing phases of flight and for a variety of short-range tasks for general aviation and recreational flying activities (e.g. gliders and balloons). The use of this band is exclusively for air-ground communications relating to the safety and regularity of flight (ATC and AOC). In 2023, the addition of an AMS(R)S allocation allowed for Space-Based VHF (SB-VHF) services to augment current terrestrial VHF coverage on a global basis, supporting both voice and data where authorized.

The band 118–132 MHz was first allocated to aviation in 1947. The extension of the band to 136 MHz was made in 1959 and the extension to 137 MHz in 1979. In 2023, a new AMS(R)S allocation was made across the whole 117.975–137 MHz band with a prioritization required for terrestrial services.

To satisfy increased demand and to decrease frequency congestion in high-density traffic areas, the channel width has been reduced on four occasions (from 200 kHz to 100 kHz in the 1950s, to 50 kHz in the 1960s, to 25 kHz in 1972 (Seventh Air Navigation Conference) and finally to 8.33 kHz in 1995 (Special COM/OPS/95)). Frequency assignments and equipment standards may be chosen by regional agreement to suit local demand patterns. Currently, 25 kHz channel spacing is used in all regions; in parts of the EUR region 8.33 kHz channel spacing has also been implemented.

Single channel simplex is the mode of operation. Double sideband amplitude modulation voice is the major modulation method. Although FANS recommendations envisaged a transition to data in the future in this band for routine communications, still the main use is for air-ground voice communications. In cases where future data communications will become predominant, voice capability will still be required for non-routine communication.

ICAO has allotted the band to national and international services (see Annex 10, Volume V, Chapter 4, Table 4-1).

The AM(R)S is defined in RR Nos. **1.33** and **43.1** (see Attachment A and 7-III.3.8, Article 43 of this handbook) as "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". Public correspondence, as defined in RR No. **1.116**, is prohibited under RR No. **43.4** in the bands allocated exclusively to the aeronautical mobile service.

Frequencies for AOC use are covered by the Recommendation in Annex 10, Volume V, Chapter 4, 4.1.6.1.2, which prescribes that frequencies be selected for this purpose subject to regional agreement. Control of AOC communications content rests with the national licensing authority in accordance with Annex 10, Volume II, Chapter 5, 5.1.8.6 and 5.1.8.6.1 together with the note to 5.1.8.6.1. AOC communications are defined in Annex 10, Volume III, Part I, Chapter 1, as "communication[s] required for the exercise of authority over the initiation, continuation, diversion or termination of a flight for safety, regularity and efficiency reasons." AOC is part of the AM(R)S. Specific requirements for flight operations, including AOC, are contained in Annex 6.

The frequency 121.5 MHz is the aeronautical emergency frequency (Annex 10, Volume V, Chapter 4, 4.1.3.1) and is designated in the Radio Regulations (Chapter II) for general distress and safety and emergency locator transmitter (ELT) purposes. The frequency 121.5 MHz is no longer monitored by the International Satellite System for Search and Rescue (COSPAS/SARSAT). Annex 10 requires

that ELTs that are carried in compliance with the relevant provisions of Annex 6 operate on both 121.5 MHz and 406 MHz.

The frequency 123.1 MHz is designated as the frequency auxiliary to 121.5 MHz (Annex 10, Volume V, Chapter 4, 4.1.3.4, refers). This frequency is to be used as an auxiliary search and rescue frequency. The Radio Regulations also designate 123.1 MHz for general search and rescue purposes.

Frequency 123.450 MHz is the frequency designated for air-air communications between aircraft engaged in flights over remote and oceanic areas and while out of range of VHF ground stations.

The frequency 136.975 MHz is globally designated for the VDL Mode 2 Common Signalling Channel (see Annex 10, Volume III, Attachment to Part I, 6.1.2). Access to this frequency for terrestrial VDL Mode 2 services is required to maintain continuity of service.

To give low-level coverage over a large area, offset carrier operation is employed in some areas (see Annex 10, Volume III, Attachment to Part II, 1.2). Such systems, using up to five carriers in one channel, are possible with channel spacing of at least 25 kHz. Offset carrier systems could also be used with 8.33 kHz channel spacing, but cannot be implemented at this time due to lack of avionics equipage of 8.33 kHz offset carrier radios.

VHF receivers in the frequency band 117.975–137 MHz are susceptible to interference from FM broadcast signals in the band 87–108 MHz. Annex 10, Volume III, Part II, specifies performance requirements to provide protection from this possibility (see Section 7-III of this handbook). ITU-R SM.1009-1 provides technical planning guidance. Guidance on applying these performance requirements is in Volume II of this handbook.

**COMMENTARY:**

***Channel spacing***

The Special COM/OPS/95 discussed the shortage of assignable VHF channels necessary to support the growth in air traffic in the years ahead. This scarcity situation occurred in 1992 in the core area of Europe and gradually has expanded into other areas or regions with the increase in air traffic.

*Note.— The core area in Europe includes Austria, Belgium, Denmark, France, Germany, Ireland, Luxembourg, Netherlands, Switzerland and the United Kingdom.*

The Special COM/OPS/95 agreed to a near-term improvement by using a VHF voice system based on 8.33 kHz channel spacing while recognizing that not all ICAO regions would need to apply this new Standard. Recommendation 6/1 from this divisional meeting, endorsed by the Air Navigation Commission, called for SARPs for 8.33 kHz channel spacing DSB-AM to be incorporated in Annex 10, Volume III. These SARPs were adopted by the Council of ICAO in 1996. Implementation of 8.33 kHz channel spacing is subject to regional agreement.

Implementation of 8.33 kHz channel spacing in a limited form, i.e. for upper airspace services initially, started around 2000 in Europe under the aegis of ICAO, assisted by the European Organization for the Safety of Air Navigation (EUROCONTROL) in a coordination/planning role. The mandatory carriage of 8.33 kHz radio equipment was introduced for flights above FL 195 in the ICAO EUR region in 2007; this was further extended under EU mandate in 2014 and 2018.

Further expansion of the use of 8.33 kHz channel spacing to all airspace is to be completed around 2018 in Europe by EU regulation. Certain ground implementations remained as 25 kHz for wide area coverage, the accommodation of State aircraft and as a result of a safety requirement, e.g. 121.5 MHz. Further conversions are potentially foreseen around 2025 when non-8.33 kHz capable State aircraft are expected to have been retired, although 25 kHz offset carrier will be retained where it is spectrally efficient to do so.

Many other regions can continue to meet their requirements for VHF channels using 25 kHz channel spacing for some years without the compelling requirement to convert to 8.33 kHz channel spacing, although in some congested areas implementation of 8.33 kHz channel spacing may become necessary.

***Use of data in air-ground communications***

The CNS/ATM concept placed considerable reliance on the use of air-ground data for pilot/controller exchange of data to supplement the use of voice for certain categories of messages, primarily for routine communications between pilots and ATC. SARPs for VDL Mode 2, VDL Mode 3 and VDL Mode 4 have been incorporated in Annex 10. VDL Mode 2 will become the prime data system for the immediate future. Frequency planning guidance material on VDL Mode 2 and VDL Mode 4 has been developed by the ACP for use in frequency assignment planning.

***Band capacity issues***

In high-density congested areas such as Europe and North America, the requirement for VHF channels continues to increase. In regular ATC use under normal circumstances, the maximum utilization of a channel dedicated to an ATC sector is

around 10 to 20 per cent of the time due to other essential tasks performed by the controller. The use of air-ground data should enable an improvement in utilization of the spectrum, which should be beneficial and delay the time point of spectrum exhaustion. Further expansion of spectrum for short-range, line-of-sight communications as demand increases will meet problems due to the general shortage of frequencies in all parts of the radio frequency spectrum. The strategy and options to deal with this situation require early attention.

***Use of the band by other services***

The band extensions at 132–136 MHz and 136–137 MHz were agreed to many years ago in ITU but continue to support other services (such as the AM(OR)S) which already existed at that time and now operate under footnote provisions (RR Nos. **5.201** and **5.202**). RR Nos. **5.201** and **5.202** relate to the use, for national purposes, for off-route (OR) services, which was widespread prior to the agreement in 1959 to release 132–136 MHz for exclusive use by the AM(R)S. In areas where the (OR) service operates on these frequencies, coordination procedures agreed to in the past have been satisfactory. With increasing and intensive use of the frequencies in the band for AM(R)S purposes, it is likely that this (OR) use may become a problem, in which case it will become essential to press for a cessation of this use.

**Frequencies:** 121.5 MHz, 123.1 MHz and 243 MHz (mobile)
**Service:** AM(R)S

**Emergency frequency in mobile service (243 MHz)**

The frequency 243 MHz (twice that of the aeronautical emergency frequency 121.5 MHz) is designated by the Radio Regulations (see Annex 10, Volume V, Chapter 2 – Distress frequencies and RR No. **5.256 (WRC-07)**) for use in distress situations. Survival craft stations using VHF are normally fitted with both 121.5 MHz and 243 MHz.

**Footnotes:** 5.256.

**ICAO POLICY**

No change to the provisions in Chapter VII relating to the use of 121.5 MHz, 123.1 MHz and 243 MHz.

**AVIATION USE:** Emergency frequencies for use in aircraft emergencies and in ELT (121.5 MHz) and for search-of-scene communication (123.1 MHz).

**COMMENTARY:** Standards relating to the mandatory carriage of ELTs operating simultaneously on 121.5 MHz and 406 MHz are contained in Annex 6. ELT equipment carried to satisfy the requirements of Annex 6 shall operate in accordance with the provisions of Annex 10, Volume III on the frequencies 121.5 MHz and 406.1 MHz.

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**Band:** 328.6–335.4 MHz
**Service:** Aeronautical radionavigation (ILS glide path)
**Allocation:**

| **MHz 328.6–335.4** | | |
|---|---|---|
| Allocation to Services | | |
| Region 1 | Region 2 | Region 3 |
| **328.6–335.4** | AERONAUTICAL RADIONAVIGATION 5.258 5.259 | |

**Footnotes:**

**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)

**ICAO POLICY**

- No change to current allocation to the aeronautical radionavigation service.
- No change to RR No. **5.258**.
- Deletion of RR No. **5.259**.

On a global basis, the frequency band 328.6–335.4 MHz is used for the ILS glide path, in conjunction with the ILS localizer (see section on 108–117.975 MHz). This frequency band is expected to meet the aeronautical requirements for ILS glide path for the long term. In areas where GBAS is implemented to replace ILS systems, the use of this band for glide path systems may be reduced.

**AVIATION USE:** The ultra high frequency (UHF) glide path transmitter, operating on one of the 40 ILS channels within the frequency band from 328.6 MHz to 335.4 MHz, radiates its signals in the direction of the ILS localizer front course. The term "glide path" means that portion of the glide slope that intersects the localizer. The signal provides descent information for navigation down to the lowest authorized decision height specified in the approved ILS approach procedure. The glide path projection angle is normally adjusted to 3 degrees above the horizontal plane so that it passes through the middle marker at about 60 m (200 ft) and the outer marker at about 426 m (1 400 ft) above the runway elevation. The glide slope is normally usable to a distance of 10 NM. However, at some locations, use of the glide slope has been authorized beyond this range. RR No. **5.258** limits the use of this band to ILS glide path. Frequencies are used at a spacing of 150 kHz (Annex 10, Volume I, Chapter 3, 3.1.6.1) and are paired with those of the ILS localizer (see Figure 7-13 in the section on 108–117.975 MHz).

**COMMENTARY:** ICAO policy for the future need and use of this allocation is described in detail in the general policy for the use of ILS (see commentary on ILS localizer at 108–117.975 MHz).

***Use of the band by other services***

RR No. **5.259** was introduced at WARC-87. This footnote uses the same text (except for the list of countries) as RR No. **5.197 (WRC-12)** for the ILS localizer and VOR band at 108–117.975 MHz. At WRC-2000, most of the countries listed removed their names from this footnote. The remaining country names must now also be deleted to protect ILS glide path services in these areas and to avoid the possibility of new names being added at a future conference.

**Band:** 406–406.1 MHz
**Service:** Mobile-satellite (Earth-to-space) (search and rescue)
**Allocation:**

| **MHz 406–406.1** | | |
|---|---|---|
| Allocation to Services | | |
| Region 1 | Region 2 | Region 3 |
| **406–406.1** | MOBILE-SATELLITE (Earth-to-space) 5.265 5.266 5.267 | |

**Footnotes:**

**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.

**ICAO POLICY**

- No change to the allocation to the band 406–406.1 MHz and RR Nos. **5.265**, **5.266** and **5.267**.
- Secure protection of emergency locator transmitters (ELTs) which are used in aviation in this frequency band.

**AVIATION USE:** The use of ELTs offers the possibility of dramatically shortening the time required to alert rescue forces to the distress and to assist in final "homing" by the rescue team. In the ITU, such beacons are named emergency position-indicating radio beacons (EPIRBs). ELTs operating in this frequency band have the capacity to transmit a programmed digital message which contains information

related to the ELT and/or the aircraft on which it is carried. The COSPAS/SARSAT service, part of the global maritime distress and safety system (GMDSS) which receives the distress transmissions and relays back to Earth, is a joint enterprise operated on a multinational basis for the benefit of all users. SARPs on the use of ELTs operating in the frequency band 406–406.1 MHz are contained in Annex 10, Volume III, Part II, Chapter 5 and Volume V, Chapter 2. Carriage requirements for ELT are contained in Annex 6.

**COMMENTARY:** ICAO participates with the International Maritime Organization (IMO) and other international bodies in discussions on the global aspects of search and rescue which encompass the use and deployment of this frequency.

Recent cases of serious interference from non-emergency sources have caused concern regarding the effectiveness of COSPAS/SARSAT services. As a result, WRC-15 decided to reflect the need for providing protection of MSS systems in the frequency band 406-406.1 MHz taking into account the current and future deployment of services in adjacent bands. This was accomplished by including reference to revised Resolution **205 (Rev. WRC-19)** for the frequency band 403–410 MHz in Article **5**. The Resolution resolves the following:

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.

COSPAS/SARSAT developed specifications for 406 MHz distress beacons (COSPAS/SARSAT Doc. C/S T.001 refers) and a frequency management plan for the band 406–406.1 MHz (see Figure 7-15) (COSPAS/SARSAT Doc. C/S T.012 refers).

ITU-R Recommendation M.633-4, which is incorporated by reference into the Radio Regulations (Article **34 (WRC-12)** refers), contains the transmission characteristics of a satellite EPIRB system operating through a satellite system in the 406 MHz band.

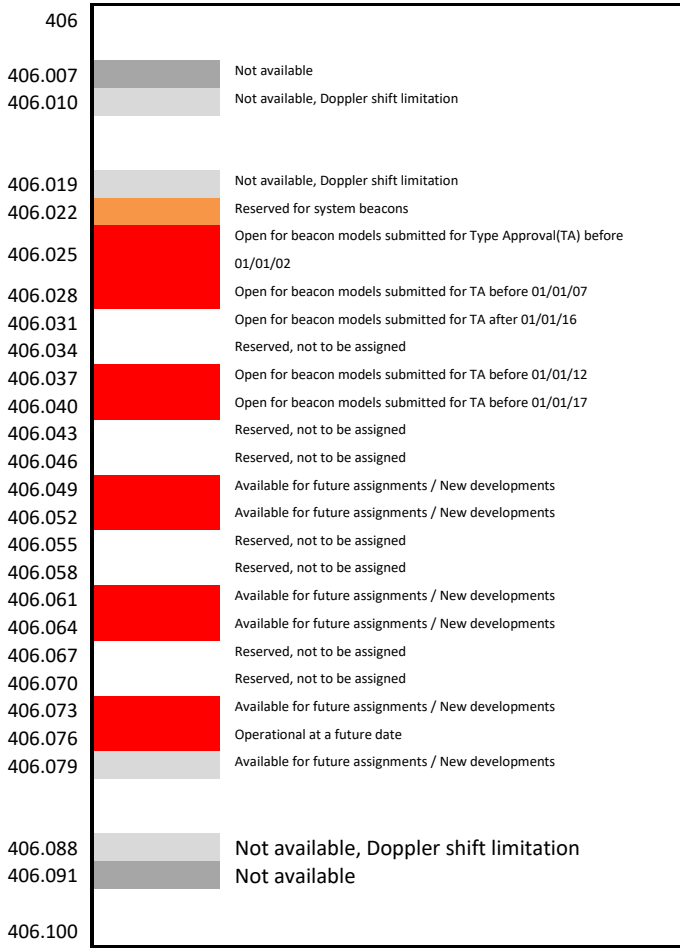


**Figure 7-15. Cospas-Sarsat 406 MHz Channel Assignment Table (Feb 2019)**

SAR processors will be able to receive signals in the band 406.01–406.09 MHz. With a Doppler shift of ±9 kHz and 1 kHz margin for spreading of beacon carrier frequencies, the channel plan should not include frequencies below 406.02 MHz and above 406.08 MHz.

Channels are made available on the basis of one pair of adjacent channels with a separation between the pair of 12 kHz in order to provide optimum capacity in both systems using geostationary satellites and low earth-orbiting satellites.

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**Band:** 960–1 215 MHz
**Service:** Aeronautical radionavigation/radionavigation satellite and AM(R)S (DME/SSR/ACAS/GNSS/1090ES/MLAT/UAT)
**Allocation:**

| **MHz**<br>**960–1 215**<br><br>Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **960–1 164** | AERONAUTICAL MOBLE (R) 5.327A<br>AERONAUTICAL RADIONAVIGATION 5.328 5.328AA | |
| **1 164–1 215** | AERONAUTICAL RADIONAVIGATION 5.328<br>RADIONAVIGATION-SATELLITE (space-to-Earth) (space-to-space) 5.328B 5.328A | |

**Footnotes:**

**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 provision 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)

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

See also:

**ARTICLE 21**

**21.18** § 7 Administration operating or planning to operate radio- navigation-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

**ICAO POLICY**

- No change to the current allocation to the aeronautical radionavigation service or to RR No. **5.328** in the band 960–1 215 MHz.
- No change to RR No. **5.328A**.
- No change to the aeronautical mobile (route) service (AM(R)S) allocation or to RR No. **5.327A** in the band 960–1 164 MHz with the exception of possible changes to remove the restrictions on the use of the AM(R)S due to non-ICAO standardized systems from ITU-R Resolution **417 (Rev. WRC-15)**.
- No change to RR No. **5.328AA**
- Support further ITU-R studies relating to Resolution **425 (Rev.WRC-19).**

On a global basis, the band 960–1 215 MHz is used for DME systems; this use is expected to continue and increase well beyond 2030. In RNAV procedures, DME-DME navigation is planned to be one of the major navigation methods as an element of PBN. The band 960–1 215 MHz is expected to satisfy, on a global basis, the future requirements for DME, taking into account the protection given to aeronautical radionavigation (DME) in the ITU Radio Regulations. In some areas, the frequency band is heavily congested with DME assignments. Rationalization in this band of frequency assignments to DME stations, including a review of the technical characteristics of DME, may be necessary.

Two sub-bands of about ±10 MHz around the frequencies 1 030 MHz and 1 090 MHz are reserved for SSR. SSR provides, in addition to secondary surveillance radar, major functionality for ACAS and automatic dependent surveillance-broadcast (ADS-B). SSR is expected to continue to be required for surveillance; the frequency bands used for SSR satisfy, on a global basis, the aeronautical requirements to well beyond 2030.

The band 1 164–1 215 MHz is also used for GPS/Galileo/Beidou/GLONASS signals and is planned to be used by SBAS. In accordance with the Radio Regulations, the use of this band by GNSS systems needs to protect DME from interference and accept interference from DME. This frequency band is expected to meet the associated GNSS requirements, on a global basis, well beyond 2030.

The frequency 978 MHz is used for the universal access transceiver (UAT), which provides for ADS-B and up-linking of data messages.

The band 960–1 164 MHz is also planned to be used for an ICAO air-ground (and air-air) communications system, namely LDACS (L-band Digital Aeronautical Communications System). In this context, frequency assignment planning rules between DME, 1 030 & 1 090 MHz systems, UAT and LDACS are being developed to ensure compatibility among these aeronautical systems. This is being pursued through continuing coordination amongst ICAO Communications Panel, Navigation System Panel, Surveillance Panel and Frequency Spectrum Management Panel.

**AVIATION USE:** The band 960–1 215 MHz is a prime radionavigation band which is used intensively, and extensively, to support a number of aviation systems, for both civil and military purposes. The band 960-1 164 MHz is also allocated to AM(R)S on a co-primary basis. The civil systems operating in the band 960–1 215 MHz are:

**Distance measuring equipment (DME):** DME is the ICAO standard system for the determination of the distance between an aircraft and a ground-based DME beacon within radio line of sight, using pulse techniques and time measurement. DME/N is the standard system used for en route and terminal navigation. It can be co-located with VOR enabling the aircraft's position to be determined through a measurement of its bearing and the distance relative to the VOR/DME. Alternatively, the aircraft's position can be determined through measurement of the distances from two or three DMEs and the flight management system equipment in the aircraft. DME/P is a precision version of DME with enhanced precision measurement capability intended for use with MLS to provide accurate distance to touchdown. DME/N is a version of DME which is used in conjunction with ILS to provide accurate distance to touchdown. TACAN is the military equivalent of DME which also has a bearing capability and uses the same channel plan as DME.

The channel plan (Annex 10, Volume I, Chapter 3, Table A) employs discrimination in both pulse length and pulse spacing, generating four possible modes (X, Y, W and Z) as a means of creating additional channels.

**Secondary surveillance radar (SSR):** SSR is the ICAO standard system for secondary surveillance radar. It is used either as a stand-alone system or co-located and synchronized with primary radar. The ground equipment is an interrogator and the aircraft equipment is a transponder responding to signals from the interrogator. SSR employs Mode A for transmitting identification and Mode C for transmitting pressure-altitude information. Mode S employs selective addressing of the aircraft and has a limited data link capability. SSR Mode S is a continuing requirement, in particular in high-density airspace.

All SSR installations operate on 1 030 MHz for the ground-to-air interrogation signal, and 1 090 MHz for the air-to-ground reply. Extensive use of pulse repetition frequency (PRF) discrimination and plot plan processing techniques assists in reducing the number of invalidated responses being processed by the ground receiving system.

**Airborne collision avoidance system (ACAS):** ACAS is the ICAO standard system for detection and avoidance of airborne conflict situations. ACAS aircraft equipment interrogates Mode A/C and Mode S transponders on aircraft in its vicinity and listens to the transponder replies. By processing these replies, the ACAS equipment determines which aircraft represent potential collision threats and provides appropriate display indication or advisories to the flight crew to avoid collisions. ACAS operates as a supplementary system to SSR using the same frequency pair of 1 030 MHz and 1 090 MHz. 1 030 MHz is used for the air-air interrogation and 1 090 MHz for the air-air reply. The three modes, I, II and III, provide increased capability at each level of functional implementation. Provision is made for air-ground communication with ground stations using the Mode S data link. Diagrams of the use of the frequencies 1 030 MHz and 1 090 MHz by air and ground elements of SSR and ACAS can be found in Figures 7-11 and 7-12. The traffic alert and collision avoidance system II (TCAS II) is the only currently available system capable of meeting the ACAS Mode II requirements, providing resolution advisories in the vertical sense (direction) telling the pilot how to regulate or adjust their vertical speed so as to avoid a collision.

**1 090 MHz extended squitter (1090ES):** 1 090 MHz extended squitter transmissions from Mode S transponders or other non-transponder devices are used to broadcast information relating to position of aircraft, aerodrome surface vehicles, fixed obstacles and/or other related information. The broadcast can be received by airborne or ground-based receivers and can contain ADS-B and/or traffic information service-broadcast (TIS-B) messages.

**Automatic dependent surveillance – broadcast (ADS-B):** ADS-B is an ICAO standardized cooperative surveillance technology in which a surveillance picture is built based on either a 1090ES signal triggered by an SSR or ACAS signal or via the periodic ADS-B broadcast from an aircraft or other obstruction. The signal can either be used by air traffic control as a supplement/replacement for SSR or by aircraft to provide situational awareness and allow self-separation. The ADS-B receivers can be located on the ground, in an aircraft or on a satellite.

**Wide area multilateration**: Wide area mutilateration systems take advantage of routine aircraft transmissions at 1 090 MHz by measuring the arrival of that signal at a number of receiving ground stations. Using the arrival time at the various ground stations and the geometry of those ground stations the aircraft's position is

calculated. In areas where there are not enough 1 090 MHz emissions, a 1 030 MHz interrogator can be installed to elicit additional signals.

**Universal access transceiver (UAT):** ICAO has adopted SARPs and guidance material for UAT. This system is intended to support ADS-B data transmission as well as ground uplink services such as TIS-B and flight information service- broadcast (FIS-B). UAT employs time division multiple access (TDMA) technique on a single 1 MHz channel at 978 MHz and is dedicated for transmission of airborne ADS-B reports and for broadcast of ground-based aeronautical information.

**L-band digital aeronautical communications system (LDACS):** Based on the AM(R)S allocation, LDACS is the L-band communications system supporting voice and data services. It provides the required capacity that cannot be achieved in the VHF band through VDL technologies. In particular, LDACS is intended to provide the required data link capacity, QoS and security means to support ATS-B2, ATS-B3 and services beyond, including trajectory planning in air traffic management. Work on the feasibility of implementing LDACS in the frequency band 960–1 164 MHz is currently (2021) ongoing and initial results indicate that the introduction of LDACS will require proper LDACS frequency assignment planning and LDACS ground station siting. Although those LDACS frequency assignment planning and ground station siting guidelines impose some constraints on the LDACS deployment, when completed the goal is that adherence to those requirements will ensure compatibility with the existing aeronautical systems (DME, 1 030 and 1 090 MHz systems, and UAT) in the L-band. LDACS is being planned to operate in the bands 964-1 010 MHz (reverse link) and 1 110-1 156 MHz (forward link). LDACS forward link complies with the emission mask according to Resolution 417 (Rev. WRC-15) ensuring protection of RNSS in the band 1 164-1 215 MHz. In order to achieve this protection, frequencies up to 1 120 MHz may be used for LDACS ground stations which transmit with maximum e.i.r.p., whereas frequencies above 1 120 MHz may only be used for LDACS ground stations which transmit with accordingly reduced e.i.r.p..

The AM(R)S allocation in the 960–1 164 MHz frequency band can be used subject to the conditions contained in Resolution **417 (Rev. WRC-15)**. That Resolution requires that any communication system, with the exception of UAT, introduced into the frequency band 960–1 164 MHz must be coordinated when intended to operate within 934 km of a number of States (mainly in eastern Europe) using non-ICAO standard systems in this band. The Resolution also places a maximum e.i.r.p limit on the emissions from any AM(R)S system that is based on the frequency offset from 1 164 MHz and a fixed out-of-band limit above 1 164 MHz for the protection of the radionavigation-satellite service.

**COMMENTARY:** The present internationally agreed channel plans for DME occupy the full 960–1 215 MHz band. The DME channel plan is displayed at Table A of Annex 10, Volume I, Chapter 3. The arrangement of air-to-ground interrogations and ground-to-air replies showing the standard 63 MHz separation and the interleaving of X and Y channels is shown at Figure 7-16. Both X and Y channels are currently deployed together with 50 kHz VOR/ILS channel spacing in the higher density areas where the implementation of DME (and TACAN) is extensive. W and Z channels are intended for use with MLS, employing an interrogation pulse pair with a different pulse length on the X and Y channels, respectively. In low-density areas, only DME X channels (paired with 100 kHz ILS/DME channel spacing) are used.

Some world areas are prone to frequency scarcity. Frequency pairing of DME with VOR or ILS, triple pairing of DME with ILS and MLS (a necessary operational technique for air safety or for the transition to MLS where this system is brought into use), and co-channel TACAN use are factors often creating difficulties in frequency planning which are not easily overcome.

To maintain the overall required safety levels, VOR/DME and DME/DME are foreseen as necessary navigation infrastructure in addition to GNSS for the foreseable future to take account of GNSS outages, such as jamming or spoofing. Specifically, where a terrestrial navigation capability is required, a DME network capable of supporting DME/DME area navigation needs to be provided, where possible. A residual capability based on VOR/DME will still need to be provided to cater to airspace users not equipped with suitable DME/DME avionics, where required. Accordingly, use of VOR and DME is expected to extend for the foreseeable future.

SSR and SSR Mode S are the main techniques for surveillance in high traffic density areas (FANS II/4 refers). SSR Mode S is a tool for air traffic management mainly in high traffic density continental airspaces.

Carriage of ACAS systems by all aircraft over 5 700 kg or authorized to carry more than 19 passengers is mandatory globally.

The overall situation in this band is one of a continuing exploitation of current systems. It can be realistically expected that some important uses of the frequency band, such as ILS/DME, VOR/DME, DME/DME and SSR Mode S, will continue as essential ATS tools in high-density airspace and this will extend beyond 2030.

***Use of the band for GNSS***

Currently, a main component of GNSS is operating in the band 1 559–1 610 MHz. The frequencies in the band 1 164–1 215 MHz have been identified as suitable to support components for the future development of GNSS, in addition to GNSS components operating on other frequencies. Currently, a main component of GNSS is operating in the band 1 559–1 610 MHz.

Draft ICAO SARPs for dual-frequency GNSS core constellations and for dual frequency SBAS, operating both in the band 1 559–1 610 MHz and in the band 1 164–1 215 MHz, have been developed by the Navigation Systems Panel (NSP) and are expected to become applicable by 2023. They will introduce a second frequency of operation in the band 1 164–1 215 MHz for the GPS (USA) and GLONASS (Russia) constellations and for SBAS, already standardized by ICAO but only for operation in the band 1 559–1 610 MHz. Furthermore, they will introduce two new GNSS constellations, Galileo (European Union) and BeiDou (China), operating in both bands. Some of these new GNSS signals include higher signal levels and more robust interference rejection characteristics.

WRC-2000 adopted RR No. **5.328A** which includes an allocation to the radionavigation-satellite service (RNSS, the ITU terminology for GNSS systems) in the band 1 164–1 215 MHz. WRC-03 developed detailed regulatory provisions for the protection of the aeronautical radionavigation service in this band. Protection of the DME channels 77X to 126X, the use of which can be affected by this allocation, is to be assured by imposing an equivalent power flux-density limit of –121.5 dB($W/m^2$) in any 1 MHz for the space-to-Earth signals produced by all satellites of all RNSS systems operating in this band, and by a regulatory provision requiring that RNSS shall not claim protection from the stations of the ARNS.

***Protection of aeronautical systems in the 960–1 215 MHz Frequency band from harmful interference***

*Potential interference from ultra-wide-band (UWB) devices*

Technological advances have resulted in the development of devices used in radar and communications applications. These emitters, known as ultra-wide-band (UWB) devices, radiate over very wide bandwidths, typically several gigahertz. Devices used in radar applications have many commercial and government uses, such as radar imaging through walls. Many of the frequency bands subject to UWB emissions are aeronautical.

Four ITU-R Recommendations (ITU-R SM.1754, 1755, 1756 and 1757) and one ITU-R report (ITU-R SM.2057) on the impact of UWB technology on radiocommunication services have been developed.

Considering especially the mobility of aircraft and the large "viewing" area to which aircraft are exposed, together with the variability and uncertainty of a significant number of factors (such as UWB emitter density, signal characteristics and activity factors) necessary for the interference analysis of devices using UWB technology with systems operating within safety services, UWB devices should in general not be operated in frequency bands allocated to safety services. In those cases where such use cannot be avoided, administrations should take all steps necessary to ensure that UWB devices do not cause harmful interference to the reception by stations operating under a safety service allocation. The level of harmful interference to safety systems needs to be determined on a case-by-case basis in the form of a safety analysis. This analysis would assess the use being made of the safety system and demonstrate that the required levels of integrity, reliability and availability are still maintained under all operational conditions. Factors such as the impact on safety service link budget margins and measures to preclude interference from UWB devices that malfunction need to be considered.

*Potential interference from IMT unwanted emissions*

By the decisions of WRC-12 and WRC-15, the frequency bands 694–790 MHz, 790–862 MHz and 1 427–1 518 MHz were identified for international mobile telecommunications (IMT) on a global or regional basis. Also, in several countries the band 470-694 MHz was identified for IMT in accordance with relevant footnotes of the Radio Regulations.

There are global navigation satellite systems operating in frequency bands below 3 GHz which have allocations for RNSS. Frequency bands identified for IMT do not overlap by their main emission with GNSS frequency bands. However, IMT can

impact on frequency bands of global navigation systems (1 164–1 300 MHz) by unwanted emissions including out-of-band and spurious emissions. In the GNSS frequency band 1 164–1 300 MHz, impact of the second harmonic of IMT stations that use frequency band 470–694 MHz is possible, as well as impact of spurious emissions from IMT stations that operate in the frequency band 1 427–1 518 MHz.

Current results of theoretical and experimental estimations indicate that the levels of unwanted emissions of IMT stations that are defined in ITU-R Recommendations M.2070 and M.2071 are not low enough to provide required protection level for RNSS receiving earth stations that operate in 1 164–1 300 MHz. Required separation distances are from 42 m to 2 446 m depending on the type of RNSS receiver, which makes impossible simultaneous application of these devices in one local spot without additional compatibility measures.

*Potential interference from AM(R)S unwanted emissions*

Resolution **417 (Rev. WRC-15)** provides the criteria to ensure that AM(R)S systems do not cause harmful interference to RNSS in the frequency band 1 164–1 215 MHz.

***Use of the band by other services***

In some countries, the band is also used by national communications systems (e.g. Joint Tactical Information Distribution System (JTIDS)/Multifunctional Information Distribution System (MIDS)). Such systems have no internationally recognized status in the band and therefore are only permitted to operate on a strict basis of non-interference to the radionavigation systems using the band in accordance with the ITU allocation (Article **4** of the Radio Regulations refers).

TACAN is a military development providing both the azimuth and distance components by equipment operating in the band 960–1 215 MHz. Where a TACAN transponder is co-located with a VOR, the distance measuring component of the TACAN substitutes for and fulfils any civil requirement for DME. The VOR is then referred to as "VORTAC". As with DME, tuning to the VOR will automatically interlock with the associated TACAN distance measuring element. When used by civil aircraft, the guidance derived from a VOR/DME and a VORTAC is identical.

Certain airborne TACAN systems function as a standard TACAN interrogator system (measuring the slant-range distance and relative bearing to a selected ground station or an airborne TACAN beacon, and computing velocity and time-to-go to that station) and providing an air-air bearing transmit capability (beacon mode) used to provide rendezvous capability between aircraft.

***Non-ICAO standard aeronautical radionavigation systems***

The frequency band 960–1 215 MHz is also used for certain non-ICAO standard aeronautical radionavigation systems and mainly used in eastern-European countries. The technical characteristics and protection criteria for these systems are in ITU-R Recommendation M.2013. Use of the band 960–1 164 MHz by the aeronautical mobile (R) service (e.g. LDACS) needs to secure protection of these systems.

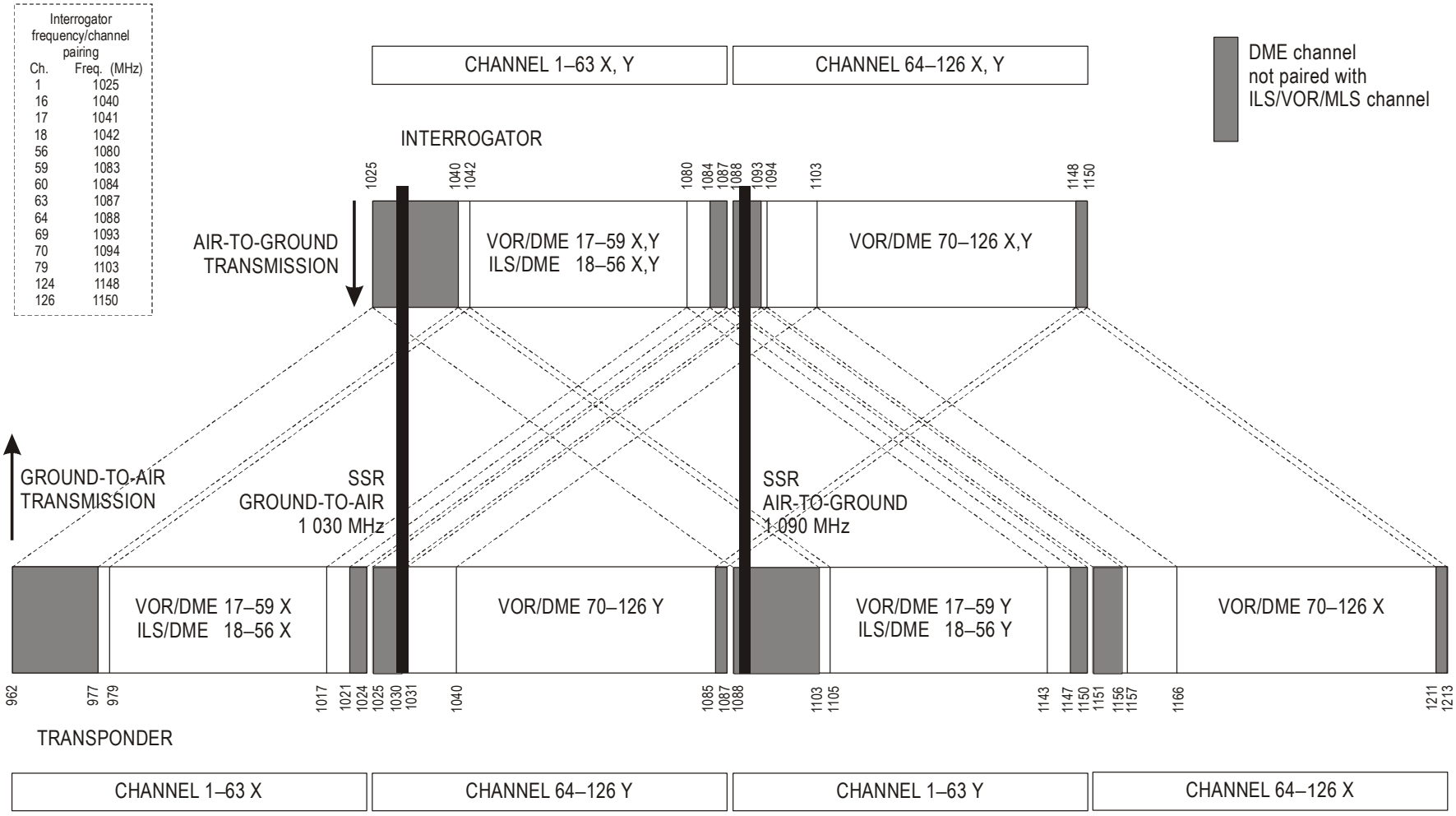


**Figure 7-16. Channelling DME bank (960–1 215 MHz)**

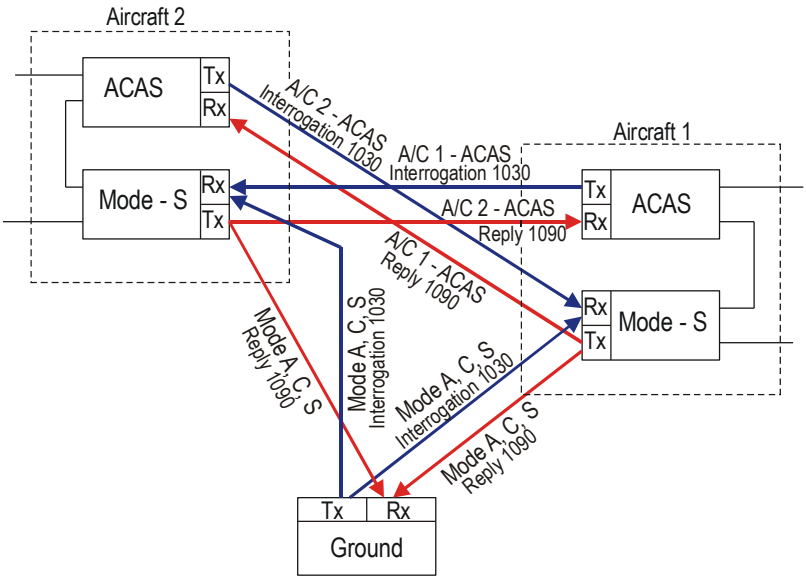


**Figure 7-17. Use of frequencies 1 030 MHz and 1 090 MHz by SSR and ACAS air and ground elements**

**Band:** 1 215–1 400 MHz
**Service:** Radionavigation/aeronautical radionavigation/
radiolocation/radionavigation-satellite
(RNSS/primary surveillance radar)
**Allocation:**

| **MHz**<br>**1 215–1 400**<br><br>Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **1 215–1 240** | EARTH EXPLORATION-SATELLITE (active)<br>RADIOLOCATION<br>RADIONAVIGATION-SATELLITE<br>(space-to-Earth) (space-to-space)<br>5.328B 5.329 5.329A<br>SPACE RESEARCH (active)<br>5.330 5.331 5.332 | |
| **1 240–1 300** | EARTH EXPLORATION-SATELLITE (active)<br>RADIOLOCATION<br>RADIONAVIGATION-SATELLITE<br>(space-to-Earth) (space-to-space)<br>5.328B 5.329 5.329A<br>SPACE RESEARCH (active)<br>Amateur<br>5.282 5.330 5.331 5.332 5.332A<br>5.335 5.335A | |
| **1 300–1 350** | RADIOLOCATION<br>AERONAUTICAL RADIONAVIGATION 5.337<br>RADIONAVIGATION-SATELLITE<br>(Earth-to-space)<br>5.149 5.337A | |
| **1 350–1 400**<br>FIXED<br>MOBILE<br>RADIOLOCATION<br>5.149 5.338 5.338A | **1 350–1 400**<br>RADIOLOCATION 5.338A | |

| | |
|---|---|
| 5.339 | 5.149 5.334 5.339 |

**Footnotes:**

**5.149** In making assignments to stations of other services to which the bands: ... 1 330–1 400 MHz, ... 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)

**5.282** 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.

**5.328B** 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)

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

**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)

**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)

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

**5.331** *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, Palistine*, the Kingdom of the Netherlands, Poland, Portugal, Qatar, the Syrian Arab Republic, Turkiye, Dem. People's Rep. of Korea, Slovakia, the United Kingdom, Serbia, Slovenia, Somalia, Sudan, South Sudan, Sri Lanka, South Africa, Sweden, Switzerland, Thailand, Togo, Turkey, 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 5to 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)

**5.334** *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)

**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.

**ICAO POLICY**

- No change to the status of the allocation to the radionavigation service in RR Nos. **5.331** and **5.334**.
- No change to RR No. **5.332**.
- No change to the provisions of RR Nos. **5.329** and **5.337A** regarding the protection of radar stations from the radionavigation-satellite service.
- Support further ITU-R studies relating to Resolution **608 (Rev. WRC-19)**.

On a global basis, the band 1 300–1 350 MHz (and in many countries also the band 1 215–1 300 MHz) is extensively used for primary surveillance radar, mainly providing long-range independent non-cooperative airspace surveillance. This use is expected to continue to be required for the long term.

The use of this band for GNSS signals (GPS L2, GLONASS L2, Galileo E6 and Beidou B6) is not for civil aircraft applications.

A new development in radar technology is the multi-static primary surveillance radar (MSPSR). MSPSR may provide more spectrum-efficient use of this band and better coverage at lower altitudes. However, the implementation of MSPSR is dependent on the cost and improved spectrum efficiency that can be obtained.

**AVIATION USE:** These bands are used extensively for 23 cm (L-band) primary surveillance radar (PSR), for both en route and terminal surveillance tasks. Modern systems employing digitized plot extraction often operate on multiple frequencies

and use pulse repetition frequency (PRF) discrimination where up to four or even six frequencies may be used by a single radar spaced over a band of 100 MHz. For these requirements, the band from around 1 215 to 1 370 MHz (as for example in RR No. **5.334**) must be available. The band is also used extensively by other users for the long-range detection of aircraft targets. Co-located SSR and PSR are often employed with combined plot extraction, electronic processing and display. Electronically generated labels displaying flight number and other data, i.e. altitude reported from SSR Mode C, are often added to provide a complete radar data picture. Twenty-three centimetres is the preferred wavelength for long-range radar where a sufficiently large antenna can be installed to provide narrow beams in azimuth and phased arrays for beam switching for multi-purpose mode operation.

**COMMENTARY:** Under FANS recommendations, also discussed at the Tenth Air Navigation Conference held in 1991, the use of PSR is expected, in the long term, to diminish in both en route and terminal areas. The recommended replacement system is SSR Mode S or some form of ADS using air-ground data link. Future possible use of ADS or ADS-B may affect the requirements for primary or secondary surveillance radar. Primary surveillance radar with its high-level investment is, however, expected to continue to be utilized in civil aviation for many years into the future. One of the important features of PSR is the independent role it plays in the surveillance of airspace, allowing for the detection of non-cooperating aircraft.

The Communications/Meteorology/Operations (COM/MET/OPS) Divisional Meeting (1990) (Attachment 4 to Appendix B to the report on Agenda Item 1 refers) reported the wide use of this band (and also of the band 2 700–2 900 MHz) for en route and terminal surveillance. Table 1 in Attachment 4 provides estimates of the use amounting to 583 radars worldwide. Paragraph 4 proposes the ICAO Position of no change to the allocation at 1 300–1 350 MHz and adjoining bands.

The conclusion of these considerations was that these bands should be retained and protected for the foreseeable future for the operation of radar systems.

***Use of the band by the radionavigation-satellite service***

The band 1 215–1 300 MHz is also used for GLONASS (operates on 14 frequencies spaced at 0.4375 MHz in the band between 1 242.9375 MHz and 1 248.6250 MHz). The frequency 1 227.6 MHz is used for the precise positioning service (PPS, L2) of GPS, extending the accuracy of GPS. A new signal, GPS L2C, remains pre-operational. Techniques have been developed for the use of ground stations to correct for ionospheric delays (see also commentary on GNSS usage of the band 1 559–1 610 MHz).

WRC-2000 introduced an allocation to the RNSS in the frequency bands 1 260–1 300 MHz for space-to-Earth and space-to-space directions, and 1 300–1 350 MHz for the Earth-to-space direction. The components in these bands are not being considered as a part of the ICAO GNSS system.

WRC-03 reviewed the allocation and decided that in the frequency band 1 215–1 300 MHz the radionavigation-satellite service shall be subject to the condition that no harmful interference is caused to, and no protection claimed from, the radionavigation service authorized under RR No. **5.331 (Rev. WRC-19)**. 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. Resolution **608 (Rev. WRC-19)** resolves that no constraints in addition to those in place prior to WRC-2000 shall be placed on RNSS (space-to-Earth) frequency assignments in the frequency band 1 215–1 260 MHz brought into use before 2 June 2000.

Studies in ITU-R have defined the interference environment that could be experienced by PSR.

***Protection of aeronautical systems in the 1 215–1 300 MHz frequency band from harmful interference***

*Potential interference from ultra-wide-band (UWB) devices*

Technological advances have resulted in the development of devices used in radar and communications applications. These emitters, known as ultra-wide-band (UWB) devices, radiate over very wide bandwidths, typically several gigahertz. Devices used in radar applications have many commercial and government uses, such as radar imaging through walls. Many of the frequency bands subject to UWB emissions are aeronautical.

Four ITU-R Recommendations (ITU-R SM.1754, 1755, 1756 and 1757) and one ITU-R report (ITU-R SM.2057) on the impact of UWB technology on radiocommunication services have been developed.

Considering especially the mobility of aircraft and the large “viewing” area to which aircraft are exposed, together with the variability and uncertainty of a significant number of factors (such as UWB emitter density, signal characteristics and activity factors) necessary for the interference analysis of devices using UWB technology with systems operating within safety services, UWB devices should in general not be operated in frequency bands allocated to safety services. In those cases where such use cannot be avoided, administrations should take all steps necessary to ensure that UWB devices do not cause harmful interference to the reception by stations

operating under a safety service allocation. The level of harmful interference to safety systems needs to be determined on a case-by-case basis in the form of a safety analysis. This analysis would assess the use being made of the safety system and demonstrate that the required levels of integrity, reliability and availability are still maintained under all operational conditions. Factors such as the impact on safety service link budget margins and measures to preclude interference from UWB devices that malfunction need to be considered.

*Potential interference from IMT unwanted emissions*

By the decisions of WRC-12 and WRC-15, the frequency bands 694–790 MHz, 790–862 MHz and 1 427–1 518 MHz were identified for international mobile telecommunication (IMT) on a global or regional basis. Also, in several countries the band 470-694 MHz was identified for IMT in accordance with relevant footnotes of the Radio Regulations.

There are global navigation satellites systems operating in frequency bands below 3 GHz which have allocations for RNSS. Frequency bands identified for IMT do not overlap by their main emission with GNSS frequency bands. However, IMT can impact on frequency bands of global navigation systems (1 164–1 300 MHz) by unwanted emissions including out-of-band and spurious emissions. In the GNSS frequency band 1 164–1 300 MHz, impact of the second harmonic of IMT stations that use frequency band 470–694 MHz is possible, as well as impact of spurious emissions from IMT stations that operate in the frequency band 1 427–1 518 MHz.

Current results of theoretical and experimental estimations indicate that the levels of unwanted emissions of IMT stations that are defined in ITU-R Recommendations M.2070 and M.2071 are not low enough to provide required protection level for RNSS receiving earth stations that operate in 1 164–1 300 MHz. Required separation distances are from 42 m to 2 446 m depending on the type of RNSS receiver, which makes impossible simultaneous application of these devices in one local spot without additional compatibility measures.

**Bands:** Mobile-satellite bands 1 525–1 559 MHz and 1 626.5–1 660.5 MHz
**Service:** AMS(R)S (satellite communications)

### 1. Space-to-Earth

<table>
<tr><th colspan="3">MHz<br>1 525–1 559</th></tr>
<tr><td colspan="3">Allocation to Services</td></tr>
<tr><td>Region 1</td><td>Region 2</td><td>Region 3</td></tr>
<tr><td>1 525–1 530<br>SPACE OPERATION<br>(space-to-Earth)<br>FIXED<br>MOBILE-SATELLITE<br>(space-to-Earth)<br>5.208B 5.351A<br>Earth exploration-satellite<br>Mobile except aeronautical mobile 5.349<br><br>5.341 5.342 5.350<br>5.351 5.352A 5.354</td><td>1 525–1 530<br>SPACE OPERATION<br>(space-to-Earth)<br>MOBILE-SATELLITE<br>(space-to-Earth)<br>5.208B 5.351A<br>Earth exploration-satellite<br>Fixed<br>Mobile 5.343<br><br>5.341 5.351 5.354</td><td>1 525–1 530<br>SPACE OPERATION<br>(space-to-Earth)<br>FIXED<br>MOBILE-SATELLITE<br>(space-to-Earth)<br>5.208B 5.351A<br>Earth exploration-satellite<br>Mobile 5.349<br><br>5.341 5.351 5.352A<br>5.354</td></tr>
<tr><td>1 530–1 535<br>SPACE OPERATION<br>(space-to-Earth)<br>MOBILE-SATELLITE<br>(space-to-Earth)<br>5.208B 5.351A<br>5.353A<br>Earth exploration-satellite<br>Fixed<br>Mobile except aeronautical mobile<br><br>5.341 5.342 5.351<br>5.354</td><td colspan="2">1 530–1 535<br>SPACE OPERATION (space-to-Earth)<br>MOBILE-SATELLITE (space-to-Earth)<br>5.208B 5.351A 5.353A<br>Earth exploration-satellite<br>Fixed<br>Mobile 5.343<br><br>5.341 5.351 5.354</td></tr>
<tr><td>1 535–1 559</td><td colspan="2">MOBILE-SATELLITE (space-to-Earth)<br>5.208B 5.351A<br>5.341 5.351 5.353A 5.354 5.355 5.356<br>5.357 5.357A 5.359 5.362A</td></tr>
</table>

**2. Earth-to-space**

| **MHz**<br>**1 626.5–1 660.5**<br><br>Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **1 626.5–1 660** | MOBILE-SATELLITE (Earth-to-space) 5.351A<br>5.341 5.351 5.353A 5.354 5.355 5.357A<br>5.359 5.362A 5.374 5.375 5.376 | |
| **1 660–1 660.5** | MOBILE-SATELLITE (Earth-to-space) 5.351A<br>RADIO ASTRONOMY<br>5.149 5.341 5.351 5.354 5.362A 5.376A | |

**Footnotes:**

**5.149** In making assignments to stations of other services to which the bands: ... 1 660–1 670 MHz, ... 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)

**5.208B*** In the frequency bands …1 525–1 610 MHz … Resolution **739 (Rev. WRC-19)** applies. (WRC-19)

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

**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.

**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.

**5.349** *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)

**5.352A** 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)

**5.353A** 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)

**5.359** 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)

**5.362A** In the United States, in the bands 1 555–1 559 MHz and 1 656.5–1660.5 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)

**5.374** 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 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 and safety communications (see Article **31**).

**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.

**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)

**ICAO POLICY**

- If required, modify RR Nos. **5.357A** and **5.362A** to strengthen AMS(R)S access to the bands.
- No change to RR Nos. **5.357** and **5.376**.
- Support the deletion of RR Nos. **5.355** and **5.359**.
- Provide support to the procedure to implement RR No. **5.357A** and Resolution **222 (Rev. WRC-23)**.
- Support the methodology for computing AMS(R)S spectrum requirements as contained in ITU-R Recommendation M.2091.

In the bands 1 545–1 555 MHz and 1 646.5–1 656.5 MHz (and in the United States also the bands 1 555–1 559 MHz and 1 656.5–1 660.5 MHz as per RR No. **5.362A**), the provisions in ITU Radio Regulations stipulate that priority shall be given during the frequency coordination process to the spectrum requirements for the aeronautical mobile-satellite (R) service. Over a long period of time (prior to WRC-12), these provisions did not provide for the required access for aeronautical mobile-satellite (R) communications. In order to secure that the aeronautical requirements for, in particular, long-distance communications using satellite technology are met, the relevant radio regulatory provisions in Resolution **222** were amended at WRC-12 and at WRC-23 as an attempt to improve and secure, in all cases, access by aviation to those bands.

**AVIATION USE:** These frequencies are used for air-ground communications and, in the FANS scenarios, are expected to replace HF as the primary means of communication over oceanic/remote areas. In continental airspace, satellite communications may be used as a supplement to VHF. Some aeronautical satellite communications systems support voice and data for ATC or ADS-C purposes. AMS(R)S SARPs were adopted by ICAO in 1995.

Also included in the allocation table shown above are the mobile-satellite bands 1 544–1 545 MHz and 1 645.5–1 646.5 MHz which are to be used for any mobile service for distress and safety communications only.

AMS(R)S will be provided by service providers for both the space segment and the ground segment. The connection to ATC centres would normally be made by landline from the ground Earth station.

The frequency bands 1 545-1 555 MHz and 1 645.5-1 656.5 MHz have also been idntified for use by Remotely Piloted Aircraft Systems (RPAS) C2 Links (refer to Annex 10, Volume V, Chapter 5.1).

**COMMENTARY:** The use of satellites for communications (and navigation) was recommended as official ICAO policy by the Tenth Air Navigation Conference (Montreal, 5 to 20 September 1991), as part of the future CNS/ATM systems recommended by FANS. The Tenth Air Navigation Conference discussions comprehensively covered all aspects of the subject. The Council of ICAO endorsed the FANS recommendations at the twentieth meeting of its 134th Session on 29–31 October 1991. The prime use of satellites for communication and navigation would be in oceanic and continental low-density airspace. The CNS/ATM system supports voice and data, the latter being a support element for ADS.

At the above-mentioned conference, the role of ICAO in satellite communications with aircraft was explored (Agenda Item 8 of the *Report of the Tenth Air Navigation Conference (1991)* (Doc 9583) refers), and was seen to be basically that of a facilitator and coordinator. The complexities of the institutional and legal arrangements and interfaces between the concerned parties, such as air traffic service provider, space system provider and ground system provider, were addressed in Agenda Item 4 of the same conference. Appendix A to Agenda Item 4 sets out guidelines and recommendations for study on these aspects.

***Generic allocations/access to frequencies***

Until 1997, ITU allocations to the AMS(R)S were exclusive and worldwide in accordance with the definition at RR No. **1.36** and the rules at Chapter VIII for aeronautical mobile services. The exclusive condition ensured that ICAO SARPs could be applied, and the system operators would provide a service with the required integrity and reliability. Frequencies for mobile-satellite use were under intensive demand for other mobile applications, which led ITU to focus attention on the relatively unused AMS(R)S allocation.

WRC-97 discussed at great length the introduction of a generic allocation to the mobile-satellite service which replaced the exclusive allocations to the aeronautical, land and maritime mobile-satellite services, noting the dissenting views of the international civil aviation and maritime communities (see Section 7-III, paragraph 7-III.3.1.4 of this handbook). Frequencies in a generic allocation may be used for providing service to any class of mobile user (land, sea or air) and may carry any type of communication (safety, public correspondence, voice or data). Against the stated policies of ICAO and IMO, the introduction of generic allocations was approved, together with a new RR No. **5.357A** which was intended to provide a guarantee of future frequency access for aeronautical safety services. With this new generic allocation to the mobile-satellite service, aircraft have to share the 10 MHz in the bands 1 545–1 555 MHz and 1 646.5–1 656.5 MHz with non-aeronautical systems, services and service providers (and an additional 4 MHz in the bands 1 555–1 559 MHz and 1 656.5–1 660.5 MHz in the United States).

RR Nos. **5.357A** and **5.362A**, inserted at WRC-97, provide the mechanism intended by radio regulatory authorities to compensate for the loss of the exclusive 10–14 MHz (each direction) of spectrum to the AMS(R)S and assure access in the future. It relied on cooperation between administrations and satellite system operators and by itself had no apparent regulatory force. In a situation where there are no spare frequencies for aeronautical use in the bands quoted in the footnote, with some used for other (non-aeronautical) mobile-satellite systems, expansion of aeronautical use is only possible by a release of frequencies from a non-aeronautical user. In effect, there was no guarantee that such release could be made possible. Two important features of the footnote are that they address only the 10 MHz (14 MHz in the United States) of spectrum allocated to the AMS(R)S prior to WARC-92 (as quoted in the footnote) and that the priorities are Categories 1 to 6 of Article **44** of the Radio Regulations. These are identical to Annex 10, Volume II, Chapter 5, 5.1.8 (see Section 7-III, paragraph 7-III.3.8 of this handbook). This excludes public correspondence, a category which covers passenger and airline administrative communications.

The aviation concern on this point led to Resolution **222 (Rev. WRC-23)**. Resolves 3 of the Resolution states that administrations shall ensure that MSS operators yield capacity to accommodate AMS(R)S requirements, either through the coordination process described below or through prioritization and real-time pre-emptive access, where feasible. To give this Resolution a positive regulatory force, a linked reference has been placed in RR No. **5.357A**, which under present ITU rules gives it the same status as a Radio Regulation. This regulatory formula, while not fully meeting the ICAO policy calling for a recovery of the exclusive allocation to the AMS(R)S, is still a considerable improvement on the original.

The current practice of the application of RR No. **5.357A** is that all satellite service providers planning to operate in the bands 1 525–1 559 MHz and 1 626.6–1 660.5 MHz register the use of the whole band with the ITU. With this registration, the obligations of the Radio Regulations to internationally coordinate the frequency assignments are satisfied. However, the actual allotment of portions of this spectrum to satellite system operators is taking place under the auspices of a Memorandum of Understanding (MOU) between the concerned satellite system operators and relevant administrations. Under the MOU, satellite system operators are provided with spectrum on a yearly basis, using actual and predicted traffic characteristics, and satisfying their needs as long as these can be accommodated in the available spectrum. The results of these yearly consultations are not available in the public domain. ICAO is not invited to become a party to this MOU nor is it informed about the results. The frequency coordination and assignment process has been factually taken outside the traditional ITU frequency planning and coordination process. The secrecy around the results of the activities under the MOU does not give ICAO or the aviation community the possibility to assess if the aeronautical spectrum requirements will be met in the

longer term. Furthermore, the process under the MOU does not provide for any alternative measures if it is no longer supported by administrations or satellite system operators. This creates serious concern about the practical ability to make frequency spectrum available for aeronautical communications, when required, which under the MOU has already been assigned to a particular non-aeronautical satellite system operator.

***Spectrum requirements for satellite communications***

The amount of spectrum required for civil aviation has been a subject of study since 1971 when the first allocation of 15 MHz in both directions for safety communications only was made. Later (in 1987), with the realization that safety communications alone could not justify a satellite system with dedicated frequencies, and to meet airline needs, the scope was increased to include public correspondence. The WARC Mob-87 further reduced this exclusive allocation. Finally, WRC-97 concluded on the present 10 MHz (no longer exclusive) quoted in RR No. **5.357A**. The generic allocation permits public correspondence, subject to the priority terms for Categories 1 to 6 of Article **44** as quoted in the footnote.

**ITU-R studies on AMS(R)S – Intersystem real-time pre-emption**

To respond to the request by WRC-2000 with regard to Resolution **222 (Rev. WRC-23)**, the ITU-R has completed studies begun in 2000 to determine the feasibility and practicality of prioritization and real-time pre-emptive access (intersystem real-time pre-emption).

The concept of real-time pre-emption was proposed at WRC-97 as an expedient mechanism to open the sub-bands 1 545–1 555 and 1 646.5–1 656.5 MHz to generic MSS.

ITU-R considered various elements, such as characteristics of the aeronautical safety communications and aeronautical traffic, and applicability of real-time pre-emption and its practicality and effectiveness. The study also "identified a number of significant technical, operational and economic issues that would have to be overcome to make 'prioritization and intersystem real-time pre-emption' a reality." The results of this study are available from the ITU as Report M.2073 (*Feasibility and practicality of prioritization and real-time pre-emptive access between different networks of mobile-satellite service in the bands 1 525–1 559 MHz and 1 626.5–1 660.5 MHz*).

The study noted that although some mobile-satellite networks currently provide *intra*-system pre-emptive access functions, there are no actual MSS systems providing "prioritization and *inter*system real-time pre-emption" functions, and

despite several years of study there are no methods yet developed.

The study further summarized that "prioritization and intersystem real-time pre-emption" would not necessarily increase the efficiency of spectrum use compared to the current situation, but it would certainly complicate substantially the coordination process and network structure. Furthermore, it may not satisfy the operational and commercial requirements of AMS(R)S communications.

It was concluded that "prioritization and intersystem real-time pre-emption is not practical and, without significant advance in technology, is unlikely to be feasible for technical, operational and economical reasons."

Noting that the conclusions in ITU Report M.2073 identify that intersystem real-time pre-emption will not be effective to ensure spectrum availability and protection for AMS(R)S communications, WRC-12 was urged to provide appropriate regulatory provisions to ensure long-term and stable spectrum availability for AMS(R)S.

At WRC-12 the issue of recognized access for AMS(R)S systems to the frequency bands 1 525–1 559 MHz and 1 626.5–1 660.5 MHz was debated. As a result of that debate, it was agreed that the process for ensuring the enforcement of the priority access given by RR No. **5.357A** should be strengthened in a manner that also increased transparency within the process.

ITU-R Resolution 222 **(Rev. WRC-23)** was modified as follows:

- to place an obligation on administrations to ensure that their MSS operators who are not carrying AMS(R)S traffic yield capacity when a requirement for AMS(R)S traffic cannot be met otherwise;

- invite ICAO, where appropriate, to comment on the AMS(R)S traffic requirements;

- add an annex that details the procedure for the implementation of RR No. **5.357A**;

- ensure that an agreed methodology be used for the translation of traffic requirements into spectrum requirements;

- require notifying administrations to inform the ITU Bureau of the results with respect to AMS(R)S requirements of any coordination meeting;

- formalize dispute resolution meetings.

WRC-12, noting that there was not an agreed methodology for the translation of traffic requirements into spectrum requirements, also called for, through ITU-R Resolution 422, the development of such a methodology.

**Band:** 1 559–1 626.5 MHz
**Service:** Aeronautical radionavigation/
radionavigation-satellite (GNSS); AMS(R)S
**Allocation:**

| **MHz**<br>**1 559–1 613.8**<br><br>Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **1 559–1 610**<br>AERONAUTICAL RADIONAVIGATION<br>RADIONAVIGATION-SATELLITE (space-to-Earth) (space-to-space) 5.208B 5.328B 5.329A<br>5.341 | | |
| **1 610–1 610.6**<br>MOBILE-SATELLITE (Earth-to-space) 5.351A<br>AERONAUTICAL RADIONAVIGATION<br>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**<br>MOBILE-SATELLITE (Earth-to-space) 5.351A<br>AERONAUTICAL RADIONAVIGATION<br>RADIODETERMINATION-SATELLITE (Earth-to-space)<br>5.341 5.364 5.366 5.367 5.368 5.370 5.372 | **1 610–1 610.6**<br>MOBILE-SATELLITE (Earth-to-space) 5.351A<br>AERONAUTICAL RADIONAVIGATION<br>Radiodetermination-satellite (Earth-to-space)<br>5.341 5.355 5.359 5.364 5.366 5.367 5.368 5.369 5.372 |
| **1 610.6–1 613.8**<br>MOBILE-SATELLITE (Earth-to-space) 5.351A<br>RADIO ASTRONOMY<br>AERONAUTICAL RADIONAVIGATION | **1 610.6–1 613.8**<br>MOBILE-SATELLITE (Earth-to-space) 5.351A<br>RADIO ASTRONOMY<br>AERONAUTICAL RADIONAVIGATION<br>RADIODETERMINATION-SATELLITE | **1 610.6–1 613.8**<br>MOBILE-SATELLITE (Earth-to-space) 5.351A<br>RADIO ASTRONOMY<br>AERONAUTICAL RADIONAVIGATION<br>Radiodetermination-satellite |

| | | |
|---|---|---|
| 5.149 5.341 5.355 5.359 5.364 5.366 5.367 5.368 5.369 5.371 5.372 | (Earth-to-space) 5.149 5.341 5.364 5.366 5.367 5.368 5.370 5.372 | (Earth-to-space) 5.149 5.341 5.355 5.359 5.364 5.366 5.367 5.368 5.369 5.372 |
| **MHz 1 613.8–1 626.5** | | |
| Allocation to Services | | |
| Region 1 | Region 2 | Region 3 |
| **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) | **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) | **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)<br><br>5.208B 5.341 5.355 5.359 5.364 5.365 5.366 5.367 5.368 5.369 5.371 5.372 | Mobile-satellite (space-to-Earth) except maritime mobile satellite (space-to-Earth)<br><br>5.208B 5.341 5.364 5.365 5.366 5.367 5.368 5.370 5.372 | except maritime mobile satellite (space-to-Earth) Radiodetermination-satellite (Earth-to-space) 5.369<br><br>5.208B 5.341 5.355 5.359 5.364 5.365 5.366 5.367 5.368 5.372 |

**Footnotes:**

**5.149** In making assignments to stations of other services to which the bands: ... 1 610.6–1 613.8 MHz, ... 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)

**5.208B** In the frequency bands … 1 525–1 610 MHz … Resolution **739 (Rev. WRC-19)** applies. (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)

* *Note by the Secretariat:* This Resolution was revised by 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)

**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.

**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)

**5.355** *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)

**5.359** *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)

**5.364** 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 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 bands 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)

**ICAO POLICY**

- No change to the allocation to the radionavigation-satellite service in the band 1 559–1 610 MHz.
- 1 559–1 610 MHz: No change to the use of this band for future GNSS elements, including GLONASS and GPS which must be protected.
- No new allocations to be made in the band 1 559–1 610 MHz.
- No change to RR Nos. **5.364**, **5.365**, **5.366**, **5.367** and **5.368**.

- Delete RR No. **5.371**.

The band 1 559–1 610 MHz is used by GNSS satellite systems as well as by GNSS satellite augmentation systems and is intensively used for aeronautical radionavigation applications. GNSS already plays a vital role in RNAV operations, ADS-B surveillance and the GBAS landing system (GLS). This band is used by GPS, GLONASS, Beidou, Galileo and the SBAS.

The band 1 559–1 610 MHz is however subject to intentional interference (GNSS jammers) and unintentional interference (potentially caused by an inadequate regulatory framework and improper implementation of systems such as pseudolites and GNSS repeaters). In addition, a proposed use of terrestrial cellular mobile systems in the (adjacent) band 1 525–1 559 MHz in a few countries is expected to cause harmful interference to some GNSS receivers. Protection of GNSS signals is of paramount importance given the variety of GNSS applications for aeronautical navigation and surveillance.

The frequency band 1 610–1 626.5 MHz is used by IRIDIUM which is a standardized aeronautical mobile-satellite (R) system.

**AVIATION USE:** The bands between 1 559 MHz and 1 626.5 MHz are allocated to the aeronautical radionavigation service and the frequency band 1 559–1 610 MHz is allocated to the radionavigation-satellite service. At WARC-92, the allocation to the mobile-satellite service (Earth-to-space) in the band 1 610–1 626.5 MHz was introduced and currently provides the service link (to the mobile stations) for the Globalstar and the IRIDIUM mobile-satellite systems. The prime civil aviation interest is in the band 1 559–1 610 MHz which supports the main frequency components of the GPS, GLONASS, Beidou and Galileo radionavigation-satellite systems. In addition, in the frequency band 1 610–1 626.5 MHz IRIDIUM is providing aeronautical mobile (R) satellite communications in compliance with the relevant ICAO SARPs. The allocations of the band 1 610–1 626.5 MHz to the aeronautical radionavigation services and the radiodetermination satellite services are not supporting any civil aeronautical requirement. The satellites for Globalstar and IRIDIUM operate in a non-geostationary orbit.

**Band 1 559–1 610 MHz:** The radionavigation-satellite (space-to-Earth) allocation of 51 MHz is the main allocation available for GNSS. Other bands identified to support this main component and provide a more robust system with the possibility of compensation for ionospheric delay are at 1 164–1 215 MHz and planned for use by all radionavigation-satellite systems. GNSS provides the basis for many modern

civil aviation radionavigation requirements. Present use of the band includes the standard positioning service of the GPS system as well as GLONASS, Galileo and Beidou.

SARPs for the Galileo and Beidou systems operating in this band and in the 1 164–1 215 MHz were developed by the Navigation Systems Panel (NSP) and became applicable as of November 2023.

**Band 1 610–1 626.5 MHz:** The IRIDIUM non-geostationary satellite system provides AMS(R)S in this band in accordance with RR No. **5.367**. The IRIDIUM system provides for AM(R)S communications in accordance with the relevant SARPs as contained in Annex 10, Volume III, Chapter 4. Information on the IRIDIUM system and its compliance with ICAO SARPs is contained in the ICAO *Manual on the Aeronautical Mobile Satellite (Route) Service* (Doc 9925).

This frequency band has also been identified for use by Remotely Piloted Aircraft Systems C2 Links (refer to Annex 10, Volume V, Chapter 5.1).

**COMMENTARY:**

**Band 1 610–1 626.5 MHz.** The allocation to the mobile-satellite service in this band is used by the Globalstar and the IRIDIUM mobile-satellite communication systems. The allocation to the mobile-satellite service is primary in the Earth-to-space direction and secondary in the space-to-Earth direction. However, RR No. **5.367** allocates the frequency band 1 610–1 626.5 MHz to the aeronautical mobile-satellite (R) service on a primary basis in both the Earth-to-space and space-to-Earth directions. IRIDIUM uses this allocation to provide service links for the aeronautical mobile (R) communications. The allocations in this frequency band to the aeronautical radionavigation service and the radiodetermination service do not support requirements for international civil aviation.

Among MSS systems operating in the 1 610-1 626.5 band, the Globalstar and IRIDIUM non-GSO MSS systems provide a near global and global voice and data services for all classes of users and devices, including personal handset users. The Earth-to-space direction for a mobile-satellite service is the path between the mobile transmitting terminals, and the satellite. There is a potential for interference to aeronautical GNSS receivers by hand-held devices operating in the Earth-to-space direction, particularly from unwanted emissions in the GNSS band and fundamental emissions from mobile terminals in airplanes and the vicinity of airplanes GNSS antennas.ITU-R Recommendation M.1343 provides for maximum limits of unwanted emissions from these terminals into the GNSS band (see commentary for that band below). However, the latest version of ITU-R Recommendation M.1343 is dated of 2005, and new hand-held device use scenarios (e.g, on-board use by passengers, use in terminals close to aircraft gate) have arisen which were not studied as part of the ITU-R Recommendation M.1343 development.

RR No. **5.367** provides for an additional allocation to the AMS(R)S in the band 1 610–1 626.5 MHz subject to RR No. **9.21**, which requires agreement with other administrations before a registration in the MIFR can be made. Incomplete notification of AMS(R)S assignments to the MIFR prior to agreement results in the condition of non-protection/non-interference basis under RR No 11.31.1 with the States with which the required agreement has not been obtained.
As a consequence, notifying administrations of AMS(R)S in this band are urged to seek agreement under RR No 9.21 as requested by RR No 5.367. The allocation to the AMS(R)S is on a primary basis in both directions of transmission. IRIDIUM, which operates in this band, has been validated to conform to the ICAO AMS(R)S SARPs.

RR **No.5.355** provides for an additional secondary allocation to the fixed service in a number of Middle Eastern and African countries.

RR **No. 5.359** provides for an additional primary allocation to the fixed service in some Region 1 countries with the proviso that, "*Administrations are urged to make all practicable efforts to avoid the implementation of new fixed-service stations in these frequency bands.*"

The use of the band 1 610.6–1 613.8 MHz for aeronautical purposes is constrained by sharing with the radio astronomy allocation, which has primary status. RR No. **5.149** limits airborne use of this portion of the band. In practical terms, the band is of limited use for aviation services, in particular for aviation systems and services of international standard status.

RR No. **5.366** reserving the band 1 610–1 626.5 MHz for aeronautical purposes needs to be maintained.

The primary allocation to the radiodetermination-satellite service in Region 2, and in Region 1 under RR No. **5.371** and, on a secondary basis in Region 3, was made to accommodate a position-fixing service for general use, which was originally proposed for use by aviation. This service is only implemented to a limited extent and has never been recognized internationally as an approved service for aviation purposes. RR No. **5.364** requires coordination of this service with the MSS. This system is not being used by international civil aviation.

**Band 1 559–1 610 MHz.** This band is the main allocation base for RNSS available for general use. (There are other RNSS systems which operate in other bands only for special purposes or for national defence purposes.) These systems (GPS, GLONASS, Beidou and Galileo) share the band in a complex sharing arrangement which is agreed by the respective service providers. Typically, RNSS requires 20–30 MHz or so of spectrum depending on the system's chipping rate and the accuracy requirement. Signal levels at the Earth's surface tend to be low, demanding an interference-free environment. To combat the effects of ionospheric delay and to provide a system with increased immunity to interference, another GNSS component, for civil use, in the frequency band 1 164–1 215 MHz has been accommodated. (See commentary for the DME band at 960–1 215 MHz.)

WRC-2000 added a (space-to-space) service to the (space-to-Earth) allocation to RNSS on a "no constraint to existing services" basis (see RR No. **5.329A**). This use is for the many operators of space services of all kinds who utilize the GPS system as a source of accurate timing or for position fixing of the satellites. This regularizes a practice which has existed for many years but gives the service no rights over the main class of GNSS user and other allocations.

***Global navigation satellite system (GNSS)***

GNSS was identified by the FANS Committee as a replacement for many of the existing terrestrial systems and is a main component of the CNS/ATM concept. The

specifications for the ICAO GNSS presently recognize the GPS and GLONASS systems, and their augmentations. The required characteristics for GNSS are incorporated in SARPs. This forms the basis for satellite navigation as envisaged in the CNS/ATM concept and provides service for both en route and airport approach and landing. SARPs and guidance material for GNSS are included in Annex 10, Volume I, Chapters 2 and 3 and its relevant Attachment, and in the the *Global Navigation Satellite System (GNSS) Manual* (Doc 9849).

***Protection of GNSS signals from harmful interference***

The protection of GNSS signals from harmful interference is of major concern to aviation. GNSS signal levels at the aircraft receiver are of very low level (in the order of –160 dBW) and, despite receiver signal processing having high interference rejection properties, the system is vulnerable to other in-band signals and to spurious signals from non-aviation systems operating in adjacent bands. High power continuous signals in adjacent frequency bands also may cause GNSS receiver overload, impacting reception of desired GNSS signals. Additionally, the GNSS antenna placement on the aircraft and how its signal interfaces with other on-board radio systems require extreme care and careful design to ensure that the system can deliver the required performance on a continuous basis. The characteristics and protection of GNSS are addressed in a number of ITU-R Recommendations (see ITU-R Recommendation M.1903 and Attachment G) and specific studies have been made of the compatibility of GNSS with other systems to determine whether sharing is safe. In respect of the total radio environment in which GPS must operate, the aggregate sum of all interferences is of major importance. For this reason, aviation has pressed for the inclusion of a safety margin factor in all assessments for individual interfering systems. ICAO policy supports a factor of 6 to 10 dB for this feature. General details of some of the interference scenarios already identified are given below:

*Hand-held devices in the band 1 610–1 626.5 MHz*
*and mobile terminals in the band 1 626.5–1 660.5 MHz*

Problems with high levels of spurious emissions from hand-held mobile-satellite devices operating in the band 1 610–1 626.5 MHz have appeared and are the subject of European Telecommunication Standards Institute (ETSI) European Standards and ITU-R Recommendations. This work resulted in the approval of ITU-R Recommendation M.1343 and the adoption of Standards by ETSI, both of which recognize the ICAO requirements on the level of protection to be given to GNSS. Further work on the protection of the band 1 559–1 610 MHz from spurious emissions from mobile Earth stations operating in the band 1 626.5–1 660.5 MHz has been completed and resulted in ITU-R Recommendation M.1480.

*Proposal for an allocation to MSS in band 1 559–1 567 MHz*

A proposal to WRC-97 to allocate the frequency band between 1 559 MHz and 1 567 MHz to the mobile-satellite service in the space-to-Earth direction, strongly opposed by aviation interests, was eventually not adopted by that conference. The proposal was referred through Resolution **220 (WRC-23)** to the ITU-R for further study. The results of this study indicating that sharing is not feasible were included in the CPM Report to WRC-2000. WRC-2000 accepted these results, and Resolutions **226** and **227** of that conference, which address the question of additional spectrum for mobile-satellite services in the bands between 1 GHz and 3 GHz, specifically exclude the band 1 559–1 610 MHz from the study. Resolutions **220**, **226** and **227** have since been abrogated.

*Potential interference from ultra-wide-band (UWB) devices*

Recent technological advances have resulted in the development of devices used in radar and communications applications. These emitters known as ultra-wide-band (UWB) devices utilize very narrow pulses, typically less than 1 nanosecond, and radiate over very wide bandwidths, typically several gigahertz. Devices used in radar applications have many commercial and government uses, such as radar imaging through walls.

Developers of UWB devices anticipate extensive marketability due to the varied use and capabilities of these low power transmitter devices. Manufacturers of these devices are currently seeking approval to operate UWB systems on an unlicensed basis. Considering UWB device output power is low enough to operate unlicensed, their very wide bandwidth emissions would be present within restricted bands. Many of the restricted bands subject to UWB emissions include aeronautical bands reserved for safety-of-life services and, in particular, the 1 559–1 610 MHz band used by GNSS. The aggregate emission levels of UWB devices could interfere with many aeronautical systems; however, at this early stage of beginning to understand the potential degradation of aviation safety services, it is believed that GNSS receivers may be more vulnerable to interference from UWB devices. It must be realized, however, that many other aeronautical services are potentially at risk of interference from UWB devices.

In regard to growing concern with development of UWB devices which could operate as unlicensed applications causing harmful interference to aeronautical safety-of-life services, ICAO submitted a preliminary draft new question to the ITU-R Study Group 8 at its meeting in October 2000. Parallel to the concerns raised by ICAO, State regulatory and telecommunications authorities have undertaken active study and analysis of UWB emission characteristics and the potential effects on a variety of aeronautical services. Reports on the results of these ongoing activities by State authorities are currently available.

Four ITU-R Recommendations (ITU-R SM.1754, 1755, 1756 and 1757) and one ITU-R report on the impact of UWB technology on radiocommunication services have been developed. The comprehensive results may also be taken into consideration by ITU-R Study Group 5 to further advance necessary action to ensure protection of safety-of-life services.

Considering especially the mobility of aircraft and the large "viewing" area to which aircraft are exposed, together with the variability and uncertainty of a significant number of factors (such as UWB emitter density, signal characteristics and activity factors) necessary for the interference analysis of devices using UWB technology with systems operating within safety services, UWB devices should in general not be operated in frequency bands allocated to safety services. In those cases where such use cannot be avoided, administrations should take all steps necessary to ensure that UWB devices do not cause harmful interference to the reception by stations operating under a safety service allocation. The level of harmful interference to safety systems needs to be determined on a case-by-case basis in the form of a safety analysis. This analysis would assess the use being made of the safety system and demonstrate that the required levels of integrity, reliability and availability are still maintained under all operational conditions. Factors such as the impact on safety service link budget margins and measures to preclude interference from UWB devices that malfunction need to be considered.

It is recommended that State aviation representatives continue to actively participate in the ITU-R Study Group activities and provide knowledge of the potential impact to aeronautical services through liaison with their respective ITU administrations.

*Potential interference from IMT unwanted emissions*

By the decisions of WRC-12 and WRC-15, the frequency bands 694–790 MHz, 790–862 MHz and 1 427–1 518 MHz were identified for international mobile telecommunication (IMT) on a global or regional basis. Also, in several countries the band 470–694 MHz was identified for IMT in accordance with relevant footnotes of the Radio Regulations.

There are global navigation satellite systems operating in frequency bands below 3 GHz which have allocations for RNSS. Frequency bands identified for IMT do not overlap by their main emission with GNSS frequency bands. However, IMT can impact on frequency bands of global navigation systems (1 559–1 610 MHz) by unwanted emissions including out-of-band and spurious emissions. In the GNSS frequency band 1 559–1 610 MHz, impact of the second harmonic of IMT stations that use frequency bands 694–790 MHz and 790–862 MHz is possible, as well as impact of spurious emissions from IMT stations that operate in the frequency band 1 427–1 518 MHz.

Current results of theoretical and experimental estimations indicate that the levels of unwanted emissions of IMT stations that are defined in ITU-R Recommendations M.2070 and M.2071 are not low enough to provide required protection level for RNSS receiving earth stations that operate in 1 559–1 610 MHz. Required separation distances are from 42 m to 2 446 m depending on the type of RNSS receiver, which makes impossible simultaneous application of these devices in one local spot without additional compatibility measures.

**Band:** 2 700–3 300 MHz
**Service:** Aeronautical radionavigation/radionavigation/ radiolocation (primary surveillance radar)
**Allocation:**

| **MHz**<br>**2 700–3 300**<br>Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **2 700–2 900** | AERONAUTICAL RADIONAVIGATION 5.337<br>Radiolocation<br>5.423 5.424 | |
| **2 900–3 100** | RADIOLOCATION 5.424A<br>RADIONAVIGATION 5.426<br>5.425 5.427 | |
| **3 100–3 300** | RADIOLOCATION<br>Earth exploration-satellite (active)<br>Space research (active)<br>5.149 5.428 | |

**Footnotes:**

**5.149** In making assignments to stations of other services to which the bands: ... 3 260–3 267 MHz ... 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).

**5.337** 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.

**5.423** 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)

**ICAO POLICY**

- No change to the frequency allocations to the aeronautical radionavigation service in these bands.
- No change to RR Nos. **5.423**, **5.424A**, **5.426** and **5.427**.
- Oppose any in-band or near-band allocation that would endanger the operation of radar services.
- Given the pressure on the use of this frequency band from non-aeronautical sources and in support of the ICAO overall policy statement:
  a) insist that any sharing studies carried out encompass the total technical and operational aspects of radar use, including possible impact on the safety case; and
  b) oppose any proposal that places undue or unreasonable economic penalty on radar systems presently in use.

The band 2 700–2 900 MHz, and to a lesser extent the band 2 900–3 300 MHz, is heavily used for primary surveillance radar (PSR) mainly providing medium range (to about 60 NM) independent non-cooperative surveillance. These radars typically provide surveillance in terminal and approach areas around major airports.

The band 2 700–2 900 MHz is also used for meteorological radar. This use is expected, on a global basis, for the foreseeable future.

Radar stations are subject to interference from out-of-band and fundamental emissions from cellular mobile systems operating in the band below 2 690 MHz. This interference can be mitigated in principle by improving RF selectivity in the radar stations and by reducing the mobile-system emissions that fall into the radar pass-band.

Another area of interference is by the use of the band 2 700–2 900 MHz for digital cordless cameras to support electronic news gathering (ENG). In Europe, such use is permitted by some administrations on the basis of CEPT/ECC Recommendation (02)09 and ECC Report 6. Digital cordless camera operation on a frequency within about ±10 MHz of the nominal frequency of the radar station can cause harmful interference to that PSR up to distances of about 250 NM. Such use may become globally harmonized. ECC Report 6 is based on an out-of-date version of ITU-R Recommendation M.1464 and should be revised to take into account proper protection of radar stations.

The use of this band by aviation may also become subject to “spectrum pricing”. (See also Chapter 8.)

**AVIATION USE:** These bands are extensively used for PSR (10 cm) for medium-range, en route surveillance, and for terminal area and approach monitoring. The bands are also used by other radionavigation services (particularly maritime) and radiolocation as well as radars for national purposes on a shared basis. Airborne use is prohibited under the RR Nos. **5.337** and **5.426**. Civil aviation radars tend to be concentrated in the band 2 700–2 900 MHz, although the use of the band 2 900–3 400 MHz is increasing. The major users in the band 2 900–3 400 MHz are radionavigation radars for maritime purposes and radiolocation radars for national defence purposes.

Some countries are reviewing the long-term requirement for PSR. Until about the mid-1970s, PSR was the prime surveillance technology for air traffic management to support ATC. During the 1970s and the 1980s, ATC (SSR) transponders became increasingly important in supporting both ATC and the airborne collision avoidance system (ACAS). In the 1990s, some countries adopted the use of only SSR (no PSR) for en route flights, but retained PSR in terminal areas to detect potential violations

of controlled airspace and to detect aircraft with faulty SSR transponders. However, in the future, some have suggested using SSR and ADS-B only in busy terminal areas. The cost of providing PSR may be high but can be considered the extra premium that needs to be paid in order to secure the required level of surveillance in the interest of safety and security. However, the consequences of undetected violation of controlled airspace could be catastrophic.

Ten-centimetre radar technologies and practices date from the 1940s and modern versions employ the latest radar techniques for plot extraction and display on formatted synthetic displays. Frequency diversity and pulse compression techniques are used to extract weak echoes from interference and to improve range resolution. Multiple frequency operation, commonly using two to four frequencies separated by 60–100 MHz, is necessary and requires careful frequency planning and separation of stations. More stable solid state transmitter frequency control is leading to a more effective use of spectrum than older magnetron systems, although the latter systems still have many years of useful life.

**COMMENTARY:** The *Report of the Communications/Meteorology/Operations Divisional Meeting (1990)* indicated considerable use of the band 2 700–2 900 MHz for surveillance purposes worldwide. Table 1 indicated over 1 200 radars reported in response to an ICAO survey. Some use by meteorological radar was also reported.

While it is possible that SSR, GNSS and ADS will take over some of the functions of en route surveillance, it is premature to derive a timescale for a reduction in the number of radars or the use of these bands. Airport use is likely to remain for many years.

S-band marine (shipborne) radar is concentrated at 3 050 ±30 MHz.

***Proposals for other allocations in the band 2 700–2 900 MHz***

To locate spectrum for the new global terrestrial/satellite multi-purpose communications service, radio regulators and mobile systems providers have focused on these radar bands to determine possible sharing with, or release of, spectrum allocated for use by aeronautical radar systems. At the outset, sharing does not seem possible since there appears to be a high probability of intolerable interference to both services. For example, strobing on radar displays and high-power pulse interference to mobile receivers are considered as highly probable, and unacceptable, risks. An additional problem is that the terrestrial broadband spectrum requirements appear to be for overflow purposes in high demand urban areas, which is the same location requirement as that for airport radar.

The precise use of the band 2 700–2 900 MHz was initially reviewed by ITU-R WP8B in 1999. Early research indicates that air traffic radars tend to be concentrated in the 2 700–2 900 MHz band, but this is not yet considered a conclusive result. Any suggestion of compressing the band into a smaller spectrum segment must be carefully examined to determine whether there is sufficient capacity and what are the economics of such spectrum re-farming.

Any decision on changes to the allocations in these bands, whether by reduction or by sharing, can only be taken after a full examination of current and future use. Present indications are that these radars will continue for the long term, and their numbers may increase as airport congestion becomes an even greater problem than it is now. Most use of 10 cm radars is at airports, and these are installed following a national decision to provide an independent surveillance support to the air traffic services at the airport. Increase in airport movements and congestion on runways at many major airports necessitates the provision of more effective monitoring of the airspace. Primary surveillance radar has the benefit that it does not require the carriage of equipment in the aircraft and it ensures comprehensive monitoring of all aircraft in the airspace.

Intensive studies are continuing in Europe to establish the possibility of an allocation to non-aeronautical users in this band. These studies include co-frequency and off-frequency sharing, and the efficient use of the band by radars. All sharing with mobile users is viewed with extreme concern due to the difficulty of tracing sources of interference, as well as the roaming and largely uncontrolled character of mobile use.

The firm ICAO policy is to insist on a full and comprehensive study programme, including not only the technical parameters for a compatible and safe operation of radar, but also the operational and financial implications of sharing frequencies with a use – such as that by mobile users – which is not amenable to effective control.

**ITU-R studies**

An intensive study has been carried out by ITU-R to document the characteristics and protection requirements of radars operating in these bands. It is difficult to carry out a comprehensive review of this kind because of the confidential nature of those systems used for national defence. Furthermore, ITU-R work has concentrated on PPI-type display radars, often used in maritime operations, and less work has been carried out on the modern plot extracted type systems now in extensive use in civil aviation.

Results indicate that co-frequency sharing is not practicable or feasible, requiring too large a geographic separation between radar stations and other users. Refinement and extrapolation to define the separation required at offset frequencies is expected to continue. Agreements on propagation models and protection ratios also require study and documentation.

At WRC-12 and WRC-15, one of the agenda items sought to identify additional spectrum that could be allocated to International Mobile Telecommunications/ mobile broadband. The frequency band 2 700–2 900 MHz was specifically mentioned as a band of interest.

A number of studies were conducted and all of those studies indicated that co-frequency operation would not be feasible between the mobile service and radar stations in the frequency band 2 700–2 900 MHz. These studies also indicated that adjacent-frequency sharing may require additional filtering, removal of radars from certain frequencies, or implementation of frequency guardbands and geographic separations.

**Band:** 4 200–4 400 MHz
**Service:** Aeronautical radionavigation (radio altimeter)
**Allocation:**

| **MHz**<br>**4 200–4 400** | | |
|---|---|---|
| Allocation to Services | | |
| Region 1 | Region 2 | Region 3 |
| **4 200–4 400** | AERONAUTICAL MOBILE (R) 5.436<br>AERONAUTICAL RADIONAVIGATION 5.438<br>5.437 5.439 5.440 | |

**Footnotes:**

**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 (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**.

**ICAO POLICY**

- No change to the allocation to the radionavigation service in the light of the continuing requirement for radio altimeters to operate in this band and of the results of ITU-R studies indicating that the 200 MHz allocation is required to meet the stringent operational requirements for accuracy and integrity for radio altimeters.
- No change to RR No. **5.438** which could constrain the operation of radio altimeters.
- Oppose any in-band or near-band allocation that would endanger the operation of the aeronautical radionavigation service or aeronautical mobile (R) service.
- Delete RR No. **5.439**.
- No change to RR Nos. **5.436** and **5.437**.

The whole of the band 4 200–4 400 MHz is globally used for radio altimeters on board aircraft. Radio altimeters provide an essential safety-of-life function for all phases of flight, including the final stages of landing where the aircraft has to be manoeuvred into the flare position or attitude. Use of this band for radio altimeters is expected to continue for the long term. In addition, WRC-15 added an aeronautical mobile (R) service allocation limited to use for wireless avionics intra-communications (WAIC) systems.

**AVIATION USE:** The band is used extensively for airborne radio altimeters (also called radar altimeters) (see RR No. **5.438**), which have a vital task during all phases of flight, including being a prime component in automated landing for flare guidance, and as the sensor component in ground proximity warning systems. The basic function of radio altimeters is to measure the aircraft's absolute height above ground level. Considerable studies have been undertaken to identify the need for a 200 MHz-wide band for this system (see CCIR Report BL/8, Düsseldorf 1990). These studies show that the full band is required to meet the accuracy and integrity requirements of radio altimeters. As noted, these radio altimeters are operational during all phases of flight.

In addition, WRC-15 added an aeronautical mobile (R) service allocation limited to use for WAIC systems. These systems will be used in aircraft to connect safety-critical systems and sensors, enabling new functions and providing weight-reduction opportunities for fulfilling current functions.

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**Band:** 5 000–5 250 MHz
**Service:** Aeronautical radionavigation (MLS),
aeronautical mobile (R) (airport communications,
terrestrial UAS) and aeronautical mobile-satellite (R) (UAS)
**Allocation:**

| **MHz**<br>**5 000–5 250**<br><br>Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **5 000-5 010** | AERONAUTICAL MOBILE-SATELLITE (R) 5.443AA<br>AERONAUTICAL RADIONAVIGATION<br>RADIONAVIGATION-SATELLITE (Earth-to-space) | |
| **5 010-5 030** | AERONAUTICAL MOBILE-SATELLITE (R) 5.443AA<br>AERONAUTICAL RADIONAVIGATION<br>RADIONAVIGATION-SATELLITE<br>(space-to-Earth) (space-to-space)<br>5.328B 5.443B | |
| **5 030–5 091** | AERONAUTICAL MOBILE (R) 5.443C<br>AERONAUTICAL MOBILE-SATELLITE (R) 5.443D<br>AERONAUTICAL RADIONAVIGATION<br>5.444 | |
| **5 091–5 150** | FIXED-SATELLITE (Earth-to-space) 5.444A<br>AERONAUTICAL MOBILE 5.444B<br>AERONAUTICAL MOBILE-SATELLITE (R) 5.443AA<br>AERONAUTICAL RADIONAVIGATION<br>5.444 | |
| **5 150–5 250** | FIXED-SATELLITE (Earth-to-space) 5.447A<br>MOBILE except aeronautical mobile 5.446A 5.446B<br>AERONAUTICAL RADIONAVIGATION<br>5.446 5.446C 5.446D 5.447 5.447B 5.447C | |

**Footnotes:**

**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)

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

**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, 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)

**5.446** *Additional allocation*: in the countries listed in Nos. **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 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 Nos. **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**.

**ICAO POLICY**

- No change to RR Nos. **5.444, 5.444A** and **5.444B**.
- Apply the methodology contained in ITU-R Recommendation S.1342 on the coordination of microwave landing system (MLS) with fixed-satellite service (FSS) Earth stations in the band 5 091–5 150 MHz.
- Ensure that in addressing the future use of the frequency band 5 091–5 150 MHz by the FSS, current and intended future use by aeronautical systems are not adversely impacted.

Priority is given to the microwave landing system (MLS) in the band 5 030–5 091 MHz. Other applications for using this band (e.g. in the aeronautical mobile (R) service and aeronautical mobile-satellite (R) service to support unmanned aircraft; termed remotely piloted aircraft systems (RPAS) in ICAO)) are emerging.

The aeronautical mobile (R) service in the band 5 091–5 150 MHz is reserved for ICAO-standard airport surface communication systems (AeroMACS). A tuning range of 5 000–5 150 MHz for AeroMACS is being considered to support either regional or sub-regional requirements.

The band 5 000–5 030 MHz is also planned for use by the radionavigation-satellite service.

**AVIATION USE:** The band 5 000–5 250 MHz was allocated to the ARNS in 1947 in anticipation of a future MLS as a replacement for ILS, and for other radionavigation uses for which the band would be particularly suited. At that time, it was estimated that 250 MHz of spectrum was required to support an MLS, and some of the later candidate systems occupied the full 250 MHz. RR No. **5.367** was added to allow use of the band for AMS(R)S as an option which could be taken up at a later date. Following the decision by ICAO, in 1978, to adopt the time reference scanning beam MLS as the future international standard system, RR No. **5.444** was added by WARC-79 giving precedence to this system over all other uses. The scanning beam system required 60 MHz for the initial channel plan, with the possibility of needing a further 60 MHz later. As of WRC-07, the MLS only has precedence in the portion 5 030–5 091 MHz, while 5 091–5 150 MHz has also been allocated to the aeronautical mobile service, limited to AM(R)S surface applications at airports and aeronautical telemetry. See RR No. **5.444B (WRC-19)**.

Annex 10, Volume I, Chapter 3, 3.11.4.1.1, was amended to include the channelling requirement for MLS of 200 channels based on capacity studies made by the All Weather Operations Panel (AWOP). The channelling plan for 200 channels, spaced 300 kHz apart between 5 030 MHz and 5 090.7 MHz, including the pairing with DME, is at Table A in Annex 10, Volume I, Chapter 3.

One ICAO region (EUR) has prepared a regional frequency assignment and implementation plan for MLS based on possible use at airports in the region in the years ahead. In this work, it was noted that the band 5 030–5 091 MHz could only support a portion of the foreseeable regional requirements if MLS were to become the standard for all non-visual needs. The Regional Air Navigation Plans for the other ICAO regions currently lack provisions for implementation of MLS.

The longer-term requirement for aids to precision approach to support all weather operations was discussed at the Special COM/OPS/95 meeting under Agenda Item 3. Recommendation 3/4 identifies some of the options for precision approach, and Appendix C to Agenda Item 3 provides a statement of the possible MLS implementation sequence. Under Agenda Item 5 (Appendix A), a strategy for the introduction of non-visual aids was developed and incorporated in Annex 10.

Appendix B to Agenda Item 5 outlines the ICAO regional considerations for MLS, which include a progression to MLS for CAT II and III requirements if GNSS is not available at the time of the ILS replacement.

It should be noted that the total ARNS use of this band will also include systems for national requirements, civil or military, as well as those for international civil aviation purposes.

The non-aeronautical uses (for mobile services and for fixed-satellite services) of the band 5 091–5 250 MHz, allowed by RR Nos. **5.444A**, **5.446**, **5.446A**, **5.446B**, **5.447**, **5.447A**, **5.447B** and **5.447C** should also be noted.

**COMMENTARY:** This important radionavigation frequency band has, in recent years, been the subject of close attention by other ITU radio services seeking worldwide exclusive spectrum. The very long delay in implementing the new ICAO standard system (MLS), and the prospect of GNSS offering equivalent capability, have accelerated this attention and have led to new allocations to non-aeronautical radionavigation uses for the frequencies in the bands 5 150–5 250 MHz, 5 091–5 150 MHz and 5 000–5 030 MHz. These were adopted by ITU conferences in 1987, 1992, 1995, 2003 and 2007.

The band 5 000–5 150 MHz is allocated to the aeronautical mobile-satellite service on a primary basis under the provisions of RR Nos. **5.443AA** and **5.443D**. ICAO is working on developing standards to utilize the 5 030 – 5 091 MHz portion of this frequency band for AMS(R)S to support RPAS C2 Links.

At WRC-12, a new AM(R)S allocation was added in the frequency band 5 030–5 091 MHz to support terrestrial, unmanned aircraft control and non-payload communications (termed “C2 Links” in ICAO).

Since this frequency band is now allocated on a co-primary basis to both AM(R)S and AMS(R)S both of which are anticipated to support RPAS C2 Links, ICAO and other standards making organizations are coordinating to ensure that there is no need for seperation between RPAS using the different services. Additionally, ICAO is coordinating with other standards making organizations to develop a flexible band plan that can accommodate different mixes of AM(R)S and AMS(R)S usage by RPAS in different areas of the world.

A WRC-12 proposal to allocate the frequency bands 5 000–5 010 and 5 010–5 030 MHz to the AM(R)S for airport surface communication (i.e., AeroMACS) was rejected although it was demonstrated that AM(R)S and RNSS links can share these frequency bands. In order to ensure interoperability, ICAO has standardized the tuning range for AeroMACS in the ICAO SARPs to include the frequency band

5 000–5 030 MHz taking into account national/regional radio regulatory provisions for the use of this band.

An allocation to the AM(R)S in the band 5 091–5 150 MHz (MLS extension band), limited to airport surface operations was agreed at WRC-07 and updated at WRC-12. This is a shared allocation with the aeronautical radionavigation service (MLS), fixed-satellite service (FSS) and aeronautical mobile telemetry (AMT). AMT is a new allocation made during WRC-07 (see RR No. **5.444B** and Resolution **418 (Rev. WRC-19)**. The precedence that was given to MLS in this band over other uses has been removed. For the use of the band by the AM(R)S and AMT, provisions to protect the FSS (feeder link), which operates in the same band, were introduced.

The frequency band between 5 150 MHz and 5 250 MHz is shared on a joint primary basis between the ARNS, the mobile (except aeronautical mobile) and the FSS. FSS use is specifically for feeder links for NGSO mobile-satellites (see RR No. **5.447A**) in the Earth-to-space direction. In practical terms, the spectrum between 5 150 MHz and 5 250 MHz can no longer support any international standard ARNS system.

WRC-2000 approved the new RR No. **5.443A** for the RNSS in the band 5 000–5 010 MHz in the Earth-to-space direction, and RR No. **5.443B** for the RNSS in the band 5 010–5 030 MHz in the space-to-Earth direction. The latter footnote imposes power flux-density limitations on the space transmissions of the RNSS to protect MLS in the band 5 030–5 150 MHz and the radio astronomy in the band below 5 000 MHz. The addition of this RNSS allocation was not opposed by civil aviation. However, in the interest of protecting MLS, Resolution **603 (WRC-2000)** was agreed, which called for study of the necessary technical, operational and regulatory measures necessary for the protection of MLS from the spurious emissions of the RNSS. For protection of MLS from unwanted emissions from RNSS Earth stations in the 5 000–5 010 MHz band, the preferred technical measure is likely to establish a minimum separation distance between these and MLS facilities, in the same way as applies to the operation of the FSS in the 5 091–5 150 MHz band under ITU-R Rec. S.1342.

**Band:** 5 350–5 470 MHz
**Service:** Aeronautical radionavigation (airborne weather and ground mapping radar)
**Allocation:**

| **MHz 5 350–5 470** | | |
|---|---|---|
| | Allocation to Services | |
| Region 1 | Region 2 | Region 3 |
| **5 350–5 460** | EARTH EXPLORATION-SATELLITE (active) 5.448B<br>RADIOLOCATION 5.448D<br>AERONAUTICAL RADIONAVIGATION 5.449<br>SPACE RESEARCH (active) 5.448C | |
| **5 460–5 470** | EARTH EXPLORATION-SATELLITE (active)<br>RADIOLOCATION 5.448D<br>RADIONAVIGATION 5.449<br>SPACE RESEARCH (active)<br><br>5.448B | |

**Footnotes:**

**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 5 460–5 470 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.

**ICAO POLICY**

- No change to RR Nos. **5.448B**, **5.448C** and **5.448D**.
- These bands are used extensively, particularly for airborne weather radar, and are needed for the foreseeable future. No changes should be made which would restrict this aeronautical use.

The band 5 350–5 470 MHz is used for airborne weather radar. The airborne weather radar is a safety-critical instrument assisting pilots in deviating from potential hazardous weather conditions and detecting wind shear and microbursts. These uses areexpected to continue for the long term.

**AVIATION USE:** The band 5 350–5 470 MHz is used for airborne weather and ground mapping radar, which is in conformity with RR No. **5.449**.

**COMMENTARY:** Airborne weather radar equipment (a mandatory carriage item in many countries) supports the safe passage of an aircraft in the vicinity of turbulent weather conditions. It provides timely warnings of rapidly changing weather conditions as an aid to in-flight route planning. In addition, such equipment allows maintaining contact with geographic features, such as shorelines, as a supplement to navigational orientation. Annex 6, Part I, Chapter 6, 6.11, recommends that aircraft operating in areas with potentially hazardous weather conditions be equipped with airborne weather radar. The ICAO policy as agreed at the *Communications/Operations (COM/OPS) Divisional Meeting (*held in 1985*)* is to retain the allocation without changes. One of the uses of airborne weather radar is to avoid penetration of aircraft into hazardous weather.

WRC-97 added the Earth exploration service on a primary basis. At WRC-03, the Earth exploration-satellite service was also added, and the radiolocation service was upgraded to a primary service. These services can operate in this band under the express condition that they will not cause harmful interference to the (aeronautical) radionavigation service nor claim protection.

**Band:** 8 750–8 850 MHz
**Service:** Aeronautical radionavigation/radiolocation (airborne Doppler radar)
**Allocation:**

| MHz<br>8 750–8 850 | | |
|---|---|---|
| Allocation to Services | | |
| Region 1 | Region 2 | Region 3 |
| **8 750–8 850** | RADIOLOCATION<br>AERONAUTICAL RADIONAVIGATION 5.470<br>5.471 | |

**Footnotes:**

**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)

**ICAO POLICY**

- No change since the requirement is a continuing one.
- No change to RR No. **5.470**.

The band 8 750–8 850 MHz is extensively used for airborne Doppler radar and ground mapping radar. These systems are used to determine ground speed, drift and distance travelled as well as ground mapping. The use of these radar systems is expected to continue for the long term. The band 8 750–8 850 MHz is shared with the radiolocation service and the maritime radionavigation service.

**AVIATION USE:** RR No. **5.470**.

Airborne Doppler navigation systems are widely used for specialized applications such as continuous determination of ground speed and drift angle information of an aircraft with respect to the ground. The information is derived by measuring the Doppler shift of signals transmitted from the aircraft in several narrow beams pointed towards the surface, backscattered by the surface and received by the Doppler radar receiver.

**COMMENTARY:** The ICAO policy is a continuing one of no change to the allocation, as agreed at the *Communications/Operations (COM/OPS) Divisional Meeting (1985)*. Hence, the current allocation to the aeronautical radionavigation service in this band must be retained.

**Band:** 9 000 –9 200 and 9 300 –9 500 MHz
**Service:** Aeronautical radionavigation/radionavigation (precision approach radar, airborne weather radar and ground mapping radar)
**Allocation:**

| **MHz**<br>**9 000–9 500**<br><br>Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **9 000–9 200** | RADIOLOCATION<br>AERONAUTICAL RADIONAVIGATION 5.337<br>5.471 5.473A | |
| **9 200–9 300** | EARTH EXPLORATION-SATELLITE (active)<br>5.474A 5.474B 5.474C<br>RADIOLOCATION<br>MARITIME RADIONAVIGATION 5.472<br>5.473 5.474 5.474D | |
| **9 300–9 500** | EARTH EXPLORATION-SATELLITE (active)<br>RADIOLOCATION<br>RADIONAVIGATION 5.475<br>SPACE RESEARCH (active)<br>5.427 5.474 5.475A 5.475B 5.476A | |

**Footnotes:**

**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.

**5.427** 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**.

**5.471** *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)

**5.476A** 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)

**ICAO POLICY**

- Oppose any changes to the allocations that could adversely affect their use by aviation.
- No change to RR Nos. **5.337**, **5.427**, **5.473A**, **5.474**, **5.475**, **5.475A**, **5.475B** and **5.476A**.

The band 9 000–9 200 MHz is used for ground-based primary surveillance radar systems including precision approach radar (PAR) and airport surface detection equipment (ASDE). The main purpose of these systems is to provide surveillance to support precision approach to aircraft and to detect traffic at airports. This use is expected to continue to well beyond 2030. The use of the band is shared with the maritime radionavigation service and the radiolocation service.

The band 9 300–9 500 MHz is globally used for airborne weather radar and ground-based radar. This use is expected to continue to well beyond 2030. The airborne weather radar is a safety-critical instrument assisting pilots to avoid potential hazardous weather conditions and detecting wind shear and microbursts. The use of this band by the ground-based primary surveillance radar is similar to the use of the band 9 000–9 200 MHz. This band is shared with the Earth exploration-satellite service and the space research service.

**AVIATION USE:** These 3 cm radar bands are used extensively by aeronautical, maritime (land-based and shipborne) and national defence radar systems. They cater for shorter range surveillance and precision functions up to a 50 km range. In aviation, they find considerable application in precision monitoring and approach functions and in airborne weather radar (AWR) systems where their shorter wavelength is very suitable for the detection of storm clouds. One of the uses of AWR is to give warning of hazardous weather. In many countries the carriage of AWR is a mandatory requirement. AWR supports the safe passage of an aircraft in the vicinity of turbulent weather conditions. It provides timely warnings of rapidly changing weather conditions as an aid to in-flight route planning. In addition, such equipment could support maintaining contact with geographic features, such as shorelines, as a supplement to navigational orientation. This band is also used for surface detection radar. Some national uses employ transportable and mobile systems for national defence purposes.

The sharing of the bands with maritime coast and shipborne radar requires care and the application of modern technology to alleviate interaction effects. RR No. **5.475** draws attention to this sharing but does not alter the principle that both services have

equal access rights. It should be noted that AWR is categorized for aeronautical navigation, i.e. storm warning and avoidance in accordance with the definition in RR No. **1.10**, while meteorological radar for observation and recordings is in the category radiolocation (see last sentence in RR No. **5.475**).

**COMMENTARY:** The ICAO policy for these radar bands is based upon the requirement that these radars are likely to remain in service for many years into the future. Sharing with maritime radar is very manageable and practical because of the different geographical usage, and coordination between the two services is good. Sharing with other services in the areas of important operational use is not feasible.

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**Band:** 10.95–12.75 GHz

Note: 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) were identified by ITU WRC-15 for usage for command and non-payload communications of UAS (termed RPAS C2 link in ICAO), subject to being found suitable for meeting the requirements of ICAO, and completion of the requirements of Resolution **155 (Rev. WRC-19)**

**Service:** Fixed satellite service

**Allocation:**

| **GHz 10.95–12.75** | | |
|---|---|---|
| Allocation to Services | | |
| Region 1 | Region 2 | Region 3 |
| **10.95–11.2**<br>FIXED<br>FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B (Earth-to-space) 5.484<br>MOBILE except aeronautical mobile | **10.95–11.2**<br>FIXED<br>FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B<br>MOBILE except aeronautical mobile | |
| **11.2–11.45**<br>FIXED<br>FIXED-SATELLITE (space-to-Earth) 5.441 (Earth-to-space) 5.484<br>MOBILE except aeronautical mobile | **11.2–11.45**<br>FIXED<br>FIXED-SATELLITE (space-to-Earth) 5.441<br>MOBILE except aeronautical mobile | |
| **11.45–11.7**<br>FIXED<br>FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B (Earth-to-space) 5.484<br>MOBILE except aeronautical mobile | **11.45–11.7**<br>FIXED<br>FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B<br>MOBILE except aeronautical mobile | |

<table>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td rowspan="3">11.7–12.5<br>FIXED<br>MOBILE except<br>aeronautical mobile<br>BROADCASTING<br>BROADCASTING-<br>SATELLITE 5.492<br><br>5.487 5.487A</td><td>11.7–12.1<br>FIXED 5.486<br>FIXED-SATELLITE<br>(space-to-Earth)<br>5.484A 5.484B<br>5.488<br>MOBILE except<br>aeronautical mobile<br>5.485</td><td>11.7–12.2<br>FIXED<br>MOBILE except<br>aeronautical mobile<br>BROADCASTING<br>BROADCASTING-<br>SATELLITE 5.492</td></tr>
<tr><td>12.1–12.2<br>FIXED-SATELLITE<br>(space-to-Earth)<br>5.484A 5.484B<br>5.488<br>5.485 5.489</td><td>5.487 5.487A</td></tr>
<tr><td>12.2–12.7<br>FIXED<br>MOBILE except<br>aeronautical mobile<br>BROADCASTING<br>BROADCASTING-<br>SATELLITE 5.492<br><br>5.487A 5.488 5.490</td><td>12.2–12.5<br>FIXED<br>FIXED-SATELLITE<br>(space-to-Earth)<br>5.484B<br>MOBILE except<br>aeronautical mobile<br>BROADCASTING<br>5.487 5.484A</td></tr>
<tr><td>12.5–12.75<br>FIXED-SATELLITE<br>(space-to-Earth)<br>5.484A 5.484B<br>(Earth-to-space)<br><br>5.494 5.495 5.496</td><td>12.7-12.75<br>FIXED<br>FIXED-SATELLITE<br>(Earth-to-space)<br>MOBILE except<br>aeronautical mobile</td><td>12.5–12.75<br>FIXED<br>FIXED-SATELLITE<br>(space-to-Earth)<br>5.484A 5.484B<br>MOBILE except<br>aeronautical mobile<br>BROADCASTING-<br>SATELLITE 5.493</td></tr>
</table>

**Footnotes:**

**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)

**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 fixedsatellite 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.

**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.

**5.487** 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**.

**5.492** 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, Palistine*, 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)

**ICAO POLICY**

- To conduct studies within ICAO to determine if the implementation of C2 Links in this frequency band is suitable for meeting the requirements of RPAS.
- To support within the ITU-R the relevant studies of technical, operational and regulatory aspects in relation to the implementation of Resolution **155 (Rev. WRC-19).**

**Band:** 13.25–13.4 GHz
**Service:** Aeronautical radionavigation (airborne Doppler radar)
**Allocation:**

| **GHz**<br>**13.25–13.4** | | |
|---|---|---|
| Allocation to Services | | |
| Region 1 | Region 2 | Region 3 |
| **13.25–13.4** | EARTH EXPLORATION-SATELLITE (active)<br>AERONAUTICAL RADIONAVIGATION 5.497<br>SPACE RESEARCH (active)<br>5.498A 5.499 | |

**Footnotes:**

**5.497** The use of the band 13.25–13.4 GHz by the aeronautical radionavigation service is limited to Doppler navigation aids.

**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)

**ICAO POLICY**

- No change to the allocations as there is a continuing aeronautical requirement for this band.
- No change to RR No. **5.497**.

The band 13.25–13.4 GHz is extensively used for airborne Doppler radar and ground mapping radar. These systems are used to determine ground speed, drift and distance travelled as well as ground mapping. The use of these radar systems is expected to continue for the long term. The band is shared with the Earth exploration-satellite service and the space research service.

**AVIATION USE:** RR No. **5.497** limits the use to Doppler navigation aids, which will continue to be used. Airborne Doppler navigation systems are widely used for specialized applications such as continuous determination of ground speed and drift angle information of an aircraft with respect to the ground. The information is derived by measuring the Doppler shift of signals transmitted from the aircraft in several narrow beams pointed towards the surface, backscattered by the surface and received by the Doppler radar receiver.

**COMMENTARY:** The Communications Divisional Meeting (1978) and the *Communications/Operations (COM/OPS) Divisional Meeting (1985)* both confirmed the need to retain this allocation. This requirement was confirmed in 1997.

**Band:** 14.4–14.47 GHz
Note: 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) were identified by ITU WRC-15 for usage for command and non-payload communications of UAS (termed RPAS C2 link in ICAO), subject to being found suitable for meeting the requirements of ICAO, and completion of the requirements of Resolution **155 (Rev. WRC-19)**
**Service:** Fixed satellite service
**Allocation:**

| **GHz**<br>**14.4–14.47**<br><br>Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **14.4–14.47** | FIXED<br>FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.484B 5.506 5.506B<br>MOBILE except aeronautical mobile<br>Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A<br>Space research (space-to-Earth) 5.504A | |

**Footnotes:**

**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)

**5.484A** 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 fixedsatellite 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.

**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)

**5.506** 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)

**5.509A** 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)

**ICAO POLICY**

- To conduct studies within ICAO to determine if the implementation of C2 Links in this frequency band is suitable for meeting the requirements of RPAS.
- To support within the ITU-R the relevant studies of technical,

operational and regulatory aspects in relation to the implementation of Resolution **155 (Rev. WRC-19).**

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**Band:** 15.4–15.7 GHz
**Service:** Aeronautical radionavigation
(ASDE/airborne weather radar, other systems)
**Allocation:**

| **GHz**<br>**15.4–15.7**<br><br>Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **15.4–15.41** | RADIOLOCATION 5.511E 5.511F<br>AERONAUTICAL RADIONAVIGATION | |
| **15.41–15.43**<br>RADIOLOCATION<br>5.511E 5.511F<br>AERONAUTICAL<br>RADIONAVIGATION<br>Aeronautical mobile<br>(OR) 5.511G | **15.41–15.43**<br>RADIOLOCATION<br>5.511E 5.511F<br>AERONAUTICAL<br>RADIONAVIGATION | **15.41–15.43**<br>RADIOLOCATION<br>5.511E 5.511F<br>AERONAUTICAL<br>RADIONAVIGATION<br><br>5.511H |
| **15.43–15.63**<br>FIXED-SATELLITE<br>(Earth-to-space)<br>5.511A<br>RADIOLOCATION<br>5.511E 5.511F<br>AERONAUTICAL<br>RADIONAVIGATION<br>Aeronautical mobile<br>(OR) 5.511G<br><br>5.511C | **15.43–15.63**<br>FIXED-SATELLITE<br>(Earth-to-space)<br>5.511A<br>RADIOLOCATION<br>5.511E 5.511F<br>AERONAUTICAL<br>RADIONAVIGATION<br><br>5.511C | **15.43–15.63**<br>FIXED-SATELLITE<br>(Earth-to-space)<br>5.511A<br>RADIOLOCATION<br>5.511E 5.511F<br>AERONAUTICAL<br>RADIONAVIGATION<br><br>5.511C 5.511H |
| **15.63–15.7**<br>RADIOLOCATION<br>5.511E 5.511F<br>AERONAUTICAL<br>RADIONAVIGATION<br>Aeronautical mobile | **15.63–15.7**<br>RADIOLOCATION<br>5.511E 5.511F<br>AERONAUTICAL<br>RADIONAVIGATION | **15.63–15.7**<br>RADIOLOCATION<br>5.511E 5.511F<br>AERONAUTICAL<br>RADIONAVIGATION |

| | | |
|---|---|---|
| (OR) 5.511G | | 5.511H |

**Footnotes:**

**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)

**5.511C** 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)

**5.511E** 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**)**

**ICAO POLICY**

- No change to the allocation to the aeronautical radionavigation service.
- No change to RR Nos. **5.511A** and **5.511C** which would introduce further restrictions to aeronautical use of this band.

The band 15.4–15.7 GHz is used for ground-based primary surveillance radar systems including precision approach radar (PAR) and airport surface detection equipment (ASDE). The main purpose of these systems is to provide surveillance to support precision approach to aircraft and to detect traffic at airports. This use is expected to continue to well beyond 2030. The use of the band is shared with the fixed-satellite service (Earth-to-space and space-to-Earth) and the radio location service (RLS). No FSS use has been registered with the ITU within this band.

**AVIATION USE:** This 20 mm band is used for a variety of civil and military systems using conventional radionavigation and radar techniques. An important civil use of this band is for ASDE for operational control of aircraft and vehicle ground movement at airports. This is an expanding requirement, as congestion at airports spreads and ground manoeuvring areas begin to saturate. Predictions made in Europe, for example, indicate a growing problem with surface movement, already affecting a number of major hubs, with saturation having occurred at major western European airports. ASDE radar is one preferred solution, and equipment operating in this frequency band, which offers a good compromise between antenna size and propagation characteristics, is presently in use at several main international airports. Typically, in Region 2, the band 15.6–16.6 GHz is used for ASDE radar.

Another civil use is that of height and obstruction measurement using radar techniques. This use is presently limited for general application to smaller aircraft operating into secondary and temporary landing areas. A forecast expansion in this

use for specialized civil (as well as military) use has been predicted.

These civil uses are ongoing for the foreseeable future.

The band 15.5–15.7 GHz is also used for airborne weather and ground mapping radar. These systems support the safe passage of an aircraft in the vicinity of turbulent weather conditions. It provides timely warnings of rapidly changing weather conditions as an aid to in-flight route planning. In addition, such equipment could support maintaining contact with geographic features, such as shorelines, as a supplement to navigational orientation.

This band is also available for use by civil or military radionavigation systems implemented for national purposes. The band offers the possibility for compact airborne systems which are light in weight and which have small antenna dimensions. High definition radar and precision landing systems are some examples of applications.

**COMMENTARY:**

***Discussions and agreements at ITU conferences***

WRC-95 discussed and agreed upon an allocation in the band 15.4–15.7 GHz for the FSS for feeder links to NGSO mobile satellites. The decision was made without full knowledge of the use made of the band by the ARNS. To identify and resolve any compatibility problem, Resolutions **116** and **117** were adopted calling for further study. These studies were undertaken by ITU-R WP4/1 – dealing mostly with the FSS – which identified a much more extensive use of the band than had originally been envisaged at CPM-95 and WRC-95. A range of applications, covering both airborne and ground systems, for both civil and military aviation purposes was identified. Sharing criteria were developed and are now fully documented in ITU-R Recommendations S.1340 and S.1341 which also recommend a partitioning of the band into three sections, which now appear in the Table of Frequency Allocations. Primarily, this was done to give added protection to the radio astronomy service in the band below 15.4 GHz and because the bottom 300 kHz and the top 700 kHz were too restrictive to be exploited by the FSS. The FSS allocation is for both Earth-to-space and space-to-Earth directions.

WRC-97 reviewed the results of studies, adopted the partitioning of the band, and modified RR Nos. **5.511A** and **5.511D** to provide a framework of control on the FSS to protect other services. RR No. **5.511B**, which prohibited airborne use in the 15.45–15.65 GHz section, was deleted in line with the agreed ICAO policies. RR No. **5.511C** is a restriction placed on the ARNS to limit the interference to FSS Earth stations and to impose a coordination distance on the FSS for the protection of

ARNS stations.

WRC-97 also adopted Resolution **123** calling for studies of the protection required for the radio astronomy service. The Resolution was reviewed at WRC-2000 and WRC-23, which made further changes to the footnotes to make the control more effective and was subsequently deleted.

The allocation of the FSS to this band has the potential to significantly affect the flexible use by aviation systems. At WRC-95, the FSS requirement was stated as for a "small number of stations". Despite the failure of one mobile-satellite system operator (at least) to proceed with an implementation to use the band, aviation has continued to meet a determined resistance within ITU to limit the allocation to a more realistic level. A country or regional footnote would be an example of an appropriate limitation measure.

The sequence of events which has taken place in the discussions on this band is indicative of the present intense pressure to find spectrum for the new NGSO services. Towards this purpose, the normal ITU processes of "study then allocate" have been reversed. Experience shows that it is considerably more difficult to remove an unjustified allocation once agreed to at a WRC than it is to allocate one in the first place. While a moderate amount of sharing with downlink space services is technically possible in this band, as determined by the ITU-R work, constraining the present use of this band by aviation and future exploitation of the allocation by aeronautical services and systems is not a satisfactory situation.

The compatibility studies for terrestrial component are considered in possible new or modified AM(R)S allocations in the 15.4-15.5 GHz band along with 5000-5030, 5030-5091 and 5091-5150 MHz bands. Studies initially focus on existing allocations. They take into consideration links using terrestrial and/or satellite systems.

***ARNS protection and planning implications***

The ITU-R Recommendations quoted above have identified and calculated the sharing criteria necessary for the protection of all of the present ARNS systems known to use the band. These indicate, among other criteria, the need for coordination distances of between 310 km (landing and airborne radar measurement systems) and 600 km for general purpose airborne radar, referenced to the areas of operation. Coordination with the location of ground Earth stations prior to implementation is necessary to assess the potential for interference. These limitations and those of the power flux-density in the space-to-Earth direction create difficulties in terms of the siting of the FSS Earth station. Concern is expressed on the practicalities to maintain an exclusion zone around FSS stations for aircraft equipped with these systems.

The results of sharing studies (see Attachment G) to protect the aeronautical radionavigation services, which included ASDE and a radar altimeter, have been found unduly restrictive to the FSS – for example, very large dish sizes at Earth stations were necessary, and the distance separations from navigation facilities were large. The use of this band by the FSS appears to be minimal, and a worldwide allocation to the FSS is hence an inefficient deployment of scarce spectrum. Limited use in only a few countries in the future should be accommodated by a footnote. A footnote allocation is reasonable since the ITU-R Recommendation on sharing can be used as an effective criterion for coordination between countries.

In FSS terms, this band is a supplementary band for feeder link operation for possible use as a backup or spill-over from the main FSS feeder link bands at 19 and 29 GHz. Resolution **117**, recognizing (b), indicated only a small number of stations, and ITU discussions show a limited interest among FSS operators (possibly only one country in North America and one in Europe). Provided that the ARNS has a flexible use of the band, based on an agreed set of clear and safe technical sharing conditions, there is a manageable sharing situation. As a service to be shared with the ARNS, the FSS is likely to be disciplined in its operations, highly stable in its implementation and technical characteristics, and hence be preferred as a sharing partner if sharing is necessary.

***The future outlook for the band***

The considerations above are the main elements in defining the aeronautical position on this matter. The band is in intensive use and will remain so. The short wavelength of operation permits the deployment of systems on the ground with a minimum of interference planning. Likewise, airborne use is highly practical and economical. The pressures on the spectrum are such that all worldwide exclusive bands above 1 GHz are very suitable for satellite services, and existing users, such as the ARNS, will continue to be pressured to share or vacate, especially in the situation where there is a perception of less than full use. This is a highly useful band for the exploitation of compact airborne radar and radio altimeter systems for use in civil aviation and needs to be preserved for possible future implementation. The ICAO policy is based on these principles and aims to coordinate efforts to preserve future use.

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**Band:** 19.7–20.2 GHz

Note: 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) were identified by ITU WRC-15 for usage for command and non-payload communications of UAS (termed RPAS C2 link in ICAO), subject to being found suitable for meeting the requirements of ICAO, and completion of the requirements of Resolution **155 (Rev. WRC-19)**

**Service:** Fixed satellite service

**Allocation:**

| **GHz**<br>**19.7–20.2**<br><br>Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **19.7–20.1**<br>FIXED-SATELLITE<br>(space-to-Earth)<br>5.484A 5.484B<br>5.516B 5.527A<br>Mobile-satellite<br>(space-to-Earth)<br><br>5.524 | **19.7–20.1**<br>FIXED-SATELLITE<br>(space-to-Earth)<br>5.484A 5.484B<br>5.516B 5.527A<br>MOBILE-SATELLITE<br>(space-to-Earth)<br>5.524 5.525 5.526<br>5.527 5.528 5.529 | **19.7–20.1**<br>FIXED-SATELLITE<br>(space-to-Earth)<br>5.484A 5.484B<br>5.516B 5.527A<br>Mobile-satellite<br>(space-to-Earth)<br><br>5.524 |
| **20.1–20.2** | FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B 5.516B 5.527A<br>MOBILE-SATELLITE (space-to-Earth) 5.524 5.525 5.526 5.527 5.528 | |

**Footnotes:**

**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 fixedsatellite 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.

**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 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)

**5.524** *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, Palistine*, 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 (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.**

**ICAO POLICY**

- To conduct studies within ICAO to determine if the implementation of C2 links in this frequency band is suitable for meeting the requirements of RPAS.
- To support within the ITU-R the relevant studies of technical, operational and regulatory aspects in relation to the implementation of Resolution **155 (Rev. WRC-19).**

**Band:** 24.25–24.65 GHz
**Service:** Radionavigation (ASDE)
**Allocation:** (NOC)
**ICAO policy:** (NOC)

| **GHz 24.25–24.65** | | |
|---|---|---|
| Allocation to Services | | |
| Region 1 | Region 2 | Region 3 |
| **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 |
| **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 |

**Footnote:**

**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)

**5.532AA** 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)

**5.533** The inter-satellite service shall not claim protection from harmful interference from airport surface detection equipment stations of the radionavigation service.

**ICAO POLICY**

No change to the radionavigation allocations in Region 1, Region 2 and Region 3.

**AVIATION USE:** These bands are used for airport surface detection equipment (ASDE). The higher frequency provides greater target resolution. RR No. **5.533** should be noted.

**COMMENTARY:** In 1997, the need to retain this allocation was reconfirmed. The ASDE requirement assumes greater priority with increasing airport congestion.

**Band:** 29.5–30 GHz

Note: 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) were identified by ITU WRC-15 for usage for command and non-payload communications of UAS (termed RPAS C2 link in ICAO), subject to being found suitable for meeting the requirements of ICAO, and completion of the requirements of Resolution **155**. **(Rev.WRC-19)**

**Service:** Fixed satellite service

**Allocation:**

| **GHz 29.5–30** | | |
|---|---|---|
| Allocation to Services | | |
| Region 1 | Region 2 | Region 3 |
| **29.5–29.9**<br>FIXED-SATELLITE (Earth-to-space) 5.484A 5.484B 5.516B 5.527A 5.539<br>Earth exploration-satellite (Earth-to-space) 5.541<br>Mobile-satellite (Earth-to-space)<br>5.540 5.542 | **29.5–29.9**<br>FIXED-SATELLITE (Earth-to-space) 5.484A 5.484B 5.516B 5.527A 5.539<br>MOBILE-SATELLITE (Earth-to-space)<br>Earth exploration-satellite (Earth-to-space) 5.541<br>5.525 5.526 5.527 5.529 5.540 | **29.5–29.9**<br>FIXED-SATELLITE (Earth-to-space) 5.484A 5.484B 5.516B 5.527A 5.539<br>Earth exploration-satellite (Earth-to-space) 5.541<br>Mobile-satellite (Earth-to-space)<br>5.540 5.542 |
| **29.9–30** | FIXED-SATELLITE (Earth-to-space) 5.484A 5.484B 5.516B 5.527A 5.539<br>MOBILE-SATELLITE (Earth-to-space)<br>Earth exploration-satellite (Earth-to-space) 5.541<br>5.543 5.525 5.526 5.527 5.538 5.540 5.542 | |

**Footnotes:**

**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 fixedsatellite 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.

**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)

**5.525** 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 (WRC-23)**. (WRC-23)

**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**.

**5.538** *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.

**5.542** *Additional allocation: 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)(WRC-23)

**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.

**ICAO POLICY**

- To conduct studies within ICAO to determine if the implementation of C2 links in this frequency band is suitable for meeting the requirements of RPAS.
- To support within the ITU-R the relevant studies of technical, operational and regulatory aspects in relation to the implementation of Resolution **155 (Rev. WRC-19).**

**Band:** 31.8–33.4 GHz
**Service:** Radionavigation (ASDE), enhanced flight vision systems (EFVS)
**Allocation:**

| **GHz 31.8–33.4** Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **31.8–32** | FIXED 5.547A<br>RADIONAVIGATION<br>SPACE RESEARCH (deep space) (space-to-Earth)<br>5.547 5.547B 5.548 | |
| **32–32.3** | FIXED 5.547A<br>RADIONAVIGATION<br>SPACE RESEARCH (deep space) (space-to-Earth)<br>5.547 5.547C 5.548 | |
| **32.3–33** | FIXED 5.547A<br>INTER-SATELLITE<br>RADIONAVIGATION<br>5.547 5.547D 5.548 | |
| **33–33.4** | FIXED 5.547A<br>RADIONAVIGATION<br>5.547 5.547E | |

**Footnotes:**

**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 band 32.3–33 GHz, for the radionavigation service in the band 32-33 GHz, and for the space research service (deep space) in the 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)

**ICAO POLICY**

No change to the radionavigation allocations.

The band 31.8–33.4 GHz is used by aviation to support ground-based airport surface detection equipment (ASDE) radar, mainly to detect traffic at airports. The band is shared with the fixed, inter-satellite and the space research service.

The 31.8–33.4 GHz frequency range is also used by aviation for EFVS embedded radar systems. EFVS is a system composed of a forward-looking imaging sensor and a head-up display (HUD). The image from the sensor is displayed to the pilot with superposed navigation and guidance information to enhance pilots' natural

vision. EFVS allows approach and landing in degraded weather conditions even when the reported runway weather conditions do not meet the published minimums (RVR or visibility). The requirement for natural vision is replaced by a requirement for sufficient situation awareness through the system.

The band offers a good compromise between angular resolution and atmosphere penetration in bad weather conditions. The band is shared with the fixed, inter-satellite and the space research service. In accordance with ITU-R 5.547, mitigation techniques for use in reducing the potential for interference between airborne stations in the radionavigation service and stations in the fixed service in the band 31.8-33.4 GHz could be found in the Recommendation ITU-R F.1571-1.

**AVIATION USE:** Use of the band for ground movement radar detection equipment and EFVS are reported.

**COMMENTARY:** The Communications Divisional Meeting (1978) reported some use of these bands for ASDE and for airborne precision approach mapping radar. Characteristics of and protection criteria for radars operating in the radionavigation service in the frequency band 31.8-33.4 GHz are available in Recommendation ITU-R M.1466-1.

**Band:** 92–95 GHz
**Service:** Radiolocation (FOD)
**Allocation:**

| **GHz**<br>**95–100**<br><br>Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **92-94** | FIXED 5.338A<br>MOBILE<br>RADIO ASTRONOMY<br>RADIOLOCATION<br>5.149 | |
| **94-94.1** | EARTH EXPLORATION-SATELLITE (active)<br>RADIOLOCATION<br>SPACE RESEARCH (active)<br>Radio astronomy<br>5.562 5.562A | |
| **94.1-95** | FIXED<br>MOBILE<br>RADIO ASTRONOMY<br>RADIOLOCATION<br>5.149 | |

**Footnotes:**

**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-23)

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

13 360-13 410 kHz,
25 550-25 670 kHz,
37.5-38.25 MHz,
73-74.6 MHz in Regions 1 and 3,
150.05-153 MHz in Region 1,
322-328.6 MHz,
23.07-23.12 GHz,
31.2-31.3 GHz,
31.5-31.8 GHz in Regions 1 and 3,
36.43-36.5 GHz,
42.5-43.5 GHz,
48.94-49.04 GHz,

406.1-410 MHz,
608-614 MHz in Regions 1 and 3,
1 330-1 400 MHz,
1 610.6-1 613.8 MHz,
1 660-1 670 MHz,
1 718.8-1 722.2 MHz,
2 655-2 690 MHz,
3 260-3 267 MHz,
3 332-3 339 MHz,
3 345.8-3 352.5 MHz,
4 825-4 835 MHz,
4 950-4 990 MHz,
4 990-5 000 MHz,
6 650-6 675.2 MHz,
10.6-10.68 GHz,
14.47-14.5 GHz,
22.01-22.21 GHz,
22.21-22.5 GHz,
22.81-22.86 GHz,
76-86 GHz,
92-94 GHz,
94.1-100 GHz,
102-109.5 GHz,
111.8-114.25 GHz,
128.33-128.59 GHz,
129.23-129.49 GHz,
130-134 GHz,
136-148.5 GHz,
151.5-158.5 GHz,
168.59-168.93 GHz,
171.11-171.45 GHz,
172.31-172.65 GHz,
173.52-173.85 GHz,
195.75-196.15 GHz,
209-226 GHz,
241-250 GHz,
252-275 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)

**5.562** 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 explorationsatellite 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)

_ _ _ _ _ _ _ _

**Band:** 95–100 GHz
**Service:** Radionavigation (EFVS), Radiolocation (FOD)
**Allocation:**

| **GHz**<br>**95–100**<br><br>Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **95-100** | FIXED<br>MOBILE<br>RADIO ASTRONOMY<br>RADIOLOCATION<br>RADIONAVIGATION<br>RADIONAVIGATION-SATELLITE<br>5.149 5.554 | |

**Footnotes:**

**5.149** In making assignments to stations of other services to which the bands:
13 360-13 410 kHz, […], 94.1-100 GHz, […],252-275 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)

**5.554** 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)

**ICAO POLICY**

No change to the radionavigation allocations.

The band 95-100 GHz is used by aviation, under the radiolocation service, to support ground based foreign object debris (FOD) Detection systems designed to identify and remove debris from operational areas such as runways and taxiways. These

systems typically use a combination of sensors, cameras and radar to detect and locate objects that could pose a risk to aircraft. The aim of these systems is to prevent damage to aircraft engines and tires which can caused by ingesting debris during takeoff or landing.

The 95-100 GHz frequency range is also used, under the radionavigation service, by aviation for EFVS embedded radar systems. EFVS is a system composed of a forward-looking imaging sensor and a HUD. The image from the sensor is displayed to the pilot with superposed navigation and guidance information to enhance pilots' natural vision. EFVS allows approach and landing in degraded weather conditions even when the reported runway weather conditions do not meet the published minimums (RVR or visibility). The requirement for natural vision is replaced by a requirement for sufficient situation awareness through the system.

The 95-100 GHz frequency band offers a compromise between all-weather atmospheric penetration and angular resolution achievable with a small size airborne radar.

The band is also shared with the fixed, mobile, radio astronomy, radionavigation-satellite service.

**AVIATION USE:** Use of the band for EFVS and FOD Detection Systems are reported.

**COMMENTARY:** Annex 6 defines criteria for the use of automatic landing systems, including HUD or equivalent displays, EVS, synthetic vision systems (SVS) or combined vision systtems (CVS), or any combination of those systems into a hybrid system, for the safe operation of an aeroplane equipped with those systems. Information regarding automatic landing systems, HUD or equivalent displays, EVS, SVS or CVS, is contained in the Manual of All-Weather Operations (Doc 9365).

## SECTION 7-III. RADIO REGULATIONS AND OTHER ITU MATERIAL OF IMPORTANCE TO AERONAUTICAL SERVICES

### 7-III.1 GENERAL

7-III.1.1 The ITU, which is governed by its Constitution and Convention, is an important forum for aeronautical radio services, and ultimately, for the continued operation of aviation. The principal areas where the ITU organization exercises its influence are:

a) the radio frequency bands needed to sustain the radio services; these may only be obtained through agreements made at ITU World Radiocommunication Conferences (WRCs);

b) standardization of systems and equipment with other services, to the degree necessary, which are often only achievable within the technical organs of the ITU;

c) problems of radio interference;

d) important regulations relating to frequencies and procedures for distress and safety communications which also affect the maritime and land mobile services; these can only be agreed and formalized within a common international forum; and

e) provisions dealing with licensing of radio stations and personnel.

7-III.1.2 Through the exercise of its authority and competence over the full telecommunications field, the ITU provides a focus for discussion and agreement. For example, in the use of satellite navigation and communication services which usually is multinational, multi-purpose and commercial in character, the full range of representative interests may only be addressed in a common telecommunications forum such as the ITU.

7-III.1.3 The ITU Radio Regulations contain authoritative treaty provisions representing worldwide agreement on the telecommunications matters within the ITU areas of interest.

7-III.1.4 The ITU deals with all telecommunications matters, both for radio

and for line transmission purposes, and is supported by its technical agencies ITU-R and ITU-T for study and research in radio and line transmission, respectively. Their output is normally in the form of Recommendations for worldwide publication and dissemination. A small proportion of ITU-R Recommendations are validated to the same treaty status as that in the Radio Regulations through incorporation of such Recommendations in the RR by means of a linked reference.

7-III.1.5 Section 7-III-2 below highlights Regulations of special importance to aviation indicating their context and scope in relation to aeronautical use of the spectrum.

## 7-III.2 ITU CONSTITUTION AND CONVENTION

7-III.2.1 The ITU is governed by the agreements contained in its Constitution, which defines the objectives, composition and basic structure of the organization. The ITU Convention lays down the personnel procedures, working methods and other matters of a procedural character. The present Constitution and Convention were last amended at the Plenipotentiary Conference in 2010 (Guadalajara, Mexico) (PP-10). Some amendments were introduced as a consequence of extending participation of Observers and Sector Members of the ITU-R Sector to WRCs.

7-III.2.2 The need to ensure the safety of life is covered in Article 1 of the ITU Convention which states that one of the purposes of the Union is to "promote the adoption of measures for ensuring the safety of life through the cooperation of telecommunication services". Additionally, Article 40 of the ITU Constitution on the priority of telecommunications concerning safety of life states that "International telecommunication services must give absolute priority to all telecommunications concerning safety of life at sea, on land, in the air or in outer space, as well as to epidemiological telecommunications of exceptional urgency of the World Health Organization".

7-III.2.3 Of special importance is Article 50 of the Constitution, which deals with relations with other international organizations, and stipulates that "In furtherance of complete international coordination on matters affecting telecommunication, the Union shall cooperate with international organizations having related interests and activities".

7-III.2.4 The participation of ICAO in plenipotentiary conferences is regulated in Article 23 of the Convention, which states:

"...

No. 267 1 The following shall be admitted to plenipotentiary conferences:

…

No. 269 d) observers of the following organizations, agencies and entities to participate in an advisory capacity:

...

No. 269D iv) the specialized agencies of the United Nations and the International Atomic Energy Agency;

…"

7-III.2.5 The participation of ICAO in radiocommunication conferences is regulated in Article 24 of the Convention, which states:

"…

No. 276 1 The following shall be admitted to radiocommunication conferences:

...

No. 278 b) observers of organizations and agencies referred to in Nos. 269A to 269D of this Convention, to participate in an advisory capacity;

…"

7-III-2.6 The participation of ICAO in radiocommunication assemblies is regulated in Article 25 of the Convention, which states:

"…

No. 295 1 The following shall be admitted to the assembly or conference:

…

No. 297 c) observers, to participate in an advisory capacity, from:

…

No. 297bis i) the organizations and agencies referred to in Nos. 269A to 269D of this Convention;

…"

7-III.2.7 The *General Rules of Conferences, Assemblies and Meetings of the Union* state in GR 44 that "... observers that may attend conferences in accordance with the relevant provisions of the Convention, shall not be entitled to submit proposals".

7-III.2.8 The *General Rules of Conferences, Assemblies and Meetings of the Union* (GR 61) indicate that "It shall be the duty of the chairman to protect the right of each delegation to express its opinion freely and fully on the point at issue". The Annex to the Constitution defines a delegation as "The totality of the delegates ... sent by the same Member State". As a result, the right to express an opinion freely and fully is granted by the ITU solely to Member States.

7-III.2.9 The application and a peculiar interpretation of the above provisions at WRC-2000 severely restricted the ability of ICAO to express its view at WRCs. Later during that conference, the restrictions were partly lifted. Action taken by ICAO, supported by the IMO, triggered the ITU to revise the role of observers (including those observers from United Nations specialized Agencies like ICAO) at their Conferences and Meetings.

7-III.2.10 The Plenipotentiary Conference in 2002 (Marrakech, Morocco) (PP-02) considered the situation of observers in ITU conferences and meetings. Particular attention was given to the situation of observers from organizations and agencies within the United Nations system, several of which play an important role in relation to the use of the radio frequency spectrum and satellite orbits. It was recognized that the current provisions of the Constitution, Convention and General Rules support the furnishing of advice to conferences from these observers on matters within their competence. It was, however, noted that certain misunderstandings arose at WRC-2000 that resulted in a departure from the established practice of previous conferences concerning their participation. There was agreement at PP-02 that such misunderstandings must be avoided in the future.

7-III.2.11 Therefore, "the Plenipotentiary Conference decided to confirm to upcoming radiocommunication conferences that observers referred to in Nos. 259 (269A) and 262 (269D) of the Convention may submit to these conferences information documents relevant to their mandates to be noted by Member States.

These information documents will continue to be distributed to the conference as per past practice and shall be referenced for information on the relevant daily agendas. Further, observers referred to in Nos. 259 (269A) and 262 (269D) may, with the authorization of the Chairman and in accordance with the Rules of Procedures (i.e. RP 16 and 17) (GR 44), provide advice on points relevant to their mandates. The information documents and advice shall not include or be treated as proposals. The right to make proposals, either written or oral, to such conferences is clearly reserved to Member States."

7-III.2.12 PP-06 further analysed the role of observers in the ITU and agreed to various suggested modifications regarding observers to the ITU Convention and the General Rules and agreed to plenipotentiary conference Resolution 145 on the participation of observers in conferences, assemblies and meetings of the Union. The amendments consolidate the references to observers in the basic texts of the ITU and set out guidelines for the participation of different observers in various types of ITU conferences, assemblies and meetings. The resolution also incorporates the decisions of PP-02 concerning the participation of certain "observers in an advisory capacity" (including United Nations specialized agencies such as ICAO) in an advisory capacity in WRCs. The resolution stipulates, inter alia, that observers in an advisory capacity, such as ICAO:

1) are admitted to participate in plenary meetings;

2) may, if not otherwise decided by the plenary meeting, be admitted to participate in committees and their subsidiary groups;

3) are entitled to receive all documentation;

4) may submit information documents. These documents shall be clearly referenced as information documents on the appropriate meeting agendas;

5) may request the floor in these meetings in order to provide advice or information on points relevant to their mandates. Such advice shall not include or be treated as proposals;

6) are to be given the floor by the chairman after the last Member State or Sector Member on the list of speakers;

7) may be asked by the chairman during the course of a meeting to make a statement or to provide relevant information in order to assist the proceedings.

7-III.2.13 Participation of ICAO in the work of the Radiocommunication Sector (ITU-R) is primarily governed by the provisions in Article 19 of the Convention on the participation of entities and organizations other than administrations in the ITU's activities as well as by Resolution 145 on the participation of observers in conferences, assemblies and meetings of the Union as adopted by PP-06.

7-III.2.14 Article 19, subparagraph 6 (No. 236) states that "Any request from an organization referred to in Nos. 269B to 269D of this Convention to participate in the work of a Sector shall be sent to the Secretary-General, and the organization concerned shall be included in the lists referred to in No. 237 below". No. 237 indicates that "The Secretary-General shall compile and maintain lists of all entities and organizations referred to in Nos. 229 to 231 and Nos. 269B to 269D of this Convention that are authorized to participate in the work of each Sector". ICAO, as a specialized agency of the United Nations, is qualified under No. 269D to be added to this list.

7-III.2.15 Under the provisions of Articles 19, 23, 24 and 25 of the Convention and Resolution 145 of PP-06, the full participation of ICAO in the work of the ITU (plenipotentiary conferences, radiocommunication conferences and assemblies as well as sector meetings), including the submission of contributions and the full participation in the debate, is secured.

7-III.2.16 Important to note here is that the ITU-R Sector Members are admitted as observers to radiocommunication conferences on the basis of provision No. 280 contained in Article 24 of the Convention, thus identifying a different status between a Sector Member and a specialized agency of the United Nations, such as ICAO. Pursuant to Annex 3 of Resolution 145 of PP-06, ITU-R Sector Members at radiocommunication conferences are admitted to attend plenary meetings and committees, and may be asked by the chairman during the course of a meeting to provide relevant information in order to assist the proceedings or to make a statement, but shall not be authorized to participate in the debates.

## 7-III.3 RADIO REGULATIONS

7-III.3.1 The Radio Regulations are the principal ITU document (with a treaty status) for radio matters. Parts of the Radio Regulations are discussed, agreed and embodied in the Final Acts of WRCs. WRCs are now held every four years in a rolling sequence in which each conference drafts the agenda for the next, and the provisional agenda for the second sequential WRC. The agenda for a WRC is approved by the ITU Council. The Radio Regulations lay down the framework for international spectrum

management and contain the Table of Frequency Allocations, which is effectively the worldwide agreement on the deployment and conditions of use of all radio frequencies in the radio frequency spectrum. ICAO develops its material (e.g. SARPs) for radiocommunication and radionavigation systems within the framework set by the Radio Regulations. This section of the handbook reproduces Radio Regulations of particular importance to aeronautical services and presents them with background comments which highlight their context and significance.

### 7-III.3.1.1 Chapter I (Articles 1 to 3) – Terminology and technical characteristics

The three Articles in this chapter contain fundamental material addressing terminology and technical conditions relating to all of the radio services. The chapter defines the interpretations to be placed on the terms and definitions used later in the Regulations to prescribe allocations and their conditions of use. It is designed as follows:

- Article 1 contains terms and definitions;
- Article 2 deals with nomenclature; and
- Article 3 focuses on the technical characteristics of stations.

### 7-III.3.1.2 Article 1 – Terms and definitions

The terms and definitions of importance to aeronautical services are in Attachment A to this handbook. The following should be noted:

a) the hierarchical structure of radio services (see Figure 3-3) which is repeated in the definitions for stations;

b) the carefully worded definition for radionavigation, in particular the reference to “obstruction warning”. The latter is interpretable to apply to primary and secondary radar used for air traffic purposes, airborne weather radar, radio altimeters, ground proximity warning systems, etc., since they support the safe navigation of aircraft;

c) the definition for a safety service (RR 1.59) noting that a service can temporarily become such during periods when the communications fulfil the criteria of safeguarding of human life and property. All air traffic communications and radionavigation used in civil aviation fall under this classification;

d) the various definitions relating to interference (RR 1.166 to RR 1.169) noting that interference is only "harmful" when it is serious or where it endangers the functioning of a radionavigation service or other safety service;

e) the definition of public correspondence (RR 1.116) which is based on the concept of availability to the public of the service of transmission. This definition also appears in the ITU Convention. Air traffic communications do not fall within the classification of public correspondence;

f) the definition of an administration (RR 1.2) which is broad in scope covering any national entity in which the responsibility for discharging ITU obligations is vested. This definition is notable for its imprecision which constantly leads to problems in interpretation; and

g) the highly important definitions for allocation, allotment and assignment at RR 1.16, RR 1.17 and RR 1.18, together with the Table at RR 5.1 reproduced below:

| *Term* | *Frequency distribution to* |
|---|---|
| Allocation | Service |
| Allotment | Area or country |
| Assignment | Station |

The first two, "allocation" and "allotment", are for determination by an ITU conference. Article 5 contains the agreed allocations for the total spectrum. The concept of allotment is only applied in a few instances by ITU, of which Appendix 27, the HF Allotment Plan for the aeronautical mobile (R) service, is a notable example. The third, "assignment", is a matter for national administrations and results in the issue of a licence to an operator to authorize the operation or reception of a radio station.

### 7-III.3.1.3 Service merging

Recommendation 34 (Rev. WRC-12) puts forward the idea to allocate frequency bands to the most broadly defined services for consideration by administrations (*Recommends 1*) and calls on ITU-R, in conjunction with ICAO and IMO, to

undertake studies of the possibilities (*instructs the Director of the Radiocommunication Bureau and requests the ITU-R study groups 2*). In general, ICAO does not support replacing explicit aeronautical safety allocations with generic allocations.

#### 7-III.3.1.4 Access to AMS(R)S spectrum

WRC-97 agreed to convert all spectrum in the bands 1 525–1 559 MHz and 1 626.5–1 660.5 MHz into an allocation to the mobile-satellite service. These bands are now available, primarily on a first-come, first-served basis, to all space system providers and service operators, and with services available to all mobile users, land, sea or air, as commercially practicable. The sub-bands 1 545–1 555 MHz and 1 646.5–1 656.5 MHz were originally allocated to the AMS(R)S on an exclusive basis and were the key elements of the CNS/ATM system in relation to the implementation of long-distance communications for voice and data. The strong reservations of international civil aviation were not sufficient to stop this conversion process for the AMS(R)S allocations at 1 545–1 555 MHz and 1 646.5–1 656.5 MHz, and a new RR No. 5.357A was agreed which was intended to preserve a measure of assurance that sufficient frequencies for AMS(R)S needs would be available, as well as the requirement for a dynamic priority for ATC messages in a common system. In addition, WRC-97 requested ITU-R to study the feasibility of prioritization, real-time pre-emptive access and, if necessary, the interoperability between the mobile services.

This situation of generic allocations to the mobile-satellite services could have profound adverse effects on the provision and operation of satellite communications for ATC purposes in the years ahead. Apart from the practicability of non-aeronautical satellite systems to give priority to ATC satellite communications in a multi-user service, it is by no means certain whether aviation's growing needs for interference-free communications satisfying the integrity, reliability and availability requirements in Annex 10 can be met in the long term. Controlled evaluations and operational trials, with the results discussed in both ICAO and ITU-R, are necessary prerequisites to providing the short-term guarantees that are necessary. The aspect of long-term availability of sufficient frequencies is a more difficult question, which will call for new and corroborated estimates of future demand for ATC and AOC and an assessment of the available spectrum, taking into account the predicted total mobile-satellite situation at some point in the future. Aeronautical public correspondence (AAC and APC) would have access to the full mobile-satellite allocation available.

It is not probable that the allocation to the generic mobile service, as agreed at WRC-97, can be easily changed into an exclusive aeronautical allocation, and the

likelihood is that all of the spectrum in the generic mobile-satellite frequency band (33 MHz in each direction) will be rapidly implemented and shared between many non-aeronautical space system providers. A new strategy for the future is a priority subject for discussion, as is the careful monitoring and study of the practical situation as it enfolds.

### 7-III.3.1.5 Articles 2 and 3

*Article 2: Nomenclature*

This Article defines the convention for the description of frequency bands and other associated information.

*Article 3: Technical characteristics of stations*

This Article contains important guidelines which have to be observed in the engineering and design of radio stations. Of particular interest to aviation is RR 3.3 which places an obligation on services to take account of the services in adjacent bands. The full text of this Regulation is:

> 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.

Aircraft receiving equipment is vulnerable to interference over a large geographic area and the requirement placed on transmitters in this Regulation is a beneficial statement of good practice. Conversely, aircraft receivers should be designed with good interference rejection characteristics as a prior condition of seeking emission control from other radio services. Radio Regulation 3.13 has a similar message which qualifies RR 3.3 and introduces a proximity condition implying that very close operation is a special case.

**ICAO POLICY ON CHAPTER I**

- No changes should be made to the Regulations of importance to aeronautical services as identified above.
- Service merging of aeronautical radionavigation in the worldwide allocations where an ICAO standard system operates with other radiodetermination services is not practicable without prejudicing the service of the aeronautical system.
- Service merging of aeronautical mobile service allocations with other services is not possible due to the radically different operational requirements.

### 7-III.3.2 Chapter II (Articles 4 to 6) – Frequencies

#### 7-III.3.2.1 *Article 4: Assignment and use of frequencies*

This Article contains several very important provisions relating to the deployment of frequencies. The following are of special interest to aeronautical services.

**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.

The objective of this Regulation is to prevent registered assignments which are not in accordance with the Radio Regulations from causing interference to those which are in conformity. It also has the important secondary purpose of establishing rights for "non RR-conforming" registrations on a "non-interference" basis, which then establishes priority rights over those "non-interference" registrations that come later. It has a highly important conservation role in that it helps to promote and increase spectrum use. It introduces the fundamental ITU principle that individual administrations can use the spectrum in any way they wish, provided interference is not caused to services operating in conformity with the agreements in the Radio Regulations and which are registered in the Master International Frequency Register (MIFR).

**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.

This Regulation establishes a long-standing major principle in the use of frequencies and originates from maritime practices, which were created in their own right with a set of discrete aeronautical radio services before aviation was established in ITU. The previous long-standing practice of not sharing radionavigation allocations with other services, whether primary or secondary, has been discarded and frequency sharing based on technical criteria is now a common, although not desirable practice. The principle of "special measures" in this Regulation still finds application in the action to be taken when interference occurs. This, together with the other provisions dealing with harmful interference, ensures that rapid attention is given by administrations when interference to a safety service takes place. Implicit in the wording of the Regulation is the fact that radionavigation is a safety service (see RR 1.59).

**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.

**4.16** 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.

**4.22** 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.

These Regulations address the situation of distress and safety, and permit and protect the necessary communications in these circumstances. In ITU, distress and safety messages have to be given special treatment in the maritime service, which is characterized by infrequent safety and distress communications on the same channel as public correspondence. These situations are comparable to that of emergency messages in the aeronautical service. Aeronautical procedures for emergency communications, as laid down in Annex 10, Volume II, are the valid rules for civil aviation.

**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.

These Regulations are principally relevant to the transmission of public correspondence. The importance of RR 4.20 diminishes with the ITU agreement at WRC-97 to apply generic type allocations to all mobile-satellite communications.

7-III.3.2.2 *Article 5: Frequency allocations*

This Article contains the Table of Frequency Allocations and is the component of the Radio Regulations which receives the constant attention of ITU conferences. It records the agreed use of the entire useable spectrum by all defined radio services over the three ITU world regions. It is extensive (occupying well over 100 pages) and detailed.

*Note.— Section 7-II of this handbook addresses the aeronautical aspects of the Table of Frequency Allocations in detail.*

In addition to the material addressed in Section 7-II, the following two Regulations in Article 5 are important to aviation:

**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)

Recent ITU conferences have agreed to the sharing of aeronautical allocations with other services either in a situation where the added service operates on an equal primary basis with the existing aviation service, or on a non-interference basis with the aviation service. However, both services must be protected with respect to any secondary allocation in the same band. A footnote applying to the added service usually contains the conditions to be observed. For example, see the band 960–1 215 MHz where the RNSS is added to the ARNS (DME, SSR, ACAS). Radio Regulations 5.43 and 5.43A address and clarify these situations, though in certain situations, 5.43 and/or 5.43A may be exempted through a footnote (e.g. 5.328A, 5.473A, 5.475B and 5.476A). This in effect creates a new category of services that falls between the categories of primary and secondary.

7-III.3.2.3 *Article 6: Special agreements*

Article 6 dealing with special agreements is of interest to aviation since some of the conditions on special agreements may be applied, in particular circumstances, to the agreements on frequency use coordinated within ICAO (see, for example, Nos. 6.2 and 6.3).

**ICAO POLICY ON CHAPTER II**

- Article 4: maintain these Regulations, particularly RR 4.10, without any change in substance.
- Article 5: see Section 7-II of this handbook.
- Article 6: maintain these Regulations without change.

### 7-III.3.3 Chapter III (Articles 7 to 14) – Coordination, notification and recording of frequency assignments and Plan modifications

7-III.3.3.1 The long-standing ITU procedure of introducing registration of frequency assignment in a central document (Master International Frequency Register (MIFR)), so as to obtain prior rights for protection against other registrations being introduced at a later time (see RR 8.3), is embodied in the terms and conditions laid down in this chapter. It may be noted that registration, which is not an absolute requirement, has as its main purpose the establishment of protection rights by countries for their assignments and is exercised at the discretion of each ITU member administration. These rights are dependent on a number of important conditions of which conformity with all of the requirements of the Regulations is the prime factor. Non-conformity provides no protection (RR 8.5) except, perhaps, against another non-conforming registration which appears later.

7-III.3.3.2 With the notable exception of high frequency (HF), non-directional radio beacon (NDB) and satellite communication (SATCOM), assignments to aeronautical services, in exclusive aeronautical bands, are normally coordinated within ICAO and entered in a register maintained under aviation auspices. This process may be considered to amount to a de facto form of compliance with the terms of Chapter III, although the consultation is wholly within aviation and technically does not meet the full ITU registration process requirement. HF assignments allotted to major world air route areas (MWARA), regional and domestic air route areas (RDARA) and worldwide use are obtained from Appendix 27 and are, as well as NDB assignments, normally registered in the MIFR.

7-III.3.3.3 Recording of frequency assignments that have been coordinated within ICAO through the Regional Offices with the MIFR represents a very important element of international regulations. Correct and up-to-date information in the MIFR may be critically important for frequency management, including the analysis of occupancy of frequency bands for sharing studies and allocation of spectrum at WRCs.

ICAO and its Regional Offices also maintain databases of coordinated aeronautical frequencies in a number of frequency bands allocated to the aeronautical mobile (R) service and aeronautical radionavigation service. A comparison of the ITU and ICAO databases has shown that only a small part of frequency assignments contained in ICAO's database is recorded in the MIFR. One possible reason for this situation is that ICAO's databases are updated by authorized aeronautical authorities of ICAO Contracting States, which could be different from ITU administrations notifying frequency assignments to the MIFR.

The Bureau and the ICAO Secretariat made preliminary consultations on the technical and regulatory feasibility of recording in the MIFR the frequency assignments contained in the ICAO databases. During these consultations, a number of technical matters requiring solutions were identified. These matters include handling differences in format and parameters of the ICAO and ITU databases, processing of changes in the ICAO database, which is frequently modified due to changing air traffic requirements, and ways of registration of aircraft systems which are not associated with ground-based stations. The initial evaluation of these issues indicates that the data conversion from ICAO to ITU format is feasible. In addition to the data handling, an urgent need to establish a regulatory basis for the relevant activities was emphasized.

WRC-12 reviewed the initiative of the ITU and ICAO and concluded, at the Seventh Plenary Meeting, the following:

> "It was suggested that the Bureau should urge administrations, through a Circular Letter, to notify aeronautical frequency assignments to the MIFR. At the same time, Committee 4 appreciated previous consultations between the ICAO Secretariat and the Radiocommunication Bureau on this matter and expressed the opinion that such consultations should continue with respect to a possible transfer of ICAO database information to the Bureau."

These consultations are ongoing, as necessary, with the involvement of the FSMP. In these consultations, both the technical and the (Radio) Regulatory aspects are reviewed.

**ICAO POLICY ON CHAPTER III**

- Maintain these Regulations without change.
- Continue the assessment on aligning the ITU database of frequency assignments with the ICAO global frequency lists.

### 7-III.3.4 Chapter IV (Articles 15 and 16) – Interferences

7-III.3.4.1 This chapter on interferences is important in aeronautical terms. It prescribes the conditions under which stations must operate to avoid causing interference, the measures to be applied when interference is detected and the actions to be taken when a resolution cannot be obtained by normal bilateral coordinative actions. The necessary actions prescribed contain a strong emphasis on the importance of removing interference in the case where it occurs to a safety service (RR 15.36 and RR 15.37), or where distress frequencies are involved (RR 15.28).

7-III.3.4.2 It is noted that the procedures in the Radio Regulations for clearing interference have no mandatory force, nor is there any procedure for the referral of disputes for arbitration. Thus, RR 15.22 mentions "goodwill and mutual assistance", and as a final attempt, an administration may request the Radio Regulations Board to help (RR 15.41, RR 15.42 and Section 1 of Article 13).

7-III.3.4.3 Regulations of particular importance to aeronautical service in this chapter are reproduced below.

**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)

**15.28** § 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)

**15.32** § 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.

**15.36** § 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)

**15.40** § 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.

**ICAO POLICY ON CHAPTER IV**

This chapter contains Regulations of importance to aeronautical services which provide for the rapid clearance of interference to these services. No changes of substance should be made, and the degree of attention accorded to safety services and distress frequencies should not be lessened.

### 7-III.3.5 Chapter V (Articles 17 to 20) – Administrative provisions

7-III.3.5.1 Several administrative provisions contained in Articles 18 and 19 of this chapter are of interest to aviation (action may either involve the telecommunications or the aviation authority, or both). Radio Regulations 18.8 and 18.11 have been included at the request of aviation to regularize the licensing of aircraft on delivery from the manufacturer, and aircraft leased to a country other than the country of registry. Radio Regulation 19.10 is a dispensation from the normal rule that radio stations must transmit an identification at all times and regularizes the Annex 10 practice with navaids where removal of the identification is an indication of malfunction. In ITU, the term “radiobeacon” has a wider significance than in aviation and can include all ground-based navaids. The most important of these Regulations are reproduced below:

**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.

**18.11** § 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.

**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.

**19.16** § 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.

7-III.3.5.2 Sections III and VII of Article 19 deal with the formation of call signs in the aeronautical service. The Regulations do not define the distinction between an identification and a call sign very clearly, and both are transmitted essentially to provide others with a means of determining the identity of a radio transmission. The usual interpretation is that identification is primarily required on transmissions by radio beacons for the purpose of identifying interference sources, while call signs have the added purpose of facilitating two-way communications. The greater majority of the requirements laid down in Section III relate to maritime services, with dispensations (as indicated below) in the case of aeronautical stations. To a large extent Annex 10 (Volume II) has been aligned with these Regulations.

**Section III — Formation of Call Signs**

**19.57** *Aircraft stations*

**19.58** § 25 — two characters and three letters.

**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.

**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.

**ICAO POLICY ON CHAPTER V**

Chapter V, which addresses identification signals and call signs, is the basic international document for these matters. Alignment with Annex 10 is essential and must be maintained either through similar text or by exemption (e.g. RR 19.10).

### 7-III.3.6 Chapter VI (Articles 21 to 29) – Provisions for services and stations

The Articles in this chapter address specific procedures and technical practices for radio services and stations that are essential for efficient and orderly operation and for efficient use of spectrum. One of the services of interest to aviation is detailed below.

*Article 28: Radiodetermination services*

Section I is general and is oriented towards the maritime service, which has no international document other than the Radio Regulations in which to prescribe obligatory requirements.

Section II contains a provision dealing with the aeronautical radionavigation-satellite service (which has not yet received an allocation in the Table of Frequency Allocations).

Section III deals with radio direction-finding stations. Such stations are no longer a standard feature in civil aviation on international services. However, where it applies, there is a dispensing regulation which permits aviation to use ICAO agreements as the rule. This is:

**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 deals with radio beacons in a general way. Radio Regulations 28.23 and 28.24 include reference to Appendix 12 which designates field strength and protection requirements for aeronautical radio beacons. The parameters and values defined in Appendix 12 are those used by ICAO in the frequency assignment planning for aeronautical NDB. The text of these Regulations is:

**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 radiobeacons 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**.

**ICAO POLICY ON CHAPTER VI**

- The provisions in the chapter are necessary as broad principles for radiodetermination services. They should be maintained and improved, as necessary, by future amendments based on practical experience.
- Appendix 12, together with the enabling provisions 28.23 and 28.24, should be maintained unchanged.

### 7-III.3.7 Chapter VII (Articles 30 to 34) – Distress and safety communications

Primarily, this chapter addresses the operational use of the global maritime distress and safety system (GMDSS) intended for ships in distress situations. However, aircraft are not precluded from using the system. Radio Regulation 30.9 provides the dispensation for aeronautical radio services to conform to the provisions in Annex 10 in any case where provisions of the Radio Regulations diverge from aeronautical practices. Regulations of relevance are:

**Article 30 — General provisions**

**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.

*Article 33: Operational procedures for urgency and safety communications in the global maritime distress and safety system (GMDSS)*

Medical transports are defined in the 1949 Geneva Convention and the definition is repeated in RR 33.19. They may be aircraft or ships involved in areas of armed conflict. Section III – *Medical transports* sets down the special identification measures, which include the use of secondary surveillance radar (SSR) for aircraft.

**ICAO POLICY ON CHAPTER VII**

Chapter VII concerns primarily the global maritime distress and safety system (GMDSS), but affects aircraft indirectly. These provisions (identified above) should be maintained, or improved as necessary, based on operational practices.

### 7-III.3.8 Chapter VIII (Articles 35 to 45) – Aeronautical services

7-III.3.8.1 This chapter deals exclusively with aeronautical matters and addresses licensing and regulatory aspects of allocations as well as service operational matters. These matters are applicable to all aircraft operations, whether for civil, national defence or governmental purposes. This chapter contains the following articles (with the type of regulation indicated in brackets):

*Article 35* *Introduction*

*Article 36* *Authority of the person responsible for the station* (operational)

*Article 37* *Operator's certificates* (licensing)

*Article 38* *Personnel* (licensing)

*Article 39* *Inspection of stations* (licensing)

*Article 40* *Working hours of stations* (operational)

*Article 41* *Communications with stations in the maritime services* (regulatory)

*Article 42* *Conditions to be observed by stations* (regulatory)

*Article 43* *Special rules relating to the use of frequencies* (regulatory)

*Article 44* *Order of priority of communications* (operational)

*Article 45:* *General communication procedure* (operational)

Radio Regulation 35.1.1 recognizes, with the exception of Articles 36, 37, 39, 42, 43 and 44.2, the application of Annexes to civil aircraft provided their implementation does not cause harmful interference to the radio services of other

countries.

7-III.3.8.2 Particular regulations of interest and importance in Chapter VIII are:

*Article 37: Operator's certificates*

This important Article lays down the requirement for operator's certificates to be issued for aircraft personnel in relation to the control and use of the radio as a transmitting device. The requirement is also reflected in Article 30 (b) of the Chicago Convention, and the requirements for the air safety aspects are laid down in Annexes 1 and 10. Several of the provisions in this Article take account of practices in civil aviation as specified in Annexes. Of relevance to aviation are:

– RR 37.1 which requires that every aeronautical radio station be certified by an "operator holding a certificate issued or recognized by the government to which the station is subject". The wording of this Regulation permits the certificate to be issued by the authority with responsibility for civil aviation.

– RR 37.2 which provides a dispensation for the use of ICAO requirements in lieu of those in the Regulations in the aspects where ICAO has specified conditions, qualifications or other relevant material. The text of this Regulation is:

**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.

– RR 37.4 and RR 37.5 which permit administrations to decide if a certificate is necessary for frequencies above 30 MHz, but not on frequencies assigned for international use.

– RR 37.14 which permits the issue of a restricted certificate in lieu of a general certificate where the frequencies used are from exclusive aeronautical bands, and operation of the equipment requires only the use of simple external switching devices. This applies to all HF and VHF radio equipment carried in modern civil aircraft.

*Article 42: Conditions to be observed by stations*

Of note in this Article is RR 42.4 which prohibits the operation of a broadcasting service by an aircraft station while over the sea. An associated RR 23.2 prohibits the establishment and use of broadcasting services outside national territory.

*Article 43: Special rules relating to the use of frequencies*

This Article lays down conditions of use for aeronautical frequencies.

RR 43.1 is often referred to in an aeronautical mobile and aeronautical mobile-satellite context in ITU discussions. It distinguishes the civil aviation use of frequencies from other aircraft uses, notably national defence use (i.e. the (OR) service). The inclusion of the words "safety and regularity" has been a deliberate transfer from the Chicago Convention. The service definitions at RR 1.33 and RR 1.36 were inserted recently to consolidate the concept insofar as the Table of Frequency Allocations is concerned. RR 43.4 prohibiting public correspondence is of long-standing and still is applicable to AM(R)S and AM(OR)S. There is no longer an exclusive allocation to the AMS(R)S.

**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.

RR 43.4 has the objectives of maintaining civil aviation frequencies exclusively for safety messages, as well as preventing their exploitation for purposes which can lead to inefficient use of spectrum. It only applies to exclusive bands and is invalid for satellite services to aircraft operating in the generic mobile-satellite bands.

**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.

*Article 44: Order of priority of communications*

The order of priority of communications in this Article (reproduced below) has been carefully aligned with that in Annex 10, Volume II, Chapter 5, 5.1.8 for Categories 1 to 6 below. These have been accorded priority over other communications by footnotes in the Table of Frequency Allocations, particularly in the allocations in the mobile-

satellite bands where other communications, e.g. public correspondence, are also transmitted on the same channel. RR No. 5.357A places only the priority Categories 1 to 6 of Article 44 as a condition to be observed by mobile-satellite service operators in the frequency bands 1 545–1 555 MHz and 1 646.5–1 656.5 MHz which are allocated to the (generic) mobile-satellite service.

**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.

**ICAO POLICY ON CHAPTER VIII**

Unless justified by studies,
Maintain Article 35 except for any consequential amendment.

- Maintain Article 43 without change.
- Maintain the order of priority in Article 44 for Categories 1 to 6 aligned with that in Annex 10.

Annex 10, Volume II, contains the order of priority of communications to be applied in the aeronautical mobile service (for voice communications). These priorities are aligned with the priorities as established by the ITU Radio Regulations in Article 44.

In addition, Annex 10, Volume III, contains a mapping of ATN network priorities to the mobile sub-network priorities. Essentially, these priorities are also aligned with those of the Radio Regulations. Some of the (air-ground data link) systems incorporate a slightly different order of priorities while meeting the general requirements placed by the Radio Regulations.

*Note.— The order of priorities for the aeronautical mobile service do not apply to the order of priorities in the aeronautical fixed service (AFTN, ATN).*

### 7-III.3.9 Chapter IX (Articles 46 to 58) – Maritime services

7-III.3.9.1 Articles 46 to 58 provide the regulatory framework for maritime services in a similar way to that in Chapter VIII for the aeronautical services.

7-III.3.9.2 Aeronautical services receive mention at isolated places within Chapter IX. The most important are identified below.

*Article 51: Conditions to be observed in the maritime services*

The provisions in Section III – *Stations on board aircraft communicating with stations of the maritime mobile service and the maritime mobile-satellite service* relate only to the situation where the frequencies used are those allocated to maritime services.

**ICAO POLICY ON CHAPTER IX**

Maintain the aeronautical provisions in this chapter without change.

## 7-III.4 APPENDICES TO THE RADIO REGULATIONS

7-III.4.1 Comments on Appendices of special significance to aeronautical services are given below.

### 7-III.4.2 Appendix 12. Section I – Aeronautical radiobeacons

The material in this Appendix defines the protection requirements for aeronautical radio beacons (non-directional beacons and locators). It achieves full Radio Regulation status through RR 28.24. (Prior to the VGE Report, the Appendix 12 provisions were contained within the main body of the Regulations.)

**ICAO POLICY ON APPENDIX 12**

No changes should be made to the provisions for aeronautical radio beacons in this Appendix.

### 7-III.4.3 Appendix 13. Distress and safety communications (non-GMDSS) (suppressed at WRC-07; see Chapter VII of the Radio Regulations)

### 7-III.4.4 Appendix 16. Documents with which stations on board ships and aircraft shall be provided

Appendix 16 was amended at WRC-07 to align its provisions with those of Chapter VII of the Radio Regulations. The section addressing documents with which stations on board aircraft need to be provided was amended as follows:

**Section IV – Stations on board aircraft**

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.

The documents referenced in paragraph 1 are:

– the radio station licence (which is prescribed by Article 18 of the Radio Regulations)

– the certificates of the operator. These are normally included in the pilot licence.

**ICAO POLICY ON APPENDIX 16**

Retain without change.

### 7-III.4.5 Appendix 27. Frequency allotment plan for the AM(R)S and related information

7-III.4.5.1 Appendix 27 was agreed to at the World Administrative Radio Conference (WARC) for the Aeronautical Mobile (R) Service in 1978 when the use of the HF spectrum was converted from double sideband (DSB) to single sideband (SSB). The main technical provisions have been reproduced in Annex 10, Volume III, Part II, Chapter 2, 2.4. Appendix 27 is notable as the single case where aeronautical frequency planning is carried out in the ITU. The registration of HF frequencies in the MIFR is necessary. There is no established amendment procedure for Appendix 27, although it is recognized in provision 27/20, that frequencies not in conformity with the Allotment Plan may be selected and registered by ITU provided that they do not reduce the protection to the frequency allotments in the Plan.

7-III.4.5.2 Some frequency management aspects of importance are covered in Annex 10, Volume V, Chapter 3.

7-III.4.5.3 Of notable importance are the allotments made for aeronautical operational control (see Annex 10, Volume V, Chapter 3, 3.1.3) and the terms of No. 27/217 authorizing their use for this purpose. The full text of this important provision is at Section 7-II of this handbook under the band 2 850–22 000 kHz.

7-III.4.5.4 Appendix 27 is notable also for the recognition given to ICAO for its coordinating role in the operational use of radio frequencies (see No. 27/19 of the above-mentioned reference). In this context it has been clarified, however, that the registration of assignments in the MIFR as a requirement covered by the Radio Regulations is effected through ITU member administrations (national telecommunication administrations). Due to these provisions, ICAO cannot play any role in the registration of Appendix 27 frequencies.

**ICAO POLICY ON APPENDIX 27**

- Appendix 27 may only be amended by an ITU aeronautical conference or by an agenda item for a WRC to which aeronautical expertise is specifically invited. The present Allotment Plan is becoming incapable of meeting requirements, which appear to exceed the possibilities under provision 27/20.
- ICAO supports any action which could lead to an increase of the frequency bands for use by the aeronautical mobile (route) service (AM(R)S) in the bands between 2 850 kHz and 22 000 kHz.

## SECTION 7-IV. REVIEW OF ITU RESOLUTIONS AND RECOMMENDATIONS

A standard item in the agenda of all WRCs is the review of past Resolutions and Recommendations and decision as to their continuing applicability. The review is normally made in the closing stages of WRC action and account is taken of the conference decisions and the new Resolutions and Recommendations agreed at the conference.

During its WRC preparation, ICAO reviews, in accordance with ITU Resolution 95 (Rev. WRC-19), Resolutions and Recommendations of previous ITU conferences. The results are contained in Attachment F of this document.

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# Chapter 8

# ICAO SPECTRUM STRATEGY AND VISION

## 8.1 INTRODUCTION

8.1.1 Air transport plays a major role in social and economic development of communities, regions and the world. The demand for passenger and freight operations is expanding geographically and growing in response to markets and demographics. Studies predict very similar patterns of activity in the years ahead. Since the mid-1970s, air traffic growth has consistently doubled approximately every 15 years, notwithstanding major historical events such as the 9/11 attack or the COVID-19 pandemic. Over the next 20 years, world passengers are expected to increase by 3.8 per cent per year on average, resulting in over 4 billion additional passenger journeys in 2043 compared to 2023.

8.1.2 The ICAO spectrum strategy presented in 8.2 is based on the recognition that adequate and appropriate spectrum availability is essential to aviation safety and to support efficient aircraft operations. This fundamental principle has been the long-standing basis for ICAO policy in spectrum matters, as recognized in Assembly Resolution 42-7 and in Recommendation 1/12 of the Twelfth Air Navigation Conference.

8.1.3 The ICAO spectrum strategy is consistent with the Fifth Edition of the *Global Air Navigation Plan* (GANP, Doc 9750), and in particular with the Technology Roadmaps contained in Appendix 5 of the 5th edition of the GANP. Future developments of the plan will be taken into account as part of the strategy update process, as discussed in 8.3, which addresses future systems and strategy evolution.

8.1.4 Section 8.4 discusses a number of current and future challenges to civil aviation's use of the radio frequency spectrum.

8.1.5 The aviation spectrum long-term vision is detailed in section 8.5.

## 8.2. ICAO SPECTRUM STRATEGY

### 8.2.1 Purpose of the ICAO spectrum strategy

8.2.1.1 The safety aspects on the use of radio frequency spectrum by aviation

require spectrum to be available on an exclusive basis or, when shared with non-aeronautical radio services, with regulatory and technical conditions that recognize aeronautical safety requirements. The overall ICAO spectrum policy includes the ICAO spectrum strategy presented here and the ICAO policy statements contained in Chapter 7. Both the spectrum strategy and the policy statements are approved by the Council of ICAO.

8.2.1.2 Implementation of the spectrum strategy will enable the advancement of technological developments and innovation to enhance safe and efficient global air transport. This is to be achieved through the development of ICAO SARPs as necessary.

8.2.1.3 The radio frequency spectrum capacity for aviation must be sufficient to meet the growing needs for aeronautical communication, navigation and surveillance systems, including any new systems that are being considered in ICAO to meet future CNS/ATM requirements. This is essential to adequately support changing trends in air traffic management such as foreseen in the GANP and the ICAO Regional Plans.

8.2.1.4 Spectrum for aeronautical radiocommunication and radionavigation (including surveillance) is allocated by the ITU with the recognition of the safety aspects identified above. The ICAO spectrum policy aims to ensure that aeronautical spectrum capacity requirements are satisfied during the frequency allocation process, taking into consideration the trends in future air traffic management.

### 8.2.2 Basis for the ICAO spectrum strategy

8.2.2.1 The ICAO spectrum strategy in this chapter has been developed on the basis of current global and regional plans for implementing CNS systems until about 2035. It identifies the spectrum necessary for each of the CNS elements and each relevant frequency band, including specific regional requirements which are part of the overall ICAO spectrum strategy.

8.2.2.2 It consists of a high-level ICAO spectrum strategy (8.2.3) and of a set of specific strategy statements for each frequency band (8.2.4). The high-level strategy is applicable to all frequency bands and should be regarded as the basis for the band-by-band strategy statements, and for the relevant ICAO policy statements contained in Section 7-II.

8.2.2.3 In many cases, aeronautical radiocommunication, radiodetermination and radionavigation systems currently in use will continue to operate well beyond 2035, either on a global basis or in certain regions. The strategy identifies requirements for the medium term and until and beyond 2035. Spectrum requirements identified for the long term indicate that such spectrum is expected to be necessary for an undetermined

period, extending to well beyond 2035.

8.2.2.4 The strategy, including the timescale, will be updated on a regular basis taking into consideration developments in the use of current and new CNS systems, as reflected in the 5th edition GANP Technology Roadmaps.

### 8.2.3 ICAO high-level spectrum strategy

**ICAO HIGH-LEVEL SPECTRUM STRATEGY**

- To secure the continuing availability of adequate radio frequency spectrum to support the current and planned aeronautical CNS infrastructure requirements as laid out in the Global Air Navigation Plan (GANP) and in the Regional Air Navigation Plans.
- To enable the advancement of technological innovation to maintain and enhance the safety of the global air transport system as well as increased efficiency in spectrum utilization.
- To ensure that proposals for new or modified allocations be supported by sharing studies on the use of frequency bands by aviation and take full account of the possible impact on the aeronautical safety case; these studies need to encompass the total technical, operational and economic aspects of aeronautical system use.
- To conduct ICAO studies on the compatibility of ICAO standard systems with other existing or planned ICAO standard systems.
- To support the ITU studies on the compatibility of ICAO standard systems with non-ICAO standard systems.
- To oppose proposals for new or modified allocations that place undue or unreasonable constraints on the continued use of current aeronautical CNS systems or affect the safety of aviation.
- To support efficient use of the frequency bands allocated to relevant aeronautical services by developing globally harmonized terrestrial-system frequency assignment planning criteria and a global frequency assignment plan in support of the GANP, while recognizing that the actual use of spectrum by aviation may vary between different regions where different system requirements and corresponding spectrum requirements exist.
- To ensure that aeronautical CNS systems, which provide safety-of-life services to aviation, operate in frequency bands that are properly allocated for use by aviation, with the objective of operating in spectrum allocated to an appropriate aeronautical safety service, and suitably protected from harmful interference that can be caused by other systems using the same or nearby frequency bands.

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### 8.2.4 ICAO specific band-by-band spectrum strategy for the frequency bands used by civil aviation

*Note. — Timescale is defined as:*
- *Short Term (Now – 2031)*
- *Medium Term (2031 – 2041)*
- *Long Term (2041 +)*

| *Frequency band* | *Aeronautical use* | *Timescale* | *ICAO spectrum strategy* | *Risk factors* | *Vision statement* |
|---|---|---|---|---|---|
| 130–535 kHz | NDB | Global: medium term<br><br>Regional: long term | Secure the continuing availability of the frequency band 130–535 kHz, parts of which are allocated to the aeronautical radionavigation service, on a global basis for use by NDB systems for at least the medium term and, in the long term, on a regional basis.<br>*Note.— Long-term use may be required to support national requirements.* | The progressive withdrawal planned by the States may encourage the beginning of a process for the sharing of this band by other non-aeronautical systems, which may create situations of interference for the NAVAIDS still in Service.<br>New applications operating in NDB frequency band or having unwanted emission falling into the NDB band such as WPT are under deployment.<br>e.g.: The deploying of the digital sound broadcasting in the band 525-1705 kHz. | Ensure that the spectrum currently allocated to the aeronautical radionavigation service is preserved till the total withdrawal of NDB<br>Consider the possibilities of reuse the 130–535 kHz band for an alternative aeronautical system. |
| 2 850–22 000 kHz (portions in accordance with RR Appendix 27) | HF air-ground communications (voice and data) | Long term | Secure the continuing availability of the HF frequency bands 2 850–22 000 kHz which are allocated to aeronautical mobile (R) service for use by air-ground communications on a global basis for both analogue and digital HF communications. | Current threats to aviation access in this band include emissions from wireless power transfer, power line communications and cable TV.<br>In addition to the deploying of digital HF wideband systems, in aeronautical mobile (OR). | Initiate an action plan for the long-term use of HF communications including usage redundancy with SATVOICE.<br>Reinforcement of HF communications capability with SATCOM.<br>To ensure an effective integration of wideband HF communications. |
| 74.8–75.2 MHz | Marker beacon | Long term | Secure the continuing availability of the frequency band 74.8–75.2 MHz, which is allocated to the aeronautical radionavigation service, for use by marker beacons on a global basis. | Current threats to this band include the increase of man-made noise due to, for example, PLC modems producing signal components as high as 300 MHz.<br>Risk of potential interference due to the allocation of mobile service in this band. | Consider a plan for the replacement of marker beacons by DME or other suitable technologies such as GNSS-based distance-to-threshold indicators.<br>Consider an alternative aeronautical system to ensure that the currently allocated spectrum is preserved. |
| 108–112 MHz | ILS — localizer | Long term | Secure the continuing availability of the frequency band 108–117.975 MHz, which is allocated to the aeronautical radionavigation service, for use by ILS-localizer on a global basis. | An external threat to this band is compatibility with FM broadcasting operating in the band 88–108 MHz (see Resolution 413 (Rev. WRC 12)). It has been reported that FM broadcast transmissions are not in accordance with the assumptions set out in the standard compatibility assessment contained in ITU-R SM.1009-1.<br>A new external threat is interference from | Consider long-term role of ILS both as an essential navigation aid in its own right and as an alternative reversionary terrestrial infrastructure capable of maintaining safety and an adequate level of operations in case of unavailability of GNSS.<br>Ensure that the VHF band of 108–112 MHz band remains free of any interference for aeronautical systems operating adjacent to the |

| *Frequency band* | *Aeronautical use* | *Timescale* | *ICAO spectrum strategy* | *Risk factors* | *Vision statement* |
|---|---|---|---|---|---|
| | | | | hybrid or fully digital broadcasting transmissions in the band 87-108 MHz (Report ITU-R BS.2503-0 (03/2022)). | 108 MHz allocation boundary with the arrival of new FM digital sound broadcasting technologies. |
| 108–117.975 MHz | GBAS;<br>VDL Mode 4 | Long term | Secure the continuing availability of the frequency band 112–117.975 MHz (108–117.975 for GBAS), which is allocated to the aeronautical mobile (R) service, for use by GBAS and VDL Mode 4 on a global basis.<br>Consider, subject to spectrum availability and spectrum requirements, the use of this band to accommodate VHF air-ground communication systems. | Current threats to aviation access in this band include emissions from high power analogue or digital modulation signals in the FM broadcast band, power line communications and cable TV. | |
| 108–117.975 MHz | VOR | Long term | Secure the continuing availability of the frequency band 108–117.975 MHz, which is allocated to the aeronautical radionavigation service, for use by VOR on a global basis. | Identical to those for the ILS localizer. | Consider rationalization of VOR as an integral part of the PBN implementation plan and reuse by GBAS of any frequencies that may become available |
| 117.975–137 MHz | VHF air-ground; voice, VDL Mode 2 and VDL Mode 4 | Long term | Secure the continuing availability of the frequency band 117.975–137 MHz, which is allocated to the aeronautical mobile (R) service and aeronautical mobile satellite (R) service, for use by VHF air-ground voice and data link on a global basis.<br>Monitor progress on the development of the future air-ground data link in this and other bands and the implementation of 8.33 kHz channelization.<br>Conduct regular capacity analysis of the existing band and, if necessary, develop and evaluate strategies for decongesting the band and its respective sub-bands. | Current threats to aviation access in this band include emissions from power line communications and cable TV, high power analogue or digital modulation signals in the FM broadcast band and harmonics from industrial, scientific and medical (ISM) systems. | Develop standards and specification to support the compatibility between terrestrial and satellite VHF components.<br>Plan for the long-term replacement of 25 kHz Double-Sideband Amplitude Modulation (DSB-AM) voice communications with more spectrum efficient systems (e.g. 8.33 kHz DSB-AM).<br>Plan for the long-term transition to digital modulation voice systems in this and in other bands.<br>The severe congestion being experienced in core Europe could be overcome by using complementary aeronautical communication systems (SATCOM, future air-ground data link. |
| 328.6–335.4 MHz | Glide path | Long term | Secure the continuing availability of the frequency band 328.6–335.4 MHz, which is allocated to the aeronautical radionavigation service, for use by ILS – glide path on a global basis. | There are no known threats to this band from other sectors seeking spectrum access. However, some States report that the increasing levels of man-made noise pose a threat to ILS deployment. The adjacent bands are used by military authorities for fixed and mobile services, including air-ground communications. There is a small guard band of around 400 kHz at each end of the aeronautical allocation. | |

| *Frequency band* | *Aeronautical use* | *Timescale* | *ICAO spectrum strategy* | *Risk factors* | *Vision statement* |
|---|---|---|---|---|---|
| | | | | Risk of potential interference due to the allocation of mobile service in this band. | |
| 960–1 164 MHz | UAT<br>LDACS<br>1090ES | Long term | Support the development of LDACS in the aeronautical mobile (R) service in the frequency band 960–1 164 MHz .<br>The implementation of LDACS must be compatible with other ICAO-standardized aviation safety systems operating in this, and the adjacent to this frequency ~~band~~ band (e.g. ADS-B, MLAT, ACAS, .DME, GNSS and SSR).<br>Secure the continuing availability of the frequency band 960–1 164 MHz, which is allocated to the aeronautical mobile (R) service, for use by air-ground and, air-air systems, by ADS-B via 1 090 MHz extended squitter and by UAT operating in 978 MHz.<br>The same surveillance applications are provided by ADS-B via passive satellite reception operating in the aeronautical mobile satellite route service. Some components of MLAT are similar to ADS-B in that they operate globally in the aeronautical mobile R service | This band, and the adjacent bands, are extremely attractive to other (non-aviation) sectors and has already seen attempts at partial sharing. Additionally, performance degradation may occur due to the growing number of aviation CNS systems in this frequency band. Introduction of new entrants are a preliminary concern if they were to try to use ADS-B channels in large numbers. | Maintain accurate and up-to-date system performance characteristics, frequency planning criteria, and interference tolerance criteria in order to support interoperability with other ICAO systems and compatibility with non-aviation users.<br>Seek methods to improve spectrum characteristics as necessary to enhance future spectrum sharing and interference resilience.<br><br>Short-term: utilize frequency channels, used by existing surveillance system, to incorporate future technologies, accommodate new entrants, and provide new surveillance applications (e.g. via ADS-B IN).<br>Medium and long-term: move the use of the frequency band towards the principles of ICNSS while improving safety, efficiency, and ensuring backward compatibility. |
| 960–1 215 MHz | DME | Long term | Secure the continuing availability of the frequency band 960–1 215 MHz, which is allocated to the aeronautical radionavigation service, for use by DME on a global basis. | This band is extremely attractive to other sectors, particularly IMT. Because of the large and growing number of aeronautical services operating in this band, it is essential that changes to the existing allocations are strongly opposed.<br>The Resolution 609 pfd threshold protecting DME from RNSS in the frequency band 1 164 – 1 215 MHz has been reached at Resolution 609 21st consultation meeting (2024), making DME vulnerable to future RNSS programs. | Support studies to Determine if there is a long-term optimization of the distance measuring function that could deliver better performance and provide legacy support for use in those parts of the world where DME/VOR will remain, while also being implementable.<br>Establish clear and lasting compatibility criteria to protect legacy navigation and transponder-based systems from future IMT services in near bands.<br>To allow future ICNSS systems to be tested and operated sometime in the future in the aeronautical L-band, the deallocation of single DME channels or the mutual allocation and co-use of a specific cpectrum range could be possible in the future. Beside any intentions on the development of new technologies, the functions and fonctionality of existing systems should not be harmed. |
| 1 030 MHz | SSR/ ACAS/ | Long term | The introduction of new systems on adjacent | The increased usage of these frequencies, in | Maintain accurate and up-to-date system |

| *Frequency band* | *Aeronautical use* | *Timescale* | *ICAO spectrum strategy* | *Risk factors* | *Vision statement* |
|---|---|---|---|---|---|
| and<br>1 090 MHz | MLAT/<br>Cooperative DAA | | frequencies may reduce the performance of 1030 and 1090 MHz systems.<br>Secure the continuing availability of the 1 030 MHz and 1 090 MHz frequencies for use by ADS-B, SSR, ACAS and Cooperative DAA. | particular 1 090 MHz, make channel loading management necessary to ensure proper operation of SSR/ACAS/MLAT/Cooperative DAA equipment. Additionally, performance degradation may occur due to the growing number of aviation CNS systems using these frequencies.<br>Specific implementation architectures make use of image frequencies in other parts of this band causing spectrum inefficiencies and potential future compatibility constraints with other aviation systems. | performance characteristics, frequency planning criteria, and interference tolerance criteria in order to support interoperability with other ICAO systems and compatibility with non-aviation users.<br>Seek methods to improve spectrum characteristics as necessary to enhance future spectrum sharing and interference resilience. |
| 1 164–1 215 MHz | GNSS | Long term | Secure the continuing availability of the frequency band 1 164–1 215 MHz, which is also allocated to the radionavigation-satellite service, for use by GNSS systems on a global basis, taking into consideration the radio regulatory conditions for using this band.<br>Continue cooperation with network managers in order to take into account the protection of GNSS when assigning frequencies to DME. | Concern about increase in numbers of DMEs, for example to improve area navigation or as a back-up to GNSS, impacting GNSS.<br>In the GNSS frequency band 1 164–1 215 MHz, impact of the second harmonic of IMT stations that use frequency band 470–694 MHz is possible.<br>The development of LEO PNT constellations increases the interference environment faced by GNSS systems used by civil aviation.<br>Current risks include proposals in some countries for adjacent-band high power terrestrial systems, and the proliferation of GNSS jamming systems. These risks are compounded by the large and growing number of aeronautical operations dependent on GNSS signals. | Contribute to the further strengthening of regulatory and technical measures to reduce the risks of interference, and in particular spoofing, to GNSS. |
| 1 215–1 350 MHz | Primary surveillance radar | Long term | Secure the continuing availability of the frequency band 1 215–1 350 MHz, which is allocated to the radionavigation and aeronautical radionavigation service, for use by primary surveillance radar on a global basis. | | |
| 1 525–1 559 MHz<br>and<br>1 610.5–1 660.5 MHz | Air-ground satellite communications | Long term | Support retention of RR No. 5.357A in order to ensure sufficient access on a global basis by the aeronautical mobile-satellite (R) service in the bands 1 545–1 555 MHz and 1 646.5–1 656.5 MHz to support the requirements for aeronautical satellite safety communications.<br>*Note.— In these frequency bands, priority access should be provided for aeronautical safety communications within a network.* | This band and the adjacent bands, are attractive to other sectors including PMSE and terrestrial broadband communications. | These bands are extensively used for aeronautical satellite safety communications and should be safeguarded against the potential for interference and receiver blocking from terrestrial services. |

| *Frequency band* | *Aeronautical use* | *Timescale* | *ICAO spectrum strategy* | *Risk factors* | *Vision statement* |
|---|---|---|---|---|---|
| | | | Support the continuing retention of footnote No 5.367. Promote seeking agreement under No 9.21 as requested by No 5.367 for the allocation to the aeronautical mobile-satellite (R) service (E s, s-E) in the frequency band 1 610–1 626.5 MHz.<br>*Note.— This frequency band has been allocated to the aeronautical mobile-satellite (R) service on a primary basis as per RR No. 5.367.*<br>Ensure that any new or existing uses of these frequency bands will not cause harmful interference to the use of the bands by the aeronautical mobile-satellite (R) service.<br>*Note.— 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 has priority and immediate access over other mobile-satellite communications within a network.* | | |
| 1 559–1 610 MHz | GNSS | Long term | Secure the continuing availability of the frequency band 1 559–1 610 MHz, which is allocated to the aeronautical radionavigation and the radionavigation satellite services, for use by aeronautical GNSS systems, including augmentation systems, on a global basis.<br>Support the development of regulatory measures to enforce prevention and removal of occurrences of in-band and out-of-band interference. | There is the ongoing risk of intentional interference (e.g. from GPS jammers and spoofers) and unintentional interference (e.g. from pseudolites and GNSS repeaters). Regulatory and enforcement measures may be necessary to contain these threats.<br>The development of LEO PNT constellations increases the interference environment faced by GNSS systems used by civil aviation.<br>In the GNSS frequency band 1 559–1 610 MHz, impact of the second harmonic of IMT stations that use frequency bands 694–790 MHz and 790–862 MHz is possible, as well as impact of spurious emissions of IMT stations that use frequency band 1 427–1 518 MHz.<br>In addition, deployment of mobile devices capable of operating on satellite systems (Direct to Device) in bands directly above 1610 MHz is a raising concern for GNSS operating in the adjacent band. | Contribute to the further strengthening of regulatory measures to reduce the risks of interference to GNSS.<br><br>Dual-frequency, multi-constellation equipment should be encouraged. |
| 2 700–2 900 MHz | Primary surveillance radar | Long term | Secure the continuing availability of the frequency band 2 700–2 900 MHz, which is | This spectrum is attractive to the IMT sector for mobile broadband services. Compatibility | Develop new non-cooperative surveillance techniques that are spectrally efficient and |

| *Frequency band* | *Aeronautical use* | *Timescale* | *ICAO spectrum strategy* | *Risk factors* | *Vision statement* |
|---|---|---|---|---|---|
| | | | allocated to the aeronautical radionavigation service, for use by primary surveillance radar on a global basis.<br>Where, in adjacent frequency bands, mobile systems are in use, secure protection of radar stations from harmful interference from mobile systems operating in adjacent bands. | studies have shown band sharing between PSR and mobile services (i.e. long-term evolution (LTE)) not to be feasible. This is supported by experience of the roll-out of LTE in the band 2 670–2 690 MHz, which caused harmful interference to aeronautical PSRs operating in the band 2 700–3 100 MHz. The 2 700–2 900 MHz frequency band is also being considered in some countries for video PMSE.<br>Beyond 2030, there is potential new development of IMT services operating above 2.9 GHz in some countries, which may cause an interference issue to PSR operating in the 2.7 – 2.9 GHz band if frequency separation, technical mitigation and PSR mitigating techniques are not sufficient to mitigate the interference risk. | resilient to interference. |
| 3 400–4 200 MHz | VSAT for aeronautical networks and AMS(R)S feeder links | Long term | Support the continuing retention of the allocation to the FSS and adequate protection from other co-band and adjacent band services. | This band is attractive to other sectors including international mobile telecommunications (IMT).<br>Mobile industry has started to use the mobile service allocation with the deployment of 5G in the 3400 – 4200 MHz bands. | Ensure interference-free to FSS earth stations that provide;<br>1. in Region 1 countries, supplementary aeronautical communications for the safe operation of aircraft to satisfy the overall communications infrastructure requirement by ICAO (e.g., air traffic control (ATC), voice or data communication).<br>2. feeder links for GSO MSS networks that support AMS(R)S communications in the 1.6 and 1.5 GHz bands. |
| 4 200–4 400 MHz | Radio altimeter | Long term | Secure the continuing availability of the frequency band 4 200–4 400 MHz, which is allocated to the aeronautical radionavigation service, for use by airborne radio altimeters on a global basis. | Current risks include potential for IMT identification in adjoining, or nearby, frequency bands. | Develop new radio altimeters requirements that are more resilient to interference and incorporate these into SARPs for new Radio altimeter systems. |
| 4 200–4 400 MHz | WAIC | Long term | Secure the continuing availability of the frequency band 4 200–4 400 MHz, which is allocated to the aeronautical mobile route service, for use by WAIC on a global basis. | Deployment of mobile terrestrial emitters in adjacent frequency band is on-going. | |

| *Frequency band* | *Aeronautical use* | *Timescale* | *ICAO spectrum strategy* | *Risk factors* | *Vision statement* |
|---|---|---|---|---|---|
| 5 000–5 150 MHz (5 000–5 030 MHz, 5 030–5 091 MHz, 5 091–5 150 MHz) | AeroMACS<br><br>RPAS terrestrial and satellite C2 | Long term | Secure the continuing availability of the frequency band 5 091–5 150 MHz, which is allocated to the aeronautical mobile (R) service, for use by on-airport communications (AeroMACS) on a global basis.<br>*Note.— While not in the Radio Regulations, some States may, on a national basis, allocate the 5 000–5 030 MHz band to the AM(R)S for use by AeroMACS.*<br>Secure future implementation of the aeronautical mobile (R) service in the band 5030 – 5091 MHz to support air-ground communications for remotely piloted aircraft systems while satisfying the spectrum requirements for MLS.<br>Secure future implementation of the aeronautical mobile (R) service and the aeronautical mobile-satellite (R) service in the frequency band 5 030–5 091 MHz to support air-ground communications for unmanned aircraft systems while satisfying the spectrum requirements for MLS.<br>Secure future implementation of the aeronautical mobile satellite (R) service in the band 5000 – 5150 subject to coordination under No 9.21 in the band 5000 – 5030 MHz and 5091 – 5150 MHz, and under No 9.11A in the band 5030 – 5091 MHz. AMS(R)S in the band 5030 – 5091 MHz supports air-ground communication for RPAS.<br>Develop sharing process between ground-based and satellite based C2 Link, in order to efficiently and fairely use the band 5030 – 5091 MHz, while accommodating spectrum requirements for the remaining MLS stations.<br>Assess, on a regional basis, requirements for the long-term implementation of MLS to establish the spectrum requirements for the few remaining MLS.<br>Investigate on the evolution of the need for MLS in the future at a national basis, and assess the evolution of spectrum requirements for MLS. | The frequency band 5 000 – 5 030 MHz is allocated to RNSS and there are plans to extend the RNSS allocation from 5 000 MHz to 5 250 MHz to enable wide band RNSS.<br>RNSS systems are often subjected to intentional harmful interference, safety services in the same band could be collateral victims. | Ensure interference-free coexistence between aeronautical systems operating in that band.<br>Finalize initial RPAS SARPs, and ensure that C2 Link systems could operate under AM(R)S and AMS(R)S.<br>Ensures that allocations in this band remains primarily for safety-critical aeronautical functions and use without interference between aeronautical services |
| 5 350–5 470 MHz | Airborne weather radar | Long term | Secure the ARNS allocation of the frequency band 5 350–5 470 MHz. | Risk of interference caused by new broadband systems, in adjacent bands (e.g., unlicensed | If new ARNS applications arise, consider this band for the development of those applications |

| *Frequency band* | *Aeronautical use* | *Timescale* | *ICAO spectrum strategy* | *Risk factors* | *Vision statement* |
|---|---|---|---|---|---|
| | | | Ensure the continuing availability of the frequency band 5 350–5 470 MHz–for use by first generation airborne weather radar. | Wi-Fi or other wireless broadband networks). | only at a local basis. |
| 8 750–8 850 MHz | Airborne Doppler and ground mapping radar | Long term | Secure the ARNS allocation of the frequency band 8 750–8 850 MHz, limited to Doppler application centred on 8 800 MHz.<br>Ensure the continuing availability of the frequency band 8 750–8 850 MHz for use by airborne Doppler radar and ground mapping radar on a local basis. | This frequency band is shared with the radiolocation service for which radiolocation systems are widely deployed on a global basis. | Ensure that standards and specifications include requirements on interference resilience in order to allow the safe sharing of the band between ARNS and RLS. |
| 9 000–9 200 MHz | Primary surveillance radar and Airport Surface Detection Equipment | Long term | Secure the continuing availability of the frequency band 9 000–9 200 MHz, which is allocated to the aeronautical radionavigation service, for use by ground-based radar systems on a global basis. | | Ensure that any potential future ARNS national applications in this frequency band include considerations on interference resilience in order to allow the safe sharing of the band between ARNS and RLS. |
| 9 300–9 500 MHz | Airborne weather radar | Long term | Secure the continuing availability of the frequency band 9 300–9 500 MHz, which is allocated to the aeronautical radionavigation service, for use by airborne weather radar and ground-based radar on a global basis. | | Define technical characteristics to support compatibility and sharing studies. |
| 9 300–9 500 MHz | Primary surveillance radar | Long term | Secure the continuing availability of the frequency band 9 300–9 500 MHz, which is allocated to the aeronautical radionavigation service, for use by airborne weather radar and ground-based radar on a global basis. | | Consider defining technical characteristics to support compatibility and sharing studies. |
| 13.25–13.4 GHz | Airborne Doppler and ground mapping radar | Long term | Secure the ARNS allocation of the frequency band 13.25–13.4 GHz, limited to Doppler application. | | Define technical characteristics to support compatibility and sharing studies. |
| 15.4–15.7 GHz | Primary surveillance radar Airborne weather radar | Long term | Secure the continuing availability of the frequency band 15.4–15.7 GHz, which is allocated to the aeronautical radionavigation service, for use by airborne weather radar and ground-based radar systems on a global basis. | | Define technical characteristics to support compatibility and sharing studies. |
| 24.25–24.65 GHz | Primary surveillance radar (ASDE) | Long term | Secure the continuing availability of the frequency band 24.25–24.65 GHz, which is allocated to the radionavigation service, for use by ground-based radar systems in Region 2 and 3 to support airport surveillance detection equipment (ASDE radar). | The frequency band 24.25-27.5 GHz is identified for use by the terrestrial component of International Mobile Telecommunications (IMT)/ (RESOLUTION 242 (REV.WRC-23)) | Define technical characteristics to support compatibility and sharing studies. |

| *Frequency band* | *Aeronautical use* | *Timescale* | *ICAO spectrum strategy* | *Risk factors* | *Vision statement* |
|---|---|---|---|---|---|
| 31.8–33.4 GHz | Primary surveillance radar (ASDE)<br><br>Enhanced flight vision systems | Long term | Secure the continuing availability of the frequency band 31.8–33.4 GHz, which is allocated to the radionavigation service, for use by Enhanced Flight Vision Systems (EFVS) expected on a global basis and locally by primary surveillance radar to support airport surface detection equipment (ASDE) radar. | | Define technical characteristics to support compatibility and sharing studies. |
| 92-95 GHz | Foreign Object Debris (FOD) Detection | Long term | Secure the continuing availability of the frequency band 92-95 GHz, which is allocated to the radiolocation service for the use by airport surface Foreign Object Debris (FOD) detection systems expected on a global basis. | The sharing study with radio astronomy in ITU WP5B is underway.<br>This may affect future allocation. | Define technical characteristics to support compatibility and sharing studies. |
| 95–100 GHz | Weather radar<br>Enhanced flight vision systems<br>Airport surface detection equipment<br>Foreign Object Debris (FOD) Detection | Long term | Secure the continuing availability of the frequency band 95-100 GHz, which is allocated to the radiolocation service for use by weather radars, airport surface detection radars, and Foreign Object Debris (FOD) detection systems and to the radionavigation service for use by enhanced flight vision systems (EFVS) on a global basis. | | Define technical characteristics to support compatibility and sharing studies. |

## 8.3 FUTURE SYSTEMS AND STRATEGY EVOLUTION

8.3.1 Growth in air traffic requires new ways of planning and enhanced ground, airborne and satellite infrastructure in order to reduce ATM costs, maintain safety, reduce the environmental impact of each flight and enhance the passenger experience. A process of international discussion and agreement, normally involving a minimum of five years for operational and technical finalization of system parameters followed by an adoption process taking several additional years (as prescribed in the Chicago Convention), is necessary to ensure that any new systems introduced as part of the infrastructure evolution are appropriate and safe. Other aeronautical systems not requiring international agreement to this degree can often be developed and implemented in a shorter timescale, but still require a minimum of several years to reach maturity and acceptance. In all these cases, the actual implementation of these systems requires additional time for implementation (e.g., regional agreement) in aircraft and on the ground, and a positive business case justifying the commitment of adequate financial resources.

8.3.2 In general, the standardization and the introduction of new systems will have to be consistent with the framework laid out in the GANP and may require updates to its relevant Technology Roadmaps (refer to the 5th edition of the GANP). This, in turn, may translate into updates to specific elements of the ICAO band-by-band spectrum strategy.

8.3.3 The impact on the ICAO spectrum strategy of the introduction of a new system will depend, inter alia, on which of the three following general categories the system falls into with respect to its spectrum requirements:

a) aviation systems that can be accommodated in existing allocations, with necessary footnote modifications, or less commonly, with modification to the allocation status or description;

b) aviation systems that require additional spectrum allocations for reasons of compatibility or frequency availability; and

c) other systems with multi-service application capability whose aviation requirements can be integrated with the other applications, entailing changes to allocation, modification of band limits or footnotes or, less commonly, a completely new allocation.

8.3.4 In any case, the allocation of spectrum for new services and systems in frequency bands already allocated for aeronautical use will have to be consistent with the high-level ICAO spectrum strategy and will need to take place within the

framework set by the relevant ICAO SARPs for communication, navigation and surveillance (CNS) systems, as well as other (industry) standards that apply to current operational systems.

*Note.— Requirements for spectrum for meteorological radar and meteorological satellite systems are addressed by the World Meteorological Organization (WMO). However, specific requirements for airborne weather radar systems are included in the ICAO spectrum policy.*

## 8.4 CHALLENGES

8.4.1 For many years, aeronautical radio frequency spectrum has been targeted for use by non-aeronautical services, in particular to satisfy requirements for mobile (terrestrial) and mobile-satellite communications. This has, for example, led to the loss of spectrum that was once allocated exclusively for aeronautical mobile-satellite communications (1.5/1.6 GHz) and to the introduction of non-aeronautical services in bands previously allocated for aeronautical use on an exclusive basis (e.g. the fixed-satellite service in the frequency band 5 091–5 250 MHz, the non-safety aeronautical mobile service for telemetry in the frequency band 5 091–5 150 MHz and the radionavigation-satellite service in the frequency band 5 000–5 030 MHz). This has created the potential for interference and/or loss of spectrum capacity to satisfy current and future aeronautical requirements for CNS systems.

8.4.2 There is currently pressure to release significant amounts of spectrum to support future commercial mobile communications and broadband wireless applications. While new systems can operate from UHF up to Ka and above, additional bandwidth has mainly been sought in the range from 300 MHz to 6 GHz. This range includes frequency bands used by a large number of safety-critical aeronautical systems, including ILS glide path, DME, primary and secondary radar, ACAS, Satcom, GNSS, VSAT aeronautical networks and radio altimeters.

8.4.3 Another new element that may affect the future availability of radio frequency spectrum for aviation is the possible introduction of “spectrum pricing” which may have a significant economic impact on the aviation industry as a whole.

8.4.4 The ICAO spectrum strategy recognizes the challenges outlined above and provides the framework within which ICAO develops the international civil aviation position on issues of interest to international civil aviation to be decided at WRCs, which are the fora where these challenges typically face aviation.

## 8.5 THE AVIATION SPECTRUM LONG-TERM VISION

### 8.5.1 The need for a long-term vision

8.5.1.1 The availability of suitable radio spectrum is essential for meeting the global demand for safe, efficient and cost-effective air transport, particularly for enabling the provision of CNS. However, spectrum is a scarce and finite natural resource, and it is clear that aviation spectrum is under a global threat from other sectors that are seeking additional spectrum allocations. For this reason, it is vital that the aviation industry demonstrate good governance and efficient use of spectrum allocated to aeronautical services.

8.5.1.2 Spectrum management is the process of ensuring the availability of appropriately protected spectrum and the development and regulation of the use of radio frequencies to support aviation's operational and technical requirements. Assignment and use of spectrum is a sovereign issue within a State, and State radio administrations will remain responsible for spectrum policy and regulation.

8.5.1.3 However, unless aeronautical spectrum management evolves on a more coordinated basis, there is a risk that demand will continue to increase at a greater rate than that at which additional spectrum becomes available. Therefore, to prevent the potential lack of availability of sufficient spectrum becoming a serious risk, aviation stakeholders will need to work more cooperatively and proactively in sustaining aeronautical spectrum needs and demonstrating efficiency in the use of allocated spectrum.

8.5.1.4 The overall aim for the aviation spectrum vision is to secure the long-term availability of suitable radio spectrum to meet all of ICAO's future objectives for aviation through cooperative engagement in the global spectrum environment.

8.5.1.5 ITU WRC cycles are too short to deliver a strategy to support the overall long-term spectrum needs of the aviation sector. Currently, typical system development cycles far exceed this time frame. Although it is an objective to reduce the development and deployment lead-in time of new systems, as these are currently up to 20 to 25 years, a strategy and vision needs to support the entire in-service phase, making provision for traffic growth, incremental development and operational evolution, etc. Innovative CNS systems may also need to consider integration timescale issues in relation to conceptual airframe designs.

### 8.5.2 Long-term vision for the future of aviation spectrum

#### 8.5.2.1 General

8.5.2.1.1 The overall goal for the future of spectrum allocated to aeronautical services and aeronautical spectrum management is to ensure the perpetual availability of spectrum through continual improvement in practices and processes. To achieve this goal, the ICAO spectrum vision focuses on the future that the aviation sector wishes to create for itself over an extended time frame.

8.5.2.1.2 While recognizing that there must be a strong drive towards reduced development cycles, the spectrum vision looks beyond those systems already in development towards the needs of conceptual systems. It should not be constrained by the timescales and technologies of existing strategic plans but should be developed on the expectation that existing spectrum allocated to aeronautical services will be under permanent pressure from other sectors and that new spectrum for aviation use is unlikely to be made available. This indicates a need to set out a vision looking forty years hence.

#### 8.5.2.2 Vision statements

8.5.2.2.1 The ICAO spectrum vision is as follows:

a) *Establish and maintain an agreed spectrum strategy.* Civil aviation shall have a single, agreed spectrum strategy that is under continual development, and which is employed to create a sustainable environment for spectrum-efficient aeronautical systems;

b) *Improve collaboration.* Enhanced collaboration processes between aviation stakeholders shall be deployed for identifying, analysing, coordinating and promoting aviation's spectrum needs in a collaborative manner. Through such collaboration, opportunities to maximize the effectiveness of existing spectrum allocated to aeronautical services and opportunities to share spectrum shall be fully explored and understood;

c) *Long-term view.* Aviation shall take a longer-term view of aeronautical spectrum requirements, i.e. forty years into the future. This shall not be constrained by the timescales and technologies of existing strategic plans;

d) *Holistic CNS and spectrum (CNS&S) approach.* A holistic CNS&S approach, taking into account any CNS&S strategy that is subsequently developed, shall be deployed as follows:

– an inter-disciplinary approach shall be taken to development, deployment and removal of aeronautical systems;

– development of spectrally efficient CNS systems shall be promoted to minimize the demand for additional spectrum to support future aviation growth; and

– withdrawal of obsolete and redundant systems shall be promoted in compliance with the future deployment programme.

e) *Financial decision-making.* Aviation needs to take into account any spectrum impact on the financial decision-making processes by:

– ensuring cost effective technological evolutions; and

– minimizing the impact and timescales of technological transitions.

### 8.5.2.3 Details of the spectrum vision

8.5.2.3.1 Realizing a long-term vision requires a strategy and an associated plan of action to deliver the strategy. Civil aviation needs to adopt a single spectrum strategy which has been agreed by national representation under specified collaborative arrangements. This strategy should set out the high-level principles to be applied in aviation spectrum management, including process improvements and interactions required to ensure that the necessary spectrum for current and planned CNS systems is secured and maintained. Such an agreed strategy should also be under continual development.

8.5.2.3.2 Improved collaboration (though interconnected, there is a need to keep separate the short-term WRC-driven strategy and the long-term strategy/vision, and a need to take into account Appendix E of this handbook.)

8.5.2.3.3 The identification of spectrum requirements entails the collaboration of a broad range of aviation expertise:

a) strategic policy makers to provide a full understanding of aviation operational strategic requirements, and what and when particular capabilities and operational improvements are required;

b) CNS developers to gain a full understanding of system performance targets;

c) spectrum experts to identify the impact on spectrum requirements through compatibility and capacity studies. In fact, these studies are likely to trigger an iterative process between developers and spectrum experts, and this is a further reason for initiating this interaction at an early stage.

8.5.2.3.4 Additionally, disparate aviation functions need to be fully appraised of the bigger picture and not work in isolation. In this way, opportunities to maximize the effectiveness of existing spectrum allocated to aeronautical services and opportunities to share spectrum will be fully explored and understood while assisting the identification and mitigation of risks around potential single points of failure. These opportunities are generally driven by the system design but must take into consideration related spectrum issues if they are to be exploited through deployment.

8.5.2.3.5 Coordination among aeronautical spectrum managers, frequency managers, CNS policy makers and developers, deployment managers, aviation economists, etc. to collaborate within an international team will ensure that the civil aviation position is strengthened in the international arena. Demonstrating to regulators an efficient and robust spectrum management regime will also help to seal support in obtaining and retaining future spectrum needs for civil aviation. In an environment where resource constraints and dilution of critical expertise can have an adverse impact, improved collaboration within aviation will provide a direct benefit to the sector.

8.5.2.3.6 *Longer-term view*

8.5.2.3.6.1 There must be a focus on the future that the aviation sector wishes to create for itself over the maximum realizable period and harmonized to deliver the long-term operational needs. This long-term view, by necessity, must be robust but sufficiently flexible to accommodate the constantly evolving needs of the sector. While recognizing that there must be a strong drive towards reduced development cycles, the spectrum vision looks beyond those systems already in development towards the needs of conceptual systems. This indicates a need to set out a vision looking forty years hence.

8.5.2.3.6.2 In general, the spectrum vision will be applicable to all new developments. To the maximum extent possible, it is set out to support spectrum requirements for conceptual CNS systems beyond the timeline of existing strategic programmes, such as the GANP and ICAO Regional Plans. As the level of certainty will be diminished as the timeline extends, the ICAO spectrum vision focuses more

on generic principles rather than addressing the needs of specific equipment types and systems.

8.5.2.3.7 *Holistic CNS&S approach*

8.5.2.3.7.1 A major element of spectrum management is to provide the necessary support to the identification and promotion of systematic improvements designed to deliver greater spectrum flexibility and efficiency. Communications, navigation and surveillance all require spectrum and often require spectrum with identical or similar propagation properties. It is not appropriate for dedicated teams operating in isolation to identify their spectrum needs because their assumptions and actions may unwittingly impact on other teams' deliverables. For new systems, through the application of holistic arrangements, it will be possible to deliver spectrum efficiency in parallel with meeting the aspirations of CNS designers. Early identification of frequency band options, system bandwidth requirements and compatibility criteria will enable the identification and resolution of spectrum factors external to CNS. In this way, the associated spectrum-related risks can be mitigated and optimum choices for spectrum efficiency can be promoted for incorporation into the system design.

8.5.2.3.7.2 Therefore, there is a need for early, effective internal engagement with all responsible aviation and aerospace parties in the development of a holistic CNS&S strategy, which does not currently exist. Such a strategy is key to maximizing spectrum usage and availability, and it will strengthen aviation's position when dealing with regulatory authorities.

8.5.2.3.8 *Spectrum availability and financial decision-making*

8.5.2.3.8.1 In understanding the impact of spectrum on revenue, aviation is in a different position from many other sectors. Many commercial sectors, for example mobile communications, are able to demonstrate that there is a direct relationship between available bandwidth and potential revenue.

8.5.2.3.8.2 For aviation safety purposes, the relationship between bandwidth and revenue is indirect. In general, making available additional spectrum will not deliver increased revenue, unless it results in increased airspace capacity. However, failure to make available sufficient spectrum will have a negative impact on aviation and its global economic revenues.

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# Chapter 9

# INTERFERENCE PROTECTION CONSIDERATIONS

## 9.1 INTRODUCTION

The regulation and control of interference is essential to the safe and efficient operation of aeronautical radio services. An agreed framework of rules and preventative measures is thus an essential requirement. This framework is laid down in the Radio Regulations for observance by ITU members when cross-border cases of interference arise. National legislation then provides each State with the regulatory means to effect the discharge of the international obligation within its territory. This chapter describes the elements in this framework and contains the following specific sections:

– 9.2 Regulatory aspects

– 9.3 Management and control of interference

– 9.4 Assessment of protection for aeronautical radio services

– 9.5 Some special cases (e.g. VSAT, ISM)

– 9.6 General protection limits for aeronautical radio.

## 9.2 REGULATORY ASPECTS

**The basic definitions of interference and harmful interference**

9.2.1 The international framework of agreements for dealing with interference to radio services is contained in the ITU Radio Regulations. The provisions in these Regulations govern the circumstances and the procedures for seeking clearance action from other ITU administrations when interference occurs. The basic qualification for claiming protection is “conformity with the Radio Regulations” which implies that the radio service which is being interfered with is operating in an agreed frequency band and with characteristics which are specified in the Regulations, including its Appendices.

9.2.2 In the Radio Regulations the basic definition of interference is:

> **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.

9.2.3 It is to be noted that interference is defined by the way in which the interfered system operation is affected. Thus, any performance degradation, misinterpretation or loss of information which would not occur in its absence constitutes interference. The definition does not imply that it is measurable in a quantitative sense, although it may well be in certain instances, but that there has been an adverse change of some detectable character. The change may be detectable by primary means, either aurally (voice signals) or visually (radar or TV), or by measurement (loss of data, inaccurate information, etc.). In some cases, it may be easier or preferable to instrument and record or use the changed condition to give warning or to apply corrective measures. It is assumed also that interference in the sense employed in the Radio Regulations arises in all cases from sources outside the receiving system itself.

9.2.4 This basic definition of interference as stated in the Radio Regulations makes no reference to whether it is acceptable, but merely to the condition of its existence and its recognition. It is in the category of interference classed as harmful interference that the concept of unacceptability appears as a qualification or condition. This is clearly stated in the Radio Regulations as follows:

> **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).

9.2.5 This regulation introduces the concept of unacceptability and defines criteria with which to make the decision. It is notable that the definition has two quite separate elements, one for radionavigation and safety services, and one for all other radio services. The former requires only proof of endangerment of the functioning, but the latter must demonstrate that a serious degradation or disruption has occurred which is at a higher level of disturbance. Again, as in the case of interference above, the means of assessment is not prescribed and could be either subjective or quantitative. It is important to observe that for interference to be considered harmful, it must be to a service that is operating in accordance with the

Radio Regulations. In this respect, accordance with the Radio Regulations means the totality of the Radio Regulations, including the Appendices. A service which does not operate in accordance with the Radio Regulations cannot claim protection as a right under the Radio Regulations, although administrations may often respond positively to the best of their ability**.** It is to be noted that all aviation safety services are operating on frequencies according to allocations to the service concerned, whether the aeronautical mobile (R) service, the aeronautical mobile-satellite (R) service or the (aeronautical) radionavigation service, and to agreed characteristics, and are operating in accordance with the Radio Regulations, as normally specified in Annex 10. This framework recognizes that interference, in its general sense, is a condition whereby a parameter of a received signal is affected in some way but not necessarily to the extent of being damaging to the reception. The interfering service must cease the interference when it creates a situation in which the operator of the interfered service decides that the service cannot be used for its intended purpose. The action to be taken is to remove interference which can include the reduction of radiated power or closing of the transmitter.

**The treatment of harmful interference**

9.2.6 Harmful interference is the condition recognized throughout the Radio Regulations as establishing a case for complaint and for the removal of the sources causing the problem. Procedures, obligations and rules related to interference are given detailed attention in **Chapter IV** of the Radio Regulations. The reporting and clearance of harmful interference to a radio service is one of the rights established by a registration in the MIFR and is a right conferred in general terms in RR **8.1** and RR **8.3**. In international terms, it creates an obligation for the country operating the interfering service to take action. The Regulations do not, however, carry mandatory force, and negotiation is the only course of action to resolve difficulties.

9.2.7 Safety services, such as a radionavigation service or an aeronautical mobile (R) service, or in certain cases the aeronautical mobile-satellite (R) service, are safety services as defined in:

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

9.2.8 Harmful interference to a safety service always requires urgent attention, and this is recognized by all ITU administrations. Safety services include not only the aeronautical services, but also maritime and land mobile services when the messages have safety-of-life content.

9.2.9 Of particular interest to aeronautical services in this context are the provisions mentioned at Section 7-III-3.4 of this handbook. Also, the permission to operate without an identification for the testing of navaids is to be noted as at RR **15.16.** These measures provide a framework of regulatory actions which ensure that interference judged as harmful is cleared in an effective and expeditious manner.

**Radiation and emission**

9.2.10 The above terms are mentioned in the definition of interference, and it is important to understand their ITU interpretations in discussions on interference and its effects. Reference to RR **1.137** indicates that "radiation" is the generic category for any radio wave energy that is propagated either deliberately or inadvertently. As a subset, RR **1.138** states that "emission" is the case of radiation produced by a radio transmitting station and only by that source. Thus, radiation could either be the radio wave energy coming from a local oscillator in a receiver, or an instrument or machine used in medical or industrial purposes, while emission is exclusively the radio energy from a transmitting antenna.

**Unwanted emissions**

9.2.11 Generation of radio energy for RF transmission purposes generally includes signals other than those required for the efficient transmission and reception of the necessary information. When radiated, these have the potential to interfere. In the Radio Regulations, these unwanted emissions are defined as:

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

The definitions of these two elements are given below.

**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*.

**1.144** *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.*

9.2.12 The understanding of these definitions is completed by the definition of the term “necessary bandwidth”:

**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.

9.2.13 With increased congestion in spectrum utilization, this set of interlinking Regulations has become a highly important starting point for dealing with interactions between adjacent services, between services sharing the same frequency band, and in any other situation of frequency use conflict. A depiction of these relationships is in Figure 9-1.

9.2.14 The Regulations, in Appendix 3, specify a Table of Maximum Permitted Spurious Emission Power Levels. These refer to the power supplied to the antenna transmission line from the transmitter and are “never to be exceeded values”. It is recognized that more stringent levels may be laid down by Conference agreement or by special agreement between administrations. For system performance reasons, ICAO SARPs often specify more stringent levels, in effect, meeting the spirit of the “special agreement” requirements of the Regulations.

**Permissible interference and accepted interference**

9.2.15 The Regulations specify these two further classes of interference:

**1.167** *permissible interference*:* 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*: 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*.

***1.167.1** and **1.168.1** The terms “permissible interference” and “accepted interference” are used in the coordination of frequency assignments between *administrations*.

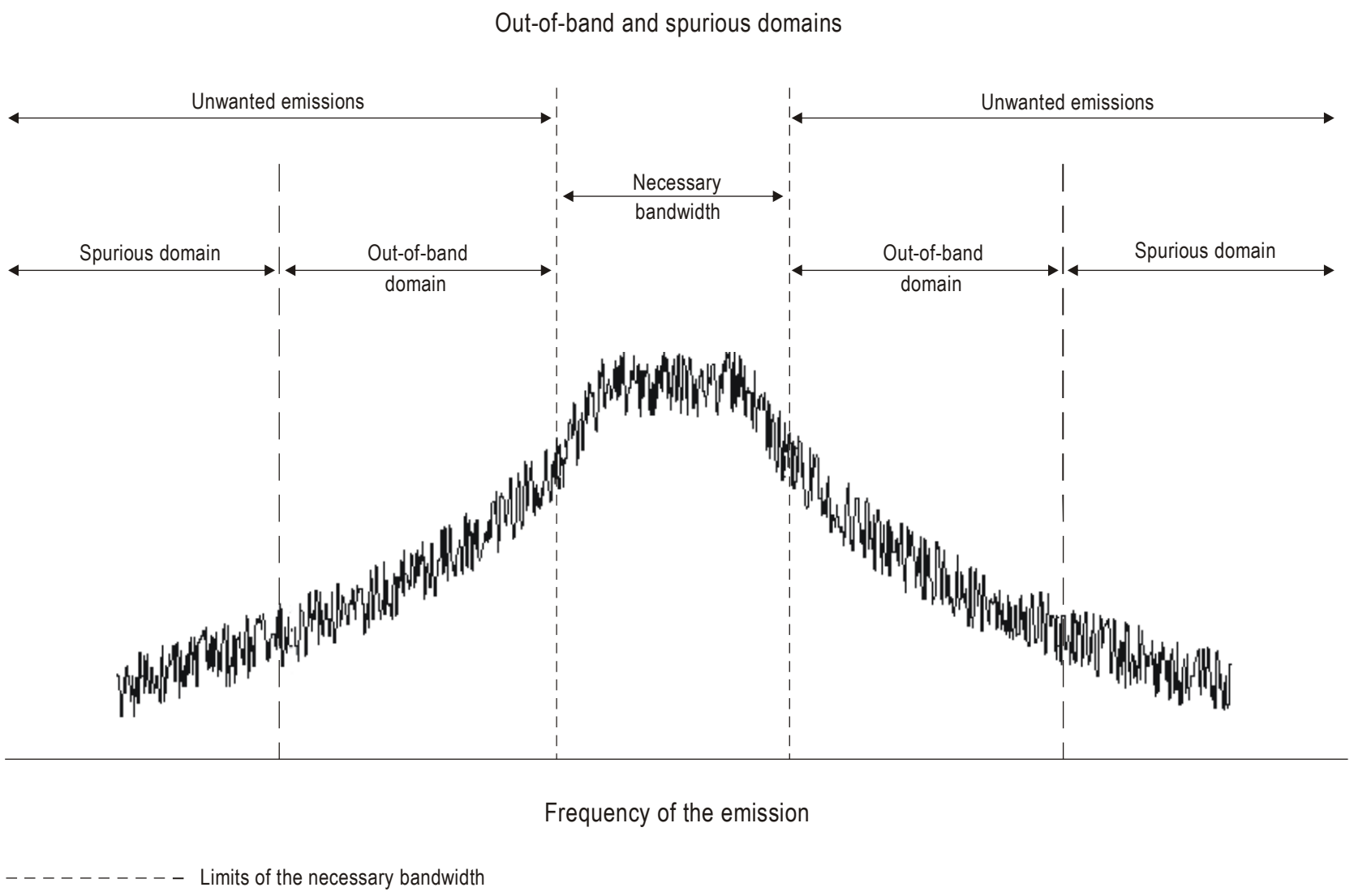


**Figure 9-1. Unwanted emissions**

9.2.16 These definitions have been developed to provide a basis for planning, and they highlight the fact that frequency planning is essentially a process involving the control of interference.

9.2.17 This concept of acceptability, based on quantitative criteria, can only be a conditional one since it cannot negate the freedom to state a complaint of harmful interference by a service suffering harmful interference. It would provide, nevertheless, a basis for review and adjustment of the criteria as a condition for the agreement to continue. In such a situation, it would be assumed that an aeronautical safety service would be permitted to continue to operate, with the prime obligation being on the interfering service to adjust, close down or take other immediate action to resolve the situation.

**Frequency sharing**

9.2.18 Assignment planning within a service is the most notable example of the concept of permissible interference and is the application of an agreed protection criterion to ensure that the strength of the unwanted signal from a like facility, or a similar facility in the same service (e.g. voice and data in the VHF communications band), is the agreed number of decibels below that of the wanted signal. In these cases, the acceptable performance change is normally minimal and quite often is a change in the noise floor or the received signal-to-noise ratio. This is highly important for systems such as VOR or ILS, or navigation systems in general, where the changes to the received signal are not easily detectable by the user. All of these quantitative criteria for in-service planning are developed by ICAO for harmonized worldwide application.

9.2.19 Non-safety-of-life services, willing to share a safety-of-life band, have to comply with the aviation safety requirements applicable in that band including certification of radio equipment, software and radio operators, as well as assumption of liability.

9.2.20 Frequency sharing has recently developed a new context with the addition of services other than aeronautical services to previously exclusive aeronautical bands. The criteria for acceptability in these cases are normally developed by the study groups of ITU-R and embodied in their recommendations. Bands where this procedure has already been applied are the aeronautical radionavigation bands at 5 000–5 250 MHz, 9 000–9 500 MHz and 15.4–15.7 GHz. As the spectrum is increasingly exploited and greater demands appear for further uses, the principle of sharing of allocations between two compatible services is likely to become more extensively relied on. In such discussions, the aviation service justifies its protection requirements. Final decisions are made at ITU conferences, sometimes against the best advice from the aviation community.

9.2.21 Sharing an allocation between two services normally places constraints on any future expansion and implementation of both services. This can ultimately be detrimental to aeronautical services whose expansion rate is slower than other, more commercially-based services, in effect resulting in a first-come, first-served situation. As mentioned above, the application of sharing criteria, whether covered by an ITU-R Recommendation or not, cannot negate the right to claim protection from harmful interference. Where the service interfered with has safety-of-life functions, harmful interference would normally require immediate termination or reduction of power of the interfering service until a permanent resolution has been found.

**Multiple interference inputs**

9.2.22 Assessments of interference effects and of acceptable levels tend to be conducted in isolation from one another. In any given practical situation, the net effect of many potentially interfering sources must be considered and due allowance made. An extra margin of at least 3 dB is recommended in general, with higher values in particular cases where a number of interference sources are known to exist (for example, see ITU-R Recommendation M.1343).

**Aviation safety factor**

9.2.23 Aeronautical safety applications are required to have continued operation through worst case interference, so all factors which contribute to harmful interference should be considered in analyses involving those applications. An aviation safety margin is included in order to address the risk that some such factors cannot be foreseen (for example impacts of differing modulation schemes). This margin is applied to the system protection criteria to increase the operational assurances to the required level. Traditionally for aviation systems/scenarios an aviation safety margin of 6–10 dB is applied. Until established on the basis of further study on a case-by-case basis, an aviation safety margin of not less than 6 dB should be applied.

**Electromagnetic compatibility (EMC)**

9.2.24 EMC is defined as the ability of a system to function satisfactorily in an electromagnetic environment without introducing intolerable electromagnetic disturbance to any other system in that environment.

9.2.25 Two elements, basically receiver rejection and transmitter unwanted emissions, are fundamental design parameters in the specification and engineering of radio systems to operate in their typical operating environment. They are normally addressed by national legislation, such as FCC Rules in the United States or ETSI

Standards in Europe. In many countries, they are a prerequisite to the approval of any equipment that generates radio frequency energy as a main functional source. This includes not only communications and navigation equipment but also computing equipment, industrial equipment, etc. The limiting values chosen are normally selected on the basis of best judgment and on the practical and economic factors applying in particular systems.

9.2.26 A good example of the essential need for EMC is in the case of the multiple radio systems (and, more recently, the digital control systems) used on board aircraft. In a modern transport aircraft, these can amount to systems operating in about 18 different frequency bands, with typically 35 antennas. Great care in the placement of antennas and in the internal cabling, and severe limitation of both output power and spurious products is necessary to maintain all installed systems within performance limits. Provisions addressing this point may be found in the specifications for airborne equipment produced by RTCA/EUROCAE and ARINC.

**Other important radio regulations**

9.2.27 Article **15** of the Radio Regulations lays down procedures and priorities for the actions to be taken in identifying, reporting and clearing interference. This material should be referred to for the detailed rules governing the circumstances, scope for reporting, and actions to be taken. Important provisions in the Radio Regulations are summarized below.

RR 15.16: Provides, in the aeronautical radionavigation service, for the removal of identification signals when tests or adjustments are being carried out.

RR 15.36: When the service being interfered with is a safety service, provides for direct communication to the administration having jurisdiction over the transmitting station causing the interference.

RR 15.40: Where there is a specialized agency (such as ICAO), reports of interference may be copied to that agency coincident with notifying the administration responsible for the station causing the interference.

RRs 15.41 to 15.46: Describe the procedure for the reference of disputes to the Radiocommunication Bureau. It should be noted that the Bureau has no power of enforcement, and its actions are solely those of investigation, reporting and arbitration.

**The registration of frequencies**

9.2.28 The Master International Frequency Register (MIFR) is held at the headquarters of the ITU in Geneva and is the document in which administrations may register their national frequency use. Following a request to the Radiocommunication Bureau, which is charged with the recording process, the assignment will be checked against the requirements of the Radio Regulations, and if in compliance, the frequency is recorded with the date of request. Later requests must protect any assignment with an earlier date. If a request is not in accordance with the Regulations, an entry may still be made, provided it does not interfere with a registered service, but the assignment will enjoy no protection from later registrations meeting the requirements. This is the so-called "non-interference basis". In the Radio Regulations, the status of recorded assignments is defined in Article **8,** and the notification procedure followed in the recording process is laid down in Article **11**.

9.2.29 Recorded assignments are the highest category of assignment and must always be protected. However, administrations normally accept an interference complaint provided the service is operating in accordance with the Regulations.

9.2.30 Apart from frequencies used for NDB or HF communications, aviation assignments are not registered with ITU on a systematic basis, although administrations may do so if they wish. The ICAO coordination, or the bilateral coordination in some world areas, has traditionally been accepted as a quasi-registration process. In these cases, the ICAO Regional Air Navigation Plan assumes the same role as the MIFR.

**Summary of regulatory processes**

9.2.31 The protection of aeronautical radio services is an end-to-end process, covered at all points by agreed technical protection criteria and by regulatory provisions, all of which are embodied in ITU Regulations, ITU-R Recommendations and aviation documents. Considerable attention is given in these to the needs of safety services, of which aeronautical services are examples. Exercise of the regulatory functions is the responsibility of national telecommunication administrations which have the necessary powers to license equipment which conforms to agreed specifications and to take action within their own jurisdiction, and with other administrations, to clear harmful interference. Important elements in these processes are:

– the existence of national and international agreements on safe planning criteria and practices;

– agreed mandatory equipment specifications which embody the necessary control of unwanted emissions and radiations;

– an assignment planning process which is safely applied and which is coordinated to the extent necessary with other services and administrations;

– the efficient and effective monitoring and reporting of interference;

– immediate attention to clearing cases of harmful interference to aeronautical radio services.

## 9.3 MANAGEMENT AND CONTROL OF INTERFERENCE

9.3.1 Interference of all kinds is an ever-present feature of all radio frequency bands, arising from the transmissions from a multiplicity of different radio services, increasing in quantity and in power almost daily. The higher power services, such as broadcasting, radar and some specialized defence systems, have a potential to cause considerable disruption and must be carefully controlled. In addition to radio services, there are many other sources of interfering radio energy, such as industrial and medical machinery, motor vehicles, power transmission lines and many other electrical and electronic sources. Over cities and industrial areas particularly, the ambient radio noise can attain quite high levels making the detection of weak signals difficult, and on occasion impossible, affecting in particular the reception of radio in aircraft.

9.3.2 The management and control of the interference present in the radio environment is a highly important supplementary activity to that of the management of the radio spectrum itself. As with spectrum management, the overall process is a layered activity with international agreement on fundamentals in the upper layer, followed by national legislation and enforcing machinery. Good management and minimization of harmful products also increases the effective utilization of frequencies.

9.3.3 The basic elements in the process are:

***International agreement on the regulatory basis.*** The elements of the basic regulatory framework are contained in the Radio Regulations and have been described above. These define a set of principles and actions which are designed to provide administrations with agreed understandings for use with

other administrations and internally within their own countries. This activity is international in character and is centred on the ITU in the first instance. ITU Regulations are treaty obligations and in respect of interference clearance are conscientiously followed. Where normal negotiation fails to resolve an issue, there is scope for reference of problems to the ITU Radio Regulations Board. However this is not a compulsory arbitration procedure, and in the unlikely event that this fails, the service suffering the interference may have to take independent action.

***System and equipment standards.*** Development of standards and specifications for systems and equipment is the second step in the process. The standards and specifications must contain essential performance requirements relating to the maximum permitted levels of unwanted emissions. Internationally developed standards, such as those in aviation agreed by ICAO and RTCA or in ITU-R Recommendations, and in Europe those of Eureka and ETSI, have to incorporate clauses addressing these aspects. The Spurious Emission Limits at Appendix 3 of the Radio Regulations are "never to be exceeded" limits and negotiations are often necessary to analyse individual situations and specify levels below those in the Regulations. Most Annex 10 SARPs for adjacent channel frequency planning specify levels that are lower than those in Appendix 3. A recent example of individual negotiation may be found in the case of mobile-satellite equipment operating in bands adjacent to that of GNSS with the potential to interfere with approach and landing of aircraft. In this case, it was necessary to have agreement in both ITU-R and ETSI.

***Licensing of radio services.*** Within national territory, legislation is necessary to provide the enforcement powers to manage and control the processes at the operating level. National telecommunication authorities hold this responsibility for the licensing of all radio services within their jurisdiction. In this process, the authority must ensure that the radio system is approved to agreed standards, that its EMC performance is adequate, and that it operates with characteristics which are in accordance with international agreements. The national telecommunication authority remains the regulating body for its operation in regard to interference with other radio services. The most important international obligation is to the Radio Regulations and ITU-R Recommendations; others may be regional standards such as those developed in Europe by ETSI. In the case of radio for civil aviation safety purposes, both ground and airborne, other requirements may be applied emanating from ICAO SARPs, RTCA and EUROCAE specifications, and for airworthiness purposes, the TSO laid down by the FAA in the United States and the JAA in Europe.

***Control and clearance of interference.*** As with radio licensing, the responsibility for control and clearance of interference will normally rest with the national telecommunication authority under the same national legislation which addresses the detecting, the resolving and, if necessary, the closing down of sources of interference. This will include, in addition to radio stations, licensed or unlicensed, any equipment or system capable of radiating and causing interference. Many industrial, scientific, computer and line transmission systems have the potential for interference. If the service is a safety service, action must be taken on an urgent basis. Identification of an interference source is a difficult and often time-consuming activity. Some aviation authorities have found it beneficial in effecting a speedy clearance to assist the national telecommunication authority by local detection actions in which local knowledge is used to good advantage.

## 9.4 ASSESSMENT OF PROTECTION FOR AERONAUTICAL RADIO SERVICES

**The nature of interference and its detection**

9.4.1 Interference may not result in a change in the receiver output signal. Particular care is necessary with systems in which the output is neither aural nor visual, such as digital systems or systems where the output is used to operate control systems, where interference may not be detected for some time. The task of assessing the threat posed by other signals so as to make a decision of acceptability, for example in allocation sharing, must however have a basis which is logical and amenable to analysis.

9.4.2 For the assessment of compatible sharing with other radio services (a situation becoming more common), or where the threat is unwanted emissions from a known non-aviation system, a quantitative criterion has to be stated and used as a reference for decision-making. For this purpose, a maximum interference threshold limit is normally chosen which has been selected on the basis of acceptable degradation, taking into account all other environmental conditions. In the absence of other data, the usual planning ratio for wanted-to-unwanted signals within the aviation service should be enhanced to give a margin for uncertainties which cannot be quantified (see 9.2.23).

9.4.3 At higher frequencies in the GHz ranges, and for wide-band low signal services, the criterion often used is the acceptable increase in the noise floor, or the noise temperature, of the receiving system. Antenna gains or losses are included to replicate real-life conditions. The final approach and landing phase is accepted as

being the most important of the safety-critical services. The model described below is recommended for this analysis.

**The concept of a generalized assessment method**

9.4.4 Many interference predictions have to be assessed on the basis of theoretical analysis. An agreed standard model and methodology is used as a basis for comparing the results of separate analyses and in formulating a conclusion on acceptability. The need to predict interference will arise in many different situations and, particularly, in the case where a decision on acceptable sharing of an allocation by two services is the issue. Real-life conditions are not accurately predictable, and theoretical analysis will invariably have to be verified under actual operational conditions before full acceptance is given to any proposal for sharing.

9.4.5 The effects of interference and the particular form of the signal degradation that it causes are usually dependent on the characteristics of the interfering signal. Pulsed and continuous-type signals often produce different results, with one or the other having more objectionable effects, or with more invasion of the demodulating process. Whenever data relating to the effects of specific modulations are available, these should be used to provide near realistic analyses of the interference situation. Tests and experiments should carefully replicate the actual interference situation as closely as possible, and quantitative analysis should clearly indicate the relevance of the criteria to the case in question.

**Variables**

9.4.6 In the minimization of the effects of interference there are four main areas on which to concentrate efforts to make improvements:

***The source of the interfering signals.*** Control of the source is often the only practical means of protecting aviation radio services. This can take many forms depending on the nature of the potentially interfering signal. For radio transmitters, close control of unwanted emissions is essential, and the use of only necessary transmitting power to meet the requirements stated in RR **15.2** is also a discipline for operators of stations. Control at source is dependent on effective measures at a national licensing level, and these measures themselves should be aligned with standards agreed internationally, either globally or regionally.

A particular example is that of industrial, scientific and medical (ISM) equipment which use the heating effect of radio wave energy, are potential sources of interference, and are required to operate only in designated bands and exercise control and monitoring in accordance with RR **15.13** (see 9.5 below).

Another recent example is that of mobile-satellite terminals operating in bands close to GNSS services, for which ITU-R and ETSI standards have been developed.

***Frequency separation.*** Where the interfering source operates on a discrete frequency, the provision of a frequency separation, or guard band, between the source and the receiver may be employed to provide the requisite protection. In using this, account can be taken of the receiver's rejection response to reduce the overall effect.

***Distance separation between the interference source and the aviation receiver.*** Distance separation to reduce the energy of the potentially interfering signal to an acceptable level is a standard method of establishing the protection necessary in many practical applications. It is the method normally employed in assignment planning, for which purpose agreed protection and propagation path criteria are used in the calculation. In coordination between two services, a limiting value of separation, based on worst-case evaluation beyond which no coordination is required, is often employed. Another notable example is the analysis of final approach situations where a typical minimum separation distance between source and receiver may be chosen and used in calculations to establish the acceptability of proposed maximum spurious levels. (An ITU-R standard model for approach and landing has been developed.)

***The aviation receiver.*** Receivers having a good interference rejection performance are now, in an ever-increasingly crowded spectrum, an essential requirement. No service user can claim protection until the receiving equipment employed in that service has been designed and built with full regard to this requirement. The Radio Regulations in RR **3.3** make mention of this obligation to take all measures which are economically and technically justifiable to minimize the effects of transmissions, particularly in adjacent bands, and RRs **3.12** and **3.13** require that radio receivers should have adequate performance to minimize the effects of signals outside the occupied bandwidth. The principle applied is based on the joint responsibility of both the service that is vulnerable and the potential interferer to share equally the burden of compatibility. Where the affected service is a safety service, such as aeronautical radionavigation or communications, the same general considerations apply, and receivers are expected to be resistant to expected interferences. An example of this is the case of VOR and ILS receivers operating adjacent to FM broadcasting.

9.4.7 Consideration of the above four elements leads to the concept of a "standard model" for use as a tool in theoretical assessments. This is described below.

**The standard model**

9.4.8 The source-path-receiver model is a three-element simulation of actual conditions that is commonly used for assessing on a quantitative basis the acceptability of specific limits on the production of interfering products. The analysis may be a single evaluation or an iterative simulation depending on the data and facilities available. The model is deterministic in its application to the analysis of aeronautical radio services protection. That is, the receiver susceptibility mask, the antenna losses or gains, and the propagation path and its variabilities are all considered at their worst-case limits. From these considerations the ideal radio frequency interference (RFI) source mask may be estimated and tested for practical realism. A process of adjustment of the variables, particularly distance separation, would follow to arrive at agreed standards, which if necessary may then be embodied in regulatory material.

9.4.9 Important points in the analysis are:

***Service volume.*** The aeronautical protection point and the service volume chosen must take account of agreed and specified service volumes as stated in the Annexes or in other defining documentation. Normally, this would be the nearest service volume extremity to the interfering source. This is the case where the source is outside the service volume. Where the source is close to the receiver, such as during a landing operation, a carefully prepared scenario should be used. That recommended in ITU-R Recommendation M.1343 has been prepared by ICAO Panels and may be used in many cases.

***Receiver susceptibility.*** The receiver criterion for acceptable degradation has to be carefully chosen. It must relate as appropriate to a detected change in a measurable parameter, or in perceived aural or visual reference, or in increase in error rate or other relevant characteristic, depending on the form and content of the receiver output. The receiver must under all conditions, with and without normal signal input, operate within its standard performance envelope, including measurement error limits, taking account also the real-life environment and other known interfering sources, in arriving at the limits for receiver susceptibility. Unacceptable change to the noise floor may be used as the datum for systems in the higher frequency bands, for example, in assessing interference to radar.

***Propagation data.*** The best available propagation data, usually that documented in CCIR and ITU-R Reports, should be used. Account must be taken of the variability which applies to all propagation modes, and particularly where the separation distances are at the limits, near or beyond the radio horizon, or where seasonal phenomena, such as night effect at LF/MF, ducting

at VHF, or ionosphere conditions at HF, exist. Natural features or shielding, such as that provided by terrain or by the aircraft body, may be included if they are permanent features present in all cases of interest. In many cases, free space attenuation may be used as the reference level in calculations, especially above 1 GHz and where the distance separation exceeds 20 km.

***Installation conditions.*** Variables such as antenna system losses, antenna gain in particular directions, terrain shielding or, in the case of aircraft installations, the effects of the aircraft body, may be included as variations from standard scenarios to produce more refined results in particular cases. Similarly, the interfering source conditions may be treated in the same way as a means to arrive at practical results.

**The institutional processes for protection discussions and agreements**

9.4.10 The ITU Radiocommunication Assembly adopts Recommendations dealing with all aspects of radio. This includes the interference aspects and sharing between services. Increasing congestion and sharing of two services on the same frequency has caused this activity to increase in intensity and depth. As spectrum congestion spreads, this activity is likely to increase further. Adjacent band services with a high differential in power levels, such as FM broadcast and mobile-satellite terminals, are typical real-life problem areas encountered by aviation services. The strategic siting of services in the Table of Frequency Allocations to minimize adjacent band problems is no longer practicable because of the pressures to meet requirements wherever they can be fitted in.

9.4.11 ITU-R Recommendations, resulting from the work of Study Groups, are the normal means of documenting the conclusions and agreements on technical bases. While these are generally only voluntary in their application, they are nevertheless applied conscientiously by administrations and by industry. The exceptions are a few special category subjects – NDB signal levels is one – where a linking reference placed in the Radio Regulations gives a Recommendation the same treaty status as a Regulation.

9.4.12 ITU-R Study Groups 4 and 5 are the most important for aviation and deal with all mobile services, satellite and terrestrial, and with radionavigation of all kinds. WP5B and WP4C are the principal subcomponents.

9.4.13 Extensive collaboration between all vested interests, including regulatory agencies, is required for future spectrum coexistence. Spectrum strategies should account for the continued use of current and planned safety-of-life systems and accounting for the different technological evolution of aeronautical RF systems.

Early engagement by the aviation industry and its air safety regulators with external industries, including sharing appropriate technical characteristics for sharing and compatibility studies by all stakeholders, will seek to ensure common understandings.

9.4.14 The need for an enhanced coexistence framework to protect aeronautical spectrum, while enabling the growth of commercial wireless communications, is necessary to provide a balanced perspective for future spectrum management. In this context, the ITU-R plays a vital role in developing ITU-R Recommendations and Reports studying technical and operational characteristics and recommending measures to maximize efficient use of the frequency spectrum, while mitigating potential interference from new spectrum allocations. The ITU-R is positioned to study and determine thresholds for out-of-band and adjacent-band emissions from wireless communications specifically tailored to protect aeronautical systems. ITU-R Recommendations and Reports can be used to support educational and awareness initiatives that can form a critical component in obtaining telecommunications and aviation regulator support for protecting aeronautical spectrum.

## 9.5 SOME SPECIAL CASES

### Industrial, scientific and medical (ISM) equipment

***Definition and description***

9.5.1 The definition for ISM applications appears at RR **1.15** and is:

> **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*.

9.5.2 This definition is intended to include a wide range of equipment in which the heating effect of RF energy is utilized to perform industrial and medical processes. High powers can be generated especially for such processes as metal hardening (e.g. car engine crankshafts), but the application area is local to the RF head. Measurement standards are often difficult to define, and this is particularly true in the case of large equipment assembled on site. Electromagnetic screening measures must be efficient in constraining the escape of energy and effective in maintaining that level of protection.

***Radio Regulations***

9.5.3 In the Radio Regulations, ISM does not fall within the definition of a radio service and is hence not subject to any of the provisions of the Regulations. Nevertheless, frequencies are designated for ISM use with the condition that radio services must accept interference if they are operated on the same frequencies. The text of the Regulation concerned is:

> **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**.

The text of RR **15.13** is:

**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.

9.5.4 In the above list (RR **5.150**), particular attention has to be given to the frequencies in the 13 MHz and 27 MHz bands, since harmonics of these fall into both the ILS/VOR and the VHF COM bands with the potential in each case to affect a number of assignment points within each harmonic spread (as indicated in Figure 9-2).

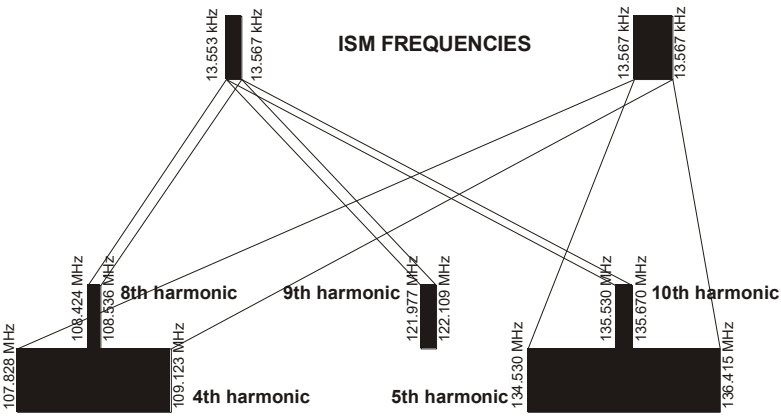


**Figure 9-2. ISM frequencies**

***Control of ISM equipment***

9.5.5 International action to agree on standards and conditions for the radio frequency radiations from ISM equipment takes place under the aegis of the International Special Committee on Radio Interference (CISPR), which is a component of the International Electrotechnical Commission (IEC). These standards are voluntary, and it is the responsibility of national authorities to decide on the extent and the nature of their national legislation required for the control of interference from these systems.

***ITU-R Recommendations and CISPR publications***

9.5.6 ITU-R Recommendation SM-1056 recommends the use of CISPR Publication 11 as a guide for the application of limits and methods of measurement for ISM equipment.

**Very small aperture terminals (VSAT)**

9.5.7 Aviation safety in certain regions of the world has been compromised by a lack of reliable fixed aeronautical telecommunications infrastructure used for providing air traffic services/direct speech (ATS/DS) and aeronautical fixed telecommunications network (AFTN) voice and data services. Service providers, working together with air traffic and navigation services and civil aviation authorities, have introduced C-band very small aperture terminal (VSAT) networks to resolve the lack of communications. The use of C-band allows for maintaining a reliable connection in all weather conditions; something that networks operating at higher frequencies would not support. The basic networks evolved with improving technology and are currently used in a number of regions to support all aeronautical communications services including the extension of VHF aeronautical mobile, navigation and surveillance. VSAT networks are also used for data links for the meteorological services. VSAT networks constitute a real infrastructure, spanning, for example, the entire African continent and beyond. Aviation access to the entire 3 400–4 200 MHz FSS (space-to-Earth) band and the associated 5 850–6 725 MHz FSS (Earth-to-space) band (5 725–6 725 MHz in Region 1) is crucial to ensure the continued growth of traffic while maintaining the required level of safety in this region.

9.5.8 During WRC-07, the issue was addressed whether the band 3 400–4 200 MHz should be identified for the international mobile telecommunications (IMT) on a global basis. After study, global identification was rejected because of the recognized need to protect FSS communications from harmful interference. “Opt-in” footnotes were adopted, however, in portions of the band in all of the ITU

Regions. In particular, allocations supporting IMT were adopted for eighty-one countries in Region 1 for the band 3 400–3 600 MHz and fourteen countries in Region 2 for the band 3 400–3 500 MHz. The 3 500–3 600 MHz band has also been identified for IMT in countries that opt-in in Region 3. At WRC-15, the issue was revisited, and the band 3 400–3600 MHz was identified for IMT for the entirety of Regions 1 and 2 and for eleven Region 3 countries, and the band 3 600–3 700 MHz was identified for IMT in four Region 2 countries. The current situation is described in RR Nos. **5.430A**, **5.431B**, **5.432A**, **5.432B**, **5.433A** and **5.434**.

9.5.9 Interference cases from IMT into VSAT were experienced after the WRC-07 decision. Tests indicated that interference was not caused by co-channel IMT/VSAT assignments, but by the harmonic content in the side lobes of the radiated IMT signal into the VSAT. As a result, WRC-15 improved technical and regulatory conditions in order to support existing and future operations of VSAT within the frequency band 3 400–4 200 MHz as an aid for safe operation of aircraft. In particular, the conference modified Resolution **154 (Rev. WRC-15)** to underscore the protection needs of existing and planned aeronautical and meteorological VSAT stations. The modified Resolution also highlights the need to license the VSAT stations and register them in the MIFR to ensure that they are visible to all administrations concerned.

**Radio Altimeters and 5G Deployment**

9.5.10 The international aviation industry has noted with concern the deployment of 5G telecommunications infrastructure, in certain frequency bands, that causes harmful interference to radio altimeters. The frequency band (4 200-4 400 MHz) is used by the radio altimeter which is a mandated aircraft safety system used to determine an aircraft's height above terrain. This information is essential to enable several safety-related flight operations and navigation functions on all commercial aircraft as well as a wide range of other civil aircraft.
Conversely, commercial telecommunications entities have an expectation that having invested in and been licensed by government agencies for 5G operations in spectrum proximate to the radio altimiter frequency band, there should be no further technical barriers to the deployment.

9.5.11 Technical and operational mitigations by the international aviation industry and the 5G telecommunications industry have provided temporary relief for coexistence. However, the international aviation industry has had to incur the burden of the costs for coexistence and the mitigations from both sides are unsustainable as a long-term strategy.

## 9.6 GENERAL PROTECTION LIMITS FOR AERONAUTICAL RADIO

The limits displayed in Table 9-1 are intended to give general guidance. For individual analysis, reference should be made to the complete definitive texts in the authoritative documents. Particular attention in these cases needs to be given to the specific spectral characteristics of the interfering systems.

**These limits can ONLY be applied to assess intra-system interference and CANNOT be used to assess compatibility between systems with different RF or spectral characteristics.**

**Table 9-1. General protection limits**

***Not to be used for assessing compatibility with dissimilar systems***

| | *Use* | *Frequency band* | *Minimum signal dB (uV/m)* | *Intra-system planning protection ratio DB* |
|---|---|---|---|---|
| 1 | Omega | 10–14 kHz | | |
| 2 | NDB | 190–850 kHz | 37 (1) | 15 |
| 3 | HF communications | 2.8–22 MHz | | 15 |
| 4 | ILS marker beacon | 74.8–75.2 MHz | 46 (1) | 20 |
| 5 | ILS localizer | 108–112 MHz | 40 (1) | 20 |
| 6 | VOR | 108–118 MHz | 39 (1) | 20 |
| 7 | VHF communications | 118–137 MHz | 37 (1) | 14 |
| 8 | ILS glide path | 328.6–335.4 MHz | 52 (1) | 20 |
| 9 | ELT | 406 MHz | | |
| 10 | DME | 960–1 215 MHz | 71 (1) | 8 |
| 11 | SSR | 1 030–1 090 MHz | | |
| 12 | Primary radar (23 cm) | 1 215–1 350 MHz | | |
| 13 | Satcom (s-E) | 1 525–1 559 MHz | | |
| 14 | GPS | 1 559–1 610 MHz | –160 dBW (2) | |
| 15 | GLONASS | 1 559–1 610 MHz | –160 dBW (2) | |
| 16 | Satcom (E-s) | 1 626.5–1 660.5 MHz | | |
| 17 | PSR (10 cm) | 2 700–3 300 MHz | | |
| 18 | Radio altimeter | 4 200–4 400 MHz | | |
| 19 | MLS | 5 030–5 150 MHz | 58 | 20 |
| 20 | Air weather radar | 5 350–5 460 MHz | | |
| 21 | Air weather radar | 9 345–9 375 MHz | | |
| 22 | Primary radar (3 cm) | 9 000–9 500 MHz | | |

| | *Use* | *Frequency band* | *Minimum signal dB (uV/m)* | *Intra-system planning protection ratio DB* |
|---|---|---|---|---|
| 23 | Air Doppler navigation | 13.25–13.4 GHz | | |
| 24 | ASDE | 15.4–15.7 GHz | | |
| 25 | RSMS | 15.4–15.7 GHz | | |
| 26 | ASDE | 24.25–24.65 GHz | | |
| 27 | ASDE, EFVS | 31.8 – 33.4 GHz | | |
| 28 | FOD | 92 – 95 GHz | | |
| 29 | EFVS, FOD | 95 – 100 GHz | | |

*Notes.—*
1. *Signal levels specified in Annex.*
2. *At receiver terminals.*

# Attachment A

# DEFINITIONS AND TERMS USED IN THE ITU RADIO REGULATIONS RELEVANT TO AVIATION

## 1. INTRODUCTION

Article 1 of the Radio Regulations contains all of the definitions used in the Radio Regulations in relation to their interpretation. Some of the most important definitions for aeronautical services have been extracted and are reproduced in this attachment. Reference should be made to the full catalogue of definitions in Article 1 in cases where there is a need to appreciate their hierarchical structure.

**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*.

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

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

**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.

**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.

**1.24** *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.

**1.32** *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.

**1.35** *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.

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

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

**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.

**1.46** *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.

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

* (R): Route

**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 radio- communication*.

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.

**1.65** *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.

**1.66A** *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.

**1.81** *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.

**1.87** *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.

**1.92** *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.

**1.100** *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.

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

## 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).

## 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*.

**1.144** *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*.

**1.147** *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*.

**1.153** *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 β/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 β/2 should be taken as 0.5%.

**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.

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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 |
|---|---|---|---|
| **1.144** | Emission hors bande | Out-of-band emission | Emisión fuera de banda |
| **1.145** | Rayonnement non essentiel | Spurious emission | Emisión no esencial |
| **1.146** | Rayonnements non désirés | Unwanted emissions | Emisiones no deseadas |

## 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*:* 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*: 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.

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* **1.167.1** and **1.168.1** The terms “permissible interference” and “accepted interference” are used in the coordination of frequency assignments between administrations.

# Attachment B

# ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| **AAC** | Aeronautical administrative communications |
| **ACAS** | Airborne collision avoidance system |
| **ACP** | Aeronautical Communications Panel (ICAO) |
| **ADF** | Automatic direction-finding equipment |
| **ADS** | Automatic dependent surveillance |
| **ADS-B** | Automatic dependent surveillance-broadcast |
| **ADSP** | Automatic Dependent Surveillance Panel (ICAO) |
| **AEEC** | Airline Electronic Engineering Committee |
| **ALS** | Aircraft landing system |
| **AM(OR)S** | Aeronautical mobile (off-route) service (ITU) |
| **AM(R)S** | Aeronautical mobile (route) service (ITU) |
| **AMS(OR)S** | Aeronautical mobile-satellite (off-route) service (ITU) |
| **AMS(R)S** | Aeronautical mobile-satellite (route) service (ITU) |
| **AMSS** | Aeronautical mobile-satellite service |
| **AMT** | Aeronautical mobile telemetry |
| **ANC** | Air Navigation Commission (ICAO) |
| **AOC** | Aeronautical operational control |
| **APC** | Aeronautical passenger communications |
| **APT** | Asia Pacific Telecommunity |
| **ARINC** | Aeronautical Radio Inc. |
| **ARNS** | Aeronautical radionavigation service (ITU) |
| **ASDE** | Airport surface detection equipment |
| **ASMG** | Arab Spectrum Management Group |
| **ATC** | Air traffic control |
| **ATM** | Air traffic management |
| **ATS** | Air traffic service |
| **ATU** | African Telecommunications Union |
| **AWOP** | All Weather Operations Panel (ICAO) |
| **AWR** | Airborne weather radar |
| **CAT** | Category (of landing) |
| **CCIR** | International Radio Consultative Committee |
| **CDMA** | Code-division multiple access |
| **CEPT** | Conférence Européene des Administrations des Postes et des Télécommunications (European Conference of Postal and Telecommunications Administrations) |
| **CISPR** | International Special Committee on Radio Interference |

| | |
|---|---|
| **CITEL** | Comisión Interamericana de Telecomunicaciones (Inter-American Telecommunication Commission) |
| **CNS** | Communications, navigation and surveillance |
| **COSPAS/SARSAT** | International Satellite System for Search and Rescue |
| **CPM** | Conference Preparatory Meeting (ITU) |
| **DGNSS** | Differential global navigation satellite system |
| **DME** | Distance measuring equipment |
| **DME/N** | Distance measuring equipment-normal |
| **DME/P** | Distance measuring equipment-precision |
| **DSB** | Double sideband |
| **DSB-AM** | Double-Sideband Amplitude Modulation |
| **EASA** | European Union Aviation Safety Agency |
| **e.i.r.p.** | Equivalent isotropically radiated power |
| **ELT** | Emergency locator transmitter |
| **EMC** | Electromagnetic compatibility |
| **EPIRB** | Emergency position-indicating radio beacon (ITU) |
| **e.r.p.** | Effective radiated power |
| **ETSI** | European Telecommunications Standards Institute |
| **EUROCAE** | European Organisation for Civil Aviation Equipment |
| **FAA** | Federal Aviation Administration |
| **FANS** | Future air navigation systems |
| **FCC** | Federal Communications Commission |
| **FDMA** | Frequency division multiple access |
| **FIS-B** | Flight information service-broadcast |
| **FM** | Frequency modulation |
| **FSMP** | Frequency Spectrum Management Panel (successor of ACP WG/F (frequency)) |
| **FSS** | Fixed-satellite service (ITU) |
| **GBAS** | Ground-based augmentation system |
| **GLONASS** | Global navigation satellite system |
| **GMDSS** | Global Maritime Distress and Safety System |
| **GNSS** | Global Navigation Satellite System |
| **GPS** | Global positioning system |
| **GPWS** | Ground proximity warning system |
| **GSO** | Geostationary orbit |
| **HF** | High frequency |
| **HFDL** | High frequency data link |
| **IATA** | International Air Transport Association |
| **IEC** | International Electrotechnical Commission |
| **ILS** | Instrument landing system |
| **IMO** | International Maritime Organization |
| **IMT** | International mobile telecommunications |
| **ISM** | Industrial, scientific and medical |

| | |
|---|---|
| **ITU-R** | International Telecommunication Union<br>– Radiocommunication Sector |
| **ITU-T** | International Telecommunication Union<br>– Telecommunication Standardization Sector |
| **JAA** | European Joint Aviation Authorities |
| **LDACS** | L-band digital aeronautical communication system |
| **LF** | Low frequency |
| **MASPS** | Minimum aviation system performance standards |
| **MES** | Mobile Earth station |
| **MF** | Medium frequency |
| **MIFR** | Master International Frequency Register |
| **MLS** | Microwave landing system |
| **MOPS** | Minimum operational performance standards |
| **MOU** | Memorandum of Understanding |
| **MPR** | Multi-purpose radar |
| **MPS** | Minimum performance specification |
| **MSPSR** | Multi-static primary surveillance radar |
| **MSS** | Mobile-satellite service (ITU) |
| **MWARA** | Major world air route area (ITU) |
| **NDB** | Non-directional radio beacon |
| **NGSO** | Non-geostationary orbit |
| **NM** | Nautical mile(s) |
| **NSP** | Navigation Systems Panel (ICAO) |
| **OR** | Off-route |
| **PAR** | Precision approach radar |
| **PRF** | Pulse repetition frequency |
| **PSR** | Primary surveillance radar |
| **R** | Route (or en route) |
| **RCC** | Regional Commonwealth in the Field of Communications |
| **RDARA** | Regional and domestic air route area (ITU) |
| **RDSS** | Radiodetermination satellite service (ITU) |
| **RF** | Radio frequency |
| **RLS** | Radiolocation service |
| **RNAV** | Area navigation |
| **RNS** | Radionavigation service |
| **RNSS** | Radionavigation-satellite service |
| **RPAS** | Remotely Piloted Aircraft Systems |
| **RR** | Radio Regulations (ITU) |
| **RSMS** | Radar sensing and measurement system |
| **RTCA** | RTCA Inc. (Radio Technical Commission for Aeronautics) |
| **SARPs** | Standards and Recommended Practices |
| **SIT** | Shipborne interrogator-transponder |
| **SMGCS** | Surface movement guidance and control system |

| | |
|---|---|
| **SRD** | Short-range device |
| **SSB** | Single sideband |
| **SSR** | Secondary surveillance radar |
| **TACAN** | UHF tactical air navigation aid |
| **TIS-B** | Traffic information service-broadcast |
| **TSO** | Technical Standard Order |
| **UAS** | Unmanned aircraft systems (equivalent ICAO acronym is RPAS) |
| **UAT** | Universal access transceiver |
| **UHF** | Ultra high frequency |
| **UWB** | Ultra-wide-band |
| **VDL** | Very high frequency digital link |
| **VGE** | Voluntary Group of Experts (ITU) |
| **VHF** | Very high frequency |
| **VOLMET** | Meteorological information for aircraft in flight |
| **VOR** | VHF omnidirectional radio range |
| **VSAT** | Very small aperture terminal |
| **WAAS** | Wide area augmentation system |
| **WAIC** | Wireless avionics intra-communications |
| **WARC** | World Administrative Radio Conference (ITU) |
| **WP** | Working Party (ITU) |
| **WRC** | World Radiocommunication Conference (ITU) |

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# Attachment C

# THE REGULATION OF RADIO EQUIPMENT IN AIRCRAFT

## 1. INTRODUCTION

This attachment describes the processes for the regulation of the radio equipment carried by civil aircraft. It identifies and highlights, in particular, the essential role of the agreements made in the ITU as they affect the radio systems carried by aircraft for air navigation. In this examination, it separates the two distinctive and complementary areas of regulation; the first for telecommunications, and the second for aviation safety. Compliance with both is necessary before any international flight can be undertaken. It shows that the constituent parts of these regulatory processes have some functions arrived at through the process of international agreements, which are then incorporated into national regulations, and others (particularly the development of performance standards) which are developed by voluntary agreement between all interested parties and then adopted by national law as the basis of the regulation.

## 2. BACKGROUND

2.1 Modern aircraft are equipped with many radio systems operating in different frequency bands ranging. Approximately half of the systems have both transmit and receive functions, and the remainder are receive only. Three are for primary communications purposes, and up to twelve are for radionavigation functions, including three which have integral and complementary data links. In the course of a flight, an aircraft may traverse territory other than that of its State of Registry and must therefore be regulated within a systematic framework of internationally agreed rules. These rules must ensure that the flight is safe for passengers and crew, and free from risk of damage to persons and property on the ground. As a part of this regulatory process, the radio installations must conform to agreed performance standards, must operate in correct frequency bands, must be licensed by appropriate authorities, and be operated by licensed personnel.

2.2 The regulatory framework to ensure these requirements has, as its basis, two quite separate international agreements which are implemented at the national level by two sets of national regulatory bodies. An outline description of the organizational elements of this framework is given below.

## 3. THE REGULATORY FRAMEWORK

**Telecommunications regulation**

3.1 ITU World Radiocommunication Conferences agree upon the allocation of radio frequency bands to be used for aeronautical communications and radionavigation which are then incorporated in the Radio Regulations as part of Chapter II, Frequencies. In this chapter, Article 5, Frequency Allocations, contains the frequency allocation limits, the geographical scope and the status of the allocation, the sharing with other services, and any special conditions which apply. Chapter VIII of the Radio Regulations, on Aeronautical Services, deals with licensing, inspection, infringements, interference and related matters for aeronautical radio stations. The basic technical parameters for frequency stability, permitted levels of spurious emissions and other spectrum use parameters are agreed by ITU-R and embodied in ITU-R Recommendations which are then incorporated by reference in the main body of the Regulations. Taken together, these form a body of regulations for use by national telecommunications authorities to control ground and airborne radio stations in regard to their basic transmit and receive functioning and their use. The use of radio in an aircraft when outside its State of Registry must conform to these basic licensing conditions.

**Aviation regulation**

3.2 The safety aspects of the operation of civil aircraft are governed by the terms of the *Convention on International Civil Aviation* (Doc 7300) (Chicago Convention). In the context of the carriage and operation of radio, Article 30 of the Chicago Convention requires an aircraft on international carriage to carry radio transmitting apparatus only if a licence to install and operate such equipment has been issued by the appropriate authorities of the State of Registry. The Chicago Convention does not define the national body to exercise the function, which is normally that body with responsibility for telecommunications. In addition, Article 31 requires that all of the radio equipment on board shall be covered by a certificate of airworthiness, invariably issued by the authority with responsibility for aviation safety. Article 37 calls for the adoption of international Standards and Recommended Practices (SARPs) dealing with, inter alia, communications and navigation aids. SARPs normally address all interface parameters, including radio frequency (RF), performance, coding, etc., to ensure worldwide interoperability. These provisions form the major part of the international framework for aviation safety in regard to the radio systems carried by aircraft. It should be noted that ICAO SARPs are only agreed for systems which are standardized on a worldwide basis, and hence do not include such self-contained systems as radio altimeters and airborne weather radar, carried as a mandatory requirement by many aircraft, and which also meet the certificate of airworthiness requirements.

**National regulations**

3.3 The respective national authorities for telecommunications and for aviation in the State of Registry of an aircraft are responsible for ensuring compliance with the international agreements within their competence and jurisdiction. It is common for the telecommunications licence to be issued by that authority only when the aviation safety requirements have been approved and a certificate of airworthiness has been granted by the aviation authorities. The total authorization thus embodies the permission to transmit and receive radio signals (the telecommunications part), and the certification that the systems are satisfactory for the navigation of the aircraft (the air safety part). Aircraft are frequently transferred from one country to another on delivery after manufacture or by wet or dry lease during their lifetime. The country of acceptance may agree to transfer the certificate of airworthiness with the aircraft as a practical means of compliance with international agreements. This latter procedure is recognized in Article 33 of the Chicago Convention and in Article 18 of the Radio Regulations.

## 4. AIRWORTHINESS APPROVAL AND THE ISSUE OF A CERTIFICATE OF AIRWORTHINESS

4.1 The process of airworthiness approval of the radio in aircraft includes requiring the assurance of the correct functioning of the equipment after its installation in the aircraft, which includes its performance as a working communications or radionavigation system, as well as its compatibility with other on-board radio and electronic systems. Prior to its installation, the equipment must have received approval under a Technical Standard Order (TSO) issued by a responsible body such as the Federal Aviation Administration (FAA) in the United States or the European Union Aviation Safety Agency (EASA) in Europe.

4.2 A TSO defines the performance and environmental requirements for the airborne radio system concerned and is traditionally based on the minimum performance specifications (MPS) developed in voluntary bodies such as RTCA in the United States and EUROCAE in Europe. This voluntary collaborative process, in which all the interested parties (administrators, radio system manufacturers, aircraft constructors, airlines, etc.) participate, has the advantage of facilitating the achievement of performance parameters that are realistic and which can be manufactured at economic cost levels.

4.3 Standardization of aircraft wiring and physical details (form and fit) is further carried out through the Aeronautical Radio Inc. (ARINC) Characteristic – a document developed by the Airline Electronic Engineering Committee (AEEC), an

international body for which ARINC provides the secretarial service. The ARINC Characteristic also includes all the performance requirements, sometimes enhanced over those of the TSO, and is the specification that is generally used for the procurement of radio for commercial aircraft.

4.4 The processes of airworthiness for most aviation radio systems recognize that some environmental and performance requirements can be relaxed for aircraft used only for private or pleasure purposes, outside the airspace used by commercial aviation and on short flights. The telecommunications requirements remain the same as those for commercial aircraft.

4.5 Airworthiness requirements for radio not used for navigation or air traffic needs, e.g. passenger telephones, are usually limited to an assurance that it is not a safety hazard and does not, in any way, affect the correct functioning of the other radio and electronic systems carried for safety purposes.

## 5. SUMMARY

The above describes the main regulatory features which apply to the use of radio in aircraft. They are characterized by:

a) the requirement to observe two sets of international treaty obligations, ITU and ICAO;

b) the participation of two national regulatory bodies, one for telecommunications aspects and one for air safety approval requirements; and

c) a voluntary collaborative process for the preparation of performance specifications.

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# Attachment D

# REVIEW AND UPDATE

1. Section 7-II identifies the prime objectives of this document, of which the most important is that of providing an up-to-date record of ICAO policy on the provisions in the ITU Radio Regulations for use by ICAO and its Member States. With ITU WRCs being held, in general, every four years, and numerous ITU-R preparatory activities and other studies taking place in the intervals, there is continuous activity in which aviation must actively participate. Appropriate responses to these activities include:

a) the timely development of the ICAO Position for WRCs; and

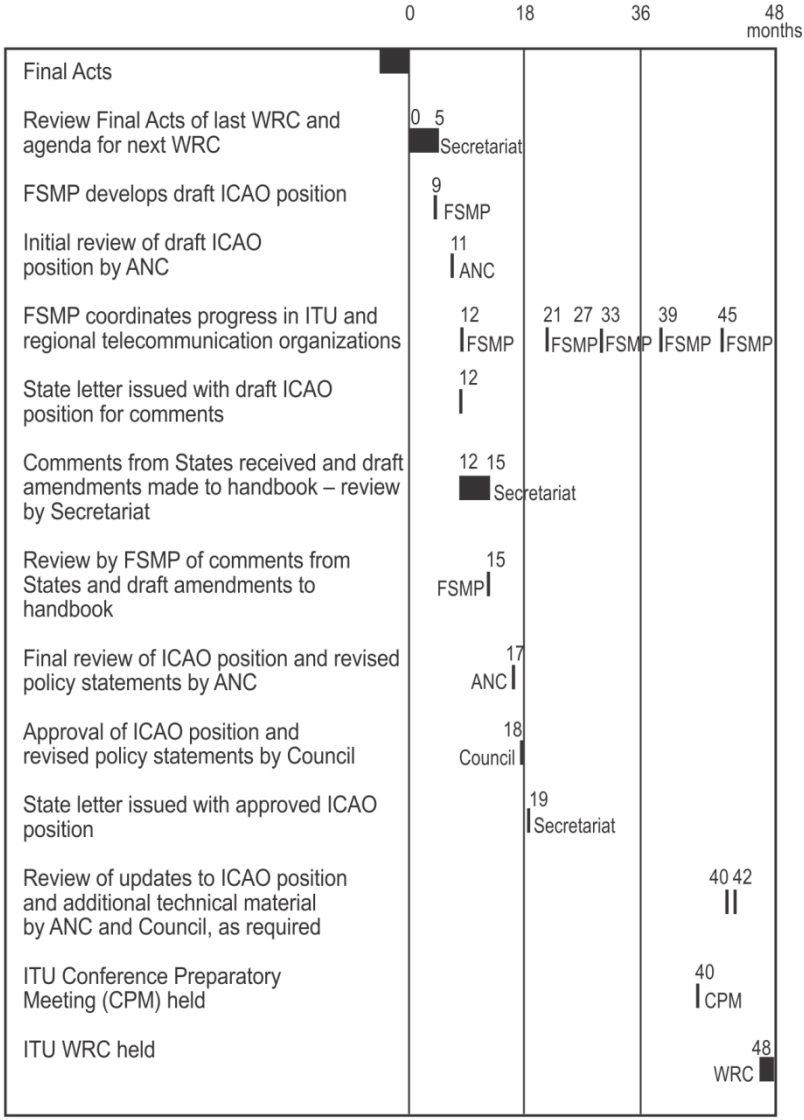
b) the development of updates to this handbook, including the relevant policy statements, in the light of the amendments to the Radio Regulations as agreed by ITU and the ICAO Position for future conferences.

A practical procedure for update of this handbook, including the policy statements and the development of the ICAO Position, is outlined below and sequenced to include the requirements for internal ICAO approval, consultation with States, divisional meetings when they occur and general publishing and dissemination requirements.

2. The review and update cycle, based on the four-year interval between WRCs, is believed to provide the best compromise between the twin goals of expediency and accuracy. It embodies important milestones such as the approval of the Air Navigation Commission (ANC) and Council of ICAO and the provision of advice to Member States in timescales that are achievable and suitable (see Figure D-1).

3. The sequence of events for the development of the ICAO Position for the next WRC, as well as necessary amendments to this handbook including the policy statements, is a process incorporating the following:

- Review by ICAO of the Final Acts of the most recent WRC, including a review of the agenda for the next WRC and the preparation of policy proposals (ICAO Position for the next WRC and revised policy statements in this handbook by the appropriate ICAO body). In this process, the focal point for developing proposals in ICAO is the FSMP.




*Note.— Bars indicate approximate timing of event.*

**Figure D-1. Review and update cycle of the ICAO Position and the RF handbook**

- Update of the technical and regulatory material in this handbook;

- Initial review of the ICAO Position for the next WRC and policy statements in this handbook by the ANC;

- Issue of State letter with the draft ICAO Position for the next WRC inviting comments from States and international organizations on the proposals sent to States and international organizations;

- Final review of States' comments and consequential updated policy statements in this handbook by the ANC;

- Approval of the ICAO Position for the next WRC and updated policy statements by the Council. Shortly before the next WRC, a last review of any necessary update of the ICAO Position will be undertaken by the ANC and Council, as required;

- Final discussions and informal briefings on the latest information; and

- Commencement of the next WRC.

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# Attachment E

# APPROACH FOR ESTABLISHING AND PROMOTING THE ICAO POSITION FOR FUTURE ITU WORLD RADIOCOMMUNICATION CONFERENCES

## 1. INTRODUCTION

This attachment presents a long-term approach for establishing and promoting the ICAO Position for future ITU World Radiocommunication Conferences (WRCs) with a view to securing support for the ICAO Position from ITU administrations and relevant international organizations.

## 2. BASIS FOR THE ICAO POSITION

2.1 The ICAO Position is developed on the basis of current and future aviation requirements for radio frequency spectrum, taking into account the expected growth in air traffic and the development of new technologies.

2.2 The long-term implementation strategy contained in the *Global Air Navigation Plan* (Doc 9750) forms the basis for the spectrum requirements.

2.3 The ICAO policy on radio frequency spectrum requirements, as approved by the Council, is contained in this handbook.

2.4 The framework for the development and support of the ICAO Position is contained in Assembly Resolution A42-7.

## 3. DEVELOPMENT OF THE ICAO POSITION

3.1 The ICAO Position for a WRC is established as early as possible after the agenda for that WRC is established. The position presents the ICAO views on all agenda items of interest to international civil aviation on the agenda of the WRC, with particular regard to the impact on safety, regularity and efficiency of flight. Technical and operational information is provided as required to support the position.

3.2 The focal point on all aspects related to the development of the ICAO Position for WRCs is the Frequency Spectrum Management Panel (FSMP).

3.3 Throughout the development of the position, proper coordination with and involvement of the ICAO Regional Offices is required. Their involvement enables the incorporation of specific regional requirements and helps achieve improved support at the regional and national level.

3.4 The draft ICAO Position developed by the FSMP is reviewed by the ANC and sent to States and relevant international organizations for comment. The comments are reviewed by the ANC, and a consolidated ICAO Position is submitted by the ANC to the Council for approval.

3.5 After approval by the Council, the ICAO Position is sent to States for use in the coordination process leading to the development of national positions. The ICAO Position is also submitted as an information paper to the WRC.

3.6 Following the development of the ICAO Position, consequential amendments to policy statements contained in this handbook are developed for approval by the Council.

3.7 Any subsequent developments arising from ICAO and ITU activities in preparation for the WRC are considered by the Council with a view to updating the ICAO Position as necessary.

## 4. SUPPORT FOR THE ICAO POSITION

4.1 Assembly Resolution A42-7 shall be fully implemented so as to secure support from States for the ICAO Position and ensure that the resources necessary to support increased participation by ICAO in international and regional spectrum management activities are made available.

4.2 In addition to being submitted to States (paragraph 3.5 refers), the ICAO Position is also disseminated, as early as possible, to the regional telecommunication organizations involved in the development of regional positions for WRCs. Presentation of the position and follow-up is provided by the relevant ICAO Regional Offices, with assistance from Headquarters as required.

4.3 ICAO contributes to WRC preparatory activities conducted by ITU (meetings of relevant ITU-R Study Groups and ITU Conference Preparatory Meetings) by submitting additional technical papers supporting the ICAO Position.

4.4 Close coordination and cooperation with other aviation organizations participating in the conference, such as IATA, need to be maintained. Also, coordination with other specialized agencies of the UN on issues of common interest is required to broaden the support for specific elements of the ICAO Position.

4.5 Regional ICAO coordination meetings to present and discuss the ICAO Position should be organized as required. These meetings could be held in conjunction with the meetings of the FMSP.

## 5. NEW TRENDS IN SPECTRUM MANAGEMENT

5.1 In the application of the strategy outlined above, a number of new trends influencing the allocation of spectrum today and in the future need to be taken into account. Such trends, which may affect the availability of adequate and protected spectrum for aviation, include:

a) the increased role of the private sector in the work of the ITU;

b) the increased economic value of spectrum for certain applications;

c) the increased availability of radio devices that do not require licensing by radiocommunication authorities; and

d) the increased pressure for sharing spectrum allocated to aeronautical services with non-aeronautical services.

5.2 The increased role of the private sector in the ITU has had an adverse impact on the influence of inter-governmental bodies such as ICAO. This situation was addressed at the 2002 ITU Plenipotentiary Conference (PP-02) with a view to strengthening the role of ICAO in ITU.

5.3 The economic value of spectrum allocated to certain applications can exceed by far the economic value of aeronautical applications of the same spectrum. This has recently been demonstrated by the results of the “spectrum auctions” conducted in several countries to support future commercial mobile multimedia systems. This situation requires aviation to clearly identify the need and economic value of required spectrum in certain bands and to consider innovative approaches to guarantee the required level of safety-service availability.

5.4 Technical trends such as the ones mentioned in sub-paragraphs 5.1 c) and d) have the potential of increasing interference levels to aeronautical systems and must therefore be carefully assessed on a case-by-case basis. A comprehensive investigation of interference levels and available margins in all aeronautical bands needs to be conducted urgently.

## 6. ASSEMBLY RESOLUTION A42-7

The ICAO Assembly approved Resolution A42-7 on the "Support of the ICAO policy on radio frequency spectrum matters" as follows:

*Whereas* ICAO is the specialized agency of the United Nations responsible for the safety, regularity and efficiency of international civil aviation;

*Whereas* ICAO adopts international Standards and Recommended Practices (SARPs) for aeronautical communications systems and radio navigation aids;

*Whereas* the International Telecommunication Union (ITU) is the specialized agency of the United Nations regulating the use of the radio frequency spectrum;

*Whereas* the ICAO position, as approved by the Council, for ITU World Radiocommunication Conferences (WRCs) is the result of the coordination of international aviation requirements for radio frequency spectrum;

*Whereas* a comprehensive frequency spectrum strategy is required by aviation to support timely availability and appropriate protection of adequate spectrum;

*Whereas* a sustainable environment for growth and technology development is required to support safety and operational effectiveness for current and future operational systems and allow for the transition between present and future technologies;

*Recognizing* that the development and the implementation of the communications, navigation, and surveillance/air traffic management (CNS/ATM) systems and the safety of international civil aviation could be seriously jeopardized unless requirements for appropriate aviation safety spectrum allocations are satisfied and the continued protection of those allocations is achieved;

*Recognizing* that unresolved spectrum issues relating to aeronautical safety services have resulted in flight cancellations, degradations of air traffic management services

and interruptions of flight operations;

*Recognizing* that civil aviation seamlessly spans across international borders and operates despite national or regional differences in implementation of non-aeronautical radio services, unresolved spectrum issues relating to global aeronautical safety services may impact international flight operations.

*Recognizing* that to ensure optimal use of the frequency spectrum allocated to aviation, efficient frequency management and use of best practices are required;

*Recognizing* that support from ITU member administrations is required to ensure that the ICAO position is supported by the WRC and that aviation requirements are met;

*Considering* the urgent need to increase such support due to the growing demand for spectrum and aggressive competition from commercial telecommunications services;

*Considering* the increased level of ITU WRC preparation activities associated with the growing demand for bandwidth from all users of the radio frequency (RF) spectrum, as well as the increased importance of the development of regional positions by regional telecommunication bodies, such as APT, ASMG, ATU, CEPT, CITEL and RCC*; and

*Considering* Recommendations 7/3 and 7/6 of the Special Communications/Operations Divisional Meeting (1995) (SP COM/OPS/95), Recommendation 5/2 of the 11th Air Navigation Conference (2003), and Recommendation 1/12 of the 12th Air Navigation Conference (2012), and Recommendation 5/5 of the High-level Conference on COVID-19 (2021)

The Assembly:

1. *Encourages* Member States to foster an environment that enables national radio regulatory authorities to work in close coordination with civil aviation authorities, thereby ensuring that aviation interests are properly reflected in national spectrum policies and State positions in preparation for and during ITU WRCs;

2. *Urges* Member States, international organizations and other civil aviation

* APT: Asia Pacific Telecommunity; ASMG: Arab Spectrum Management Group; ATU: African Telecommunications Union; CEPT: the European Conference of Postal and Telecommunications Administrations; CITEL: Comisión Interamericana de Telecomunicaciones; RCC: Regional Commonwealth in the field of Communications.

stakeholders to support firmly the ICAO frequency spectrum strategy and the ICAO position at WRCs and in regional and other international activities conducted in preparation for WRCs, including by the following means:

a) working together to deliver spectrum-efficient aeronautical systems as well as frequency management that meet current best practices;

b) supporting ICAO activities relating to the aviation frequency spectrum strategy and policy through relevant expert group meetings and regional planning groups;

c) undertaking to provide for aviation interests to be fully integrated in the development of their positions presented to regional telecommunications fora involved in the preparation of joint proposals to the WRC;

d) including in their proposals to the WRC, to the extent possible, material consistent with the ICAO position;

e) supporting the ICAO position and the ICAO policy statements at ITU WRCs as approved by Council and incorporated in the Handbook on Radio Frequency Spectrum Requirements for Civil Aviation (Doc 9718);

f) undertaking to provide civil aviation experts to fully participate in the development of States' and regional positions and development of aviation interests at the ITU; and

g) ensuring, to the maximum extent possible, that their delegations to regional conferences, ITU study groups and WRCs include experts from their civil aviation authorities and other civil aviation stakeholders who are fully prepared to represent aviation interests;

3. *Urges* Member States to actively engage with their radio regulatory authorities in order to incorporate aviation interests with other national interests, especially in preparation for and during ITU WRCs;

4. *Urges* Member States to consider, as a priority, public and aviation safety when deciding how to enable new or additional services, and to consult with aviation safety regulators, subject matter experts and airspace users, to provide all necessary considerations and to establish regulatory measures to ensure that incumbent aviation systems and services are free from harmful interference.

5. *Requests* the Secretary General to bring to the attention of ITU the importance of adequate radio frequency spectrum allocation and protection for the safety of

aviation;

6. *Instructs* the Council and the Secretary General, as a matter of high priority within the budget adopted by the Assembly, to ensure that the resources necessary to support the development and implementation of a comprehensive aviation frequency spectrum strategy, as well as increased participation by ICAO in international and regional spectrum management activities are made available; and

7. *Declares* that this resolution supersedes Resolution A41-7.

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# Attachment F

## ICAO POSITION FOR THE INTERNATIONAL TELECOMMUNICATION UNION (ITU) WORLD RADIOCOMMUNICATION CONFERENCE 2027 (WRC-27)


**SUMMARY**

This paper reviews the agenda for the International Telecommunication Union (ITU) World Radiocommunication Conference 2027 (WRC-27), discusses points of aeronautical interest and provides the ICAO Position for these agenda items.

The goal of the ICAO Position is to ensure aeronautical access to appropriately protected spectrum for radiocommunication and radionavigation systems that support current and future safety-of-flight applications. In particular, it describes the safety considerations necessary to ensure adequate protection against harmful interference.

Support of the ICAO Position by Contracting States is required to ensure that the position is supported at the WRC-27 and that aviation requirements are met.



1. Introduction
2. ICAO and the international regulatory framework
3. Spectrum requirements for international civil aviation
4. Aeronautical aspects on the agenda for WRC-27

## 1. INTRODUCTION

1.1 The ICAO Position on issues of interest to international civil aviation to be addressed at the 2027 ITU World Radiocommunication Conference (WRC-27) is presented below. The agenda of this Conference is contained in the attachment. The ICAO Position is to be considered in conjunction with sections 7-II and 8 of the *Handbook on Radio Frequency Spectrum Requirements for Civil Aviation,* Volume I — *ICAO spectrum strategy, policy statements and related information* (Doc 9718, Third Edition, 2023). It should be noted that the Handbook contains a long-term policy based on a snapshot in time and, as such, it may lag behind the ICAO WRC Position. As a result, when there is conflict between the Handbook and a current ICAO WRC Position, the Position should be seen as being the guiding document.

1.2 ICAO supports the working principle within the ITU, as established during studies for WRC-07, that ICAO will ensure the compatibility of ICAO standard systems with existing or planned aeronautical systems operating in accordance with international aeronautical standards. Compatibility of ICAO standard systems with non-ICAO standard aeronautical systems (or non-aeronautical systems) will be addressed in the ITU.

## 2. ICAO AND THE INTERNATIONAL REGULATORY FRAMEWORK

2.1 ICAO is the specialized agency of the United Nations providing for the international regulatory framework for civil aviation. The *Convention on International Civil Aviation* is an international treaty providing required provisions for the safety of flights over the territories of the 193 ICAO Contracting States and over the high seas. It includes measures to facilitate air navigation, including international Standards and Recommended Practices commonly referred to as SARPs.

2.2 The ICAO Standards constitute the rule of law through the ICAO Convention and form a regulatory framework for aviation, covering personnel licensing, technical requirements for aircraft operations, airworthiness requirements, aerodromes and systems used for the provision of communications, navigation and surveillance, as well as other technical and operational requirements.

## 3. SPECTRUM REQUIREMENTS FOR INTERNATIONAL CIVIL AVIATION

3.1 Safely connecting people and business is of paramount importance in the operation of approximately 100 000 daily flights. Today, aviation is by far the world's safest and most efficient mode of long-range mass transportation. According to the International Air Transport Association (IATA), total passenger traffic is expected to reach 4.96 billion in 2024. Over the next 20 years, world-wide passenger traffic is expected to increase, on average, by 3.8 per cent per year, resulting in over 4 billion additional passenger flights in 2043 compared to 2023. Although safety levels that global air transport enjoys today represent an achievement built on the determination and efforts of the entire aviation community, continuous safety performance improvement is required to accommodate the continuing increase of passengers.

The aviation industry connects people and the world in a unique and critical way, adding immense value to the global economy. Air travel supports over US$3.5 trillion in world economic activity annually – about 4.1 per cent of the global gross domestic product. Moreover, the global economy counts on air cargo to deliver the US$8.3 trillion of trade that gets to customers by air. The airlines' revenue is projected to reach US$996 billion in 2024, marking 9.7 per cent year-over-year growth and reaching the highest nominal value in aviation history.

3.2 The safety of air operations is dependent on the availability of reliable communication, navigation and surveillance services. Current and future communication, navigation, and surveillance/air traffic management (CNS/ATM) systems are highly dependent upon the availability of sufficient, and suitably protected radio spectrum that can support the high integrity and availability requirements associated with aeronautical safety systems. Spectrum requirements for current and future aeronautical CNS systems are specified in the ICAO Spectrum Strategy[1], as addressed by the 13th Air Navigation Conference, and as approved by the ICAO Council.

3.3 Members of the United Nations recognize the importance of protecting the safety of the travelling public and the aircraft systems that make travel safe. In order to support the critical safety requirements related to radio frequency spectrum usage by the aviation community, the ITU provides the following provisions:

[1] The ICAO spectrum strategy is included in the ICAO *Handbook on Radio Frequency Spectrum Requirements for Civil Aviation*, Volume I — *ICAO spectrum strategy, policy statements and related information* (Doc 9718, 3rd Edition).

a) **The ITU Constitution, Article 40**: "*International telecommunication services must give absolute priority to all telecommunications concerning safety of life at sea, on land, in the air or in outer space, as well as to epidemiological telecommunications of exceptional urgency of the World Health Organization*"; and

b) **The ITU Radio Regulations, Article 4.10:** "*ITU 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*."

3.4 In particular, compatibility between systems used to safely operate aircraft and air traffic systems, and systems that do not provide critical safety communications in the same or adjacent radio frequency bands, must be considered with extreme care in order to preserve the travelling public's safety. Aeronautical safety applications are required to have continued operation through worst-case scenarios, so all factors which contribute to harmful interference should be considered in analyses involving those applications. Therefore, ICAO recommends any radio frequency compatibility studies conducted at the ITU-R should account for the worst-case technical and operational scenarios that may be encountered by safety-critical aeronautical systems from non-safety-critical systems. Additionally, ICAO recommends such studies include an aviation safety margin in order to address the risk that some factors cannot be foreseen.[2]

3.5 The continuous increase in air traffic movements as well as additional requirements for accommodating new and emerging applications, are placing an increased demand on both the aviation regulatory and air traffic management mechanisms. As a result, airspace management is becoming more complex and the demand for frequency assignments is increasing. While some of this demand can be met through improved spectral efficiency of existing radio systems in frequency bands currently allocated to aeronautical services, it is inevitable that these frequency bands need to be increased in size or additional aviation spectrum allocations may need to be agreed upon to meet this demand.

3.6 The ICAO Position for the ITU WRC-27 was initially developed in 2024 with the assistance of the Frequency Spectrum Management Panel (FSMP) and was reviewed by the Air Navigation Commission at the sixth

[2] Additional ICAO guidance for spectrum compatibility involving ICAO systems is included in the ICAO *Handbook on Radio Frequency Spectrum Requirements for Civil Aviation*, Volume I — *ICAO spectrum strategy, policy statements and related information* (Doc 9718, 3rd Edition).

meeting of its 227th Session on 10 October 2024. Following the review by the Commission, it was submitted to ICAO Contracting States and relevant international organizations for comment. After a further review of the ICAO Position in light of the comments received by the Commission on 13 May 2025, the ICAO Position was reviewed and approved by the ICAO Council on 25 June 2025.

3.7 States and international organizations are requested to take into account the ICAO Position, to the maximum extent possible, in their preparatory activities for the WRC-27 at the national level, in the activities of the regional telecommunication organizations[3] and in the relevant meetings of the ITU.

## 4. AERONAUTICAL ASPECTS ON THE AGENDA FOR WRC-27

*Note 1.— The statement of the ICAO Position on an agenda item is given in a text box at the end of the section addressing the agenda item, after the introductory background material.*

*Note 2.— There are no WRC-27 Agenda Items where aviation is seeking direct action by the WRC.*

*Note 3.— WRC-27 Agenda Items **1.5, 1.7, 1.9, 1.11, 1.12, 1.13, 1.15, 1.16, 1.17, 1.18, 1.19, 4, 8, 9** and **10** could potentially affect aviation use of spectrum and hence aviation should participate in studies to ensure there is no undue impact. As a result, they are included in this position.*

*Note 4.— No impact on aeronautical services has been identified from WRC-27 Agenda Items **1.1, 1.2, 1.3, 1.4, 1.6, 1.8, 1.10, 1.14**, **2**, **3**, **5**, **6**, and **7** which are therefore not addressed in this position.*

*Note 5. — When in this document reference is made to "No. X.YYY", it means "No. X.YYY of the ITU Radio Regulations (RR)".*

*Note 6. — Agenda items that may affect non-aeronautical service ground systems that may be used by aviation in some States as part of their ground infrastructure, such as fixed links, include **1.7, 1.13, 1.15,** and **1.19**. The use of the fixed service by air traffic services data link applications in the frequency bands 932-935 MHz, 941-944 MHz, 1 780-1 850 MHz, 7 125-8 500 MHz 14.8-15.35 GHz have not been addressed in this position but should be considered on a national basis.*

[3]African Telecommunication Union (ATU), Asia-Pacific Telecommunity (APT), European Conference of Postal and Telecommunications Administrations (CEPT), Inter-American Telecommunication Commission (CITEL), Arab Spectrum Management Group (ASMG) and the Regional Commonwealth in the Field of Communications (RCC).

## WRC-27 Agenda Item 1.5

**Agenda Item Title**:

**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)**.

**Discussion:**

This agenda item seeks to identify:

- regulatory measures aimed at limiting unauthorized operations of non-geostationary-satellite orbit (GSO) Earth stations in the Earth-to-space direction within fixed-satellite and mobile-satellite services; and

- regulatory measures related to an administration's requests to exclude its territory from the service area of a non-GSO satellite system without adversely affecting the provision of service in the rest of the service area of the non-GSO satellite system.

Considering this agenda item is applicable to all non-GSO satellite fixed-satellite service (FSS) and mobile-satellite service (MSS) satellite systems, the scope would include:

- aeronautical mobile satellite (route) service (AMS(R)S) in the 117.975-137 MHz (ATC voice and data), 1 087.7-1 092.3 MHz (global flight tracking), 1 610-1 626.5 MHz (ATC voice and data), and 5 000-5 150 MHz (RPAS C2 Links) frequency bands; and

- WRC-23 No. **5.200** was updated to include AMS(R)S for 121.5 MHz aeronautical emergency frequency.

It is crucial to consider the technical and operational challenges associated with implementing territory-specific exclusions, particularly the potential negative impacts on non-GSO satellite system operations in adjacent regions where these services are authorized.

ITU-R coordination of non-GSO satellite systems with other services has traditionally been done by technical means, requiring coordination and protections at the border of different countries, as radio frequencies do not instantly stop at country borders. Should measures resulting from this agenda item be implemented, it could result in the obligation for non-GSO satellite FSS and MSS satellites to lower their transmission power in order to comply with the country exclusion. The aviation community utilizes several safety non-GSO satellite services that may be potentially affected, and it is imperative to maintain the integrity and availability of emergency and distress communication services, ensuring they remain free from operational constraints.

**ICAO Position:**

To ensure the consequences of this agenda item do not impose new regulatory and technical constraints which could disrupt or otherwise negatively impact the global provision of AMS(R)S, and aeronautical emergency frequencies used by international civil aviation.

## WRC-27 Agenda Item 1.7

**Agenda Item Title**:

**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, 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).**

**Discussion:**

This agenda item seeks, based on sharing and compatibility studies, to identify additional spectrum for international mobile telecommunications (IMT) in one or more of the following frequency bands 4 400-4 800 MHz (in Region 1 and Region 3), 7 125-8 400 MHz (in Region 2 and Region 3), 7 125-7 250 MHz and 7 750-8 400 MHz (in Region 1), and 14.8-15.35 GHz. Those studies need to ensure 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 Master International Frequency Register (MIFR), without imposing additional regulatory or technical constraints on those services, and on services in adjacent bands.

The adjacent frequency band 4 200-4 400 MHz is allocated globally to both the aeronautical mobile (route) service (AM(R)S) and aeronautical radionavigation service (ARNS) on a primary basis and used by the wireless avionics intra-communications (WAIC) and radio altimeters respectively.

Pursuant to No. **5.438**, the ARNS in frequency band 4 200-4 400 MHz is reserved exclusively for radio altimeters installed on board aircraft and for the associated transponders on the ground. Radio altimeters provide an accurate, independent, and absolute measurement of the minimum distance to the Earth's surface below an aircraft. Radio altimeters are integrated into several safety critical aircraft functions. Such systems include, but are not limited to the:

- flight control system;
- automated landing;
- terrain awareness warning system;
- airborne collision avoidance systems; and
- the wind shear detection and recovery applications.

These systems combined, enable and enhance several safety and navigation functions throughout all phases of flight on all commercial aircraft and a wide range

of other civil aircraft. Further, as the radio altimeter is the only sensor onboard the aircraft capable of providing a direct measurement of the clearance height above the terrain and any obstacles which may protrude above the terrain, it is a crucial component to enable the flight crew to maintain situational awareness. This was especially so given the increasing occurrences of global navigation satellite system (GNSS) radio frequency interference, which may affect the operations of enhanced ground proximity warning systems. Measurements from the radio altimeters are displayed on the flight deck instrumentation to the flight crew and, at lower altitudes, a separate aircraft system uses radio altimeter outputs to provide aural callouts to the flight crew of the height above terrain.

ICAO is particularly concerned about the potential impacts of IMT identification in the band adjacent to the aeronautical systems in the 4 200-4 400 MHz frequency band given the issues raised by ICAO State letter 21/22, which was further underscored at the 41st Session of the ICAO Assembly.

Pursuant to No. **5.436**, the AM(R)S usage in the frequency band 4 200-4 400 MHz is reserved exclusively for WAIC systems. WAIC systems provide safety related wireless communication between two points onboard a single aircraft. WAIC systems do not provide air-to-ground, air-to-satellite or air-to-air communications and are only used for aircraft communications involving safety and regularity of flight, allowing greater flexibility and redundancy to the existing internal aircraft wiring. One example of WAIC systems is to provide sensor information used to monitor the health of an aircraft structure and critical systems, and to communicate this information to a central onboard entity.

The frequency band 15.4-15.7 GHz is allocated to the primary aeronautical radionavigation service and used for ground-based primary surveillance radar systems including airport surface detection equipment (ASDE) and precision approach radar (PAR). The main purpose of these systems is to provide surveillance to support precision approach to runways by aircraft and to provide alerts of potential conflicts between aircraft or aircraft and vehicles. These functions are critical to maintaining public and aircraft safety. The 15.4-15.7 GHz frequency band is also identified by ICAO for use by the following systems, that may be impacted by IMT out-of-band emissions due to the considered bandwidths:

- On-board weather radar is a safety-critical instrument assisting flight crew in identifying and deviating from potentially hazardous weather conditions and detecting wind shear and microbursts. It supports the safe passage of an aircraft in the vicinity of turbulent weather conditions and provides timely warnings of rapidly changing weather conditions as an aid to in-flight route planning.

- Ground mapping radar support maintaining contact with geographic features, such as shorelines, as a supplement to navigational orientation.

- Detect and Avoid (DAA) systems are critical components of remotely piloted aircraft systems (RPAS). They contribute to mitigate the risk of separation loss and prevent collisions with the ground and other aircraft. It should be noted that DAA can either be located on-board aircraft or on the ground.

**ICAO Position**:

To oppose any new identification for IMT in the frequency band 4 400-4 800 MHz that reduces the protection of, or imposes additional regulatory or technical constraints, on radio altimeters and Wireless Avionics Intra-Communications operating in the frequency band 4 200-4 400 MHz.

To ensure the results of this agenda item would not reduce the protection of, or impose additional regulatory or technical constraints, on ground-based air traffic surveillance systems, airborne weather radar, and DAA radars, operating in the frequency band 15.4-15.7 GHz.

**WRC-27 Agenda Item 1.9**

**Agenda Item Title**:

**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 (WRC23).**

**Discussion**:

This agenda item seeks to introduce new classes of emission and wideband systems into the aeronautical mobile (off-route) service (AM(OR)S) in the frequency ranges between 3 025 kHz and 18 030 kHz regulated by Appendix **26** to the RR and to identify any potential changes required to that Appendix. This agenda item shall not modify any existing area allotments while taking into account that the current use of narrowband systems shall remain unchanged and not be impacted by any revision of Appendix **26** resulting from this agenda item.

Aeronautical HF safety communications operate under allocations to the aeronautical mobile (route) service (AM(R)S) in line with Appendix **27** to the RR. Many of those allocations to the AM(R)S in the frequency range 2 850-22 000 kHz are adjacent to allocations to the AM(OR)S. Hence, any change to the waveform or bandwidth (with or without any concatenation of channels) that affect the waveform, the unwanted emissions, and/or total power radiated compared to current AM(OR)S operations could potentially affect aviation's use of systems operating under the allocation to AM(R)S in the frequency range 2.850-22 MHz.

HF is the only terrestrial service with means of providing ubiquitous global communication coverage for aircraft and is still the long-range system required by many aviation regulators for the provision of safety and regularity of flight communications in oceanic, polar and other remote areas. Access to the various frequency bands in the range 2 850-22 000 kHz assigned to the aeronautical mobile (route) service (AM(R)S) is therefore essential and defined in Appendix **27** to the RR.

**ICAO Position:**

To ensure the results of this agenda item would not reduce the protection of, or impose additional regulatory or technical constraints, on internationally recognized aeronautical HF safety communications in line with Appendix **27** to the RR.

## WRC-27 Agenda Item 1.11

**Agenda Item Title**:

**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.WRC23).**

**Discussion**:

This agenda item seeks to identify whether any or all the following frequency bands could be used to support space-to-space links between non-GSO and GSO satellites subject to the condition that other mobile satellite and other systems operating under an appropriate allocation in the concerned frequency bands are protected:

- 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
- 2 483.5-2 500 MHz

The frequency bands 1 525-1 559 and 1 626.5-1 660.5 MHz are allocated to MSS and are used for aviation SATCOM air-ground communications for ATC and other regularity of flight functions. Additionally, improved satellite communications functionality combined with increasing aircraft data requirements has resulted in greater satellite communication usage for some aircraft operators, providing broadband connectivity during all phases of flight and in all areas. Furthermore, satellite communication can be used at airports given its coverage and capacity benefits.

In the frequency bands 1 525-1 559 and 1 626.5-1 660.5 MHz, protection of MSS should also be ensured, noting that No. **5.357A** provides additional priority considerations to AMS(R)S in the bands 1 545-1 555 MHz and 1 646.5-1 656.5 MHz. Likewise, No. **5.362A** provides similar priority considerations to AMS(R)S in the frequency bands 1 555-1 559 MHz and 1 656.5-1 660.5 MHz in one State.

The frequency band 1 610-1 626.5 MHz is allocated to the AMS(R)S on a primary basis per No. **5.367**, subject to agreement obtained under No. **9.21**, and is used for aviation satellite communications.

The adjacent frequency band 1 559-1 610 MHz is allocated on a primary basis to the ARNS and radionavigation satellite service (RNSS), used by aviation GNSS receivers for aircraft navigation, and to sustain a wide range of communications, navigations and surveillance systems, including Automatic Dependent Surveillance-Broadcast (ADS-B) systems, controller-pilot data link communication, automatic dependent surveillance-contract, terrain avoidance and warning systems and other systems.

**ICAO Position:**

To ensure the results of this agenda item would not reduce the protection of, or impose additional regulatory or technical constraints, on safety related aeronautical satellite communication for AMS(R)S in the frequency bands 1 545-1 555 MHz and 1 646.5-1 656.5 MHz, and in No. **5.362A** the frequency bands 1 555-1 559 MHz and 1 656.5-1 660.5 MHz as well as frequency band 1 610-1 626.5 MHz, and the aviation radionavigation satellite service receivers in the adjacent frequency band 1 559-1 610 MHz.

## WRC-27 Agenda Item 1.12

**Agenda Item Title**:

**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).**

**Discussion:**

This agenda item considers low data-rate non-GSO MSS systems in the following frequency bands:

- 1 427-1 432 MHz (space-to-Earth)
- 1 645.5-1 646.5 MHz (space-to-Earth and Earth-to-space)
- 1 880-1 920 MHz (space-to-Earth and Earth-to-space)
- 2 010-2 025 MHz (space-to-Earth and Earth-to-space)

According to No. **5.343**, in Region 2, use of the radio frequency band 1 435-1 535 MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile service. Aeronautical Mobile Telemetry is used by the aviation industry to certify commercial aircraft.

The frequency band 1 626.5-1 660.5 MHz is allocated to the MSS (Earth-to-space) where No. **5.357A** provides priority in the frequency band 1 646.5-1656.5 MHz to accommodate the spectrum requirements of AMS(R)S. The frequency band 1 626.5-1 660.5 MHz is used for aviation satellite communications (air-ground communications) for ATC and regularity of flight functions, ensuring the safe operation of flights. Furthermore, it is important that the potential future use of the band 1 645.5-1 646.5 MHz by low data-rate non-GSO MSS systems should consider the adjacent band co-existence with current and future aviation safety systems specified above.

**ICAO Position:**

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|---|
| To ensure that the results of this agenda item do not reduce the protection of, or impose additional regulatory or technical constraints on, aeronautical mobile-satellite (R) communications provided under the mobile satellite service allocations in the frequency band 1 646.5-1 656.5 MHz where No. **5.357A** applies. |

**WRC-27 Agenda Item 1.13**

**Agenda Item Title**:

**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).**

**Discussion**:

Report ITU-R M.2077 identified 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)[4]. This agenda item seeks to identify additional allocations to the MSS in the frequency range 694-2 700 MHz, taking into account the IMT frequency arrangements[5].

Recommendation ITU-R M.1036-7, as referenced in Resolution **253 (WRC-23)**, contains IMT frequency arrangements for the frequency ranges 470-960 MHz, 1 427-1 518 MHz, 1 710-2 200 MHz, 2 300-2 400 MHz, 2 500-2 690 MHz.

However, Resolution **253** does not formally limit the scope of the study to frequency bands identified to IMT. Consequently, ICAO identifies the following civil aviation safety systems in the range 694-2 700 MHz and adjacent to it.

| | |
|---|---|
| 960 – 1 164 MHz | Airborne collision avoidance system (ACAS), ADS-B, distance measuring equipment (DME), L-band digital aeronautical communication system (LDACS), multilateration (MLAT) systems, secondary surveillance radar (SSR) & universal access transceiver (UAT) |
| 1 164-1 215 MHz | DME and GNSS |
| 1 215-1 300 MHz | GNSS and primary surveillance radar |
| 1 300-1 370 MHz | primary surveillance radar |
| 1 525-1 559 MHz[6]* | satellite communication |
| 1 559-1 626.5 MHz | GNSS |
| 1 610-1 626.5 MHz | satellite communication |

[4] Systems beyond IMT-2000 is a concept and telecommunication standard that was evolving within ITU (see Report ITU-R M.2077, Traffic forecasts and estimated spectrum requirements for the satellite component of IMT-2000 and systems beyond IMT-2000 for the period 2010 to 2020).

[5] The IMT frequency arrangements are addressed in the most recent version of Recommendation ITU-R M.1036.

[6] Subject to RR 5.357A and RR 5.362A.

| | |
|---|---|
| 1 626.5-1 660.5 MHz[7]* | satellite communication |
| 2 700-2 900 MHz | primary surveillance (airport surveillance) radars and weather radar |

From the information provided above it can be noted that a number of key aeronautical safety systems operate in or adjacent to the frequency range 694-2 700 MHz and all of these systems will have to be taken into account, where appropriate, in studies done in response to this agenda item as the satellite transmission may change the radio frequency coexistence environment for aviation systems. As an example, the WRC-23 decisions on high altitude platform station (HIBS) have included specific measures for the protection of aeronautical radionavigation radars operating in the band 2 700-2 900 MHz. In addition, the introduction of MSS for direct connectivity between space stations and IMT user equipment has been authorized in some countries. ITU-R studies that support WRC-27 Agenda Item 1.13 should bring clarity to any potential impact to aviation systems.

**ICAO Position:**

To oppose any new allocations made, or regulatory actions taken, under Resolution 253 (WRC-23) that overlap the frequencies used by civil aviation systems operating in parts of the frequency range 694-2 700 MHz.

To ensure the results of this agenda item for bands adjacent to aeronautical systems operating in parts of the frequency range 694-2 700 MHz would not reduce the protection of, or impose additional regulatory or technical constraints, on the multiple civil aviation systems operating in parts of the frequency range 694-2 700 MHz, or the primary surveillance and weather radar adjacent to the upper end of 694-2 700 MHz frequency range.

[7] Subject to RR 5.357A and RR 5.362A.

**WRC-27 Agenda Item 1.15**

**Agenda Item Title**:

**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)**.

**Discussion:**

This agenda item seeks 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 the following ranges or portions thereof:

- 390-406.1 MHz, 420-430 MHz and 440-450 MHz, limited to outside the shielded zone of the Moon;
- 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.

The following frequency bands/ranges are used by aviation:

- 2 400-2 690 MHz is separated from the ARNS frequency band 2 700-2 900 MHz, used by aviation airport surveillance radars and the meteorological ground-based radars, by 10 MHz frequency gap. The civil aviation system may therefore be impacted by out-of-band emissions.
- 3 500-3 800 MHz, in-band to the FSS (space-to-Earth) 3 400-4 200 MHz frequency band, is used by satellite downlinks of ATC (Very small aperture terminal) and MSS feeder links.
- The frequency band 5 150-5 570 MHz is adjacent to the 5 091-5 150 MHz band which is used by aeronautical mobile airport communication systems (AeroMACS), limited to airport surface use. In addition, the frequency band 5 150-5 570 MHz is in-band to the aeronautical mobile service allocated in part of the world on a primary basis per No. **5.446C** and No. **5.446D**, limited to aeronautical telemetry transmissions from aircraft stations.
- 5 250-5 725 MHz is in the radio location service (RLS) and is used by meteorological ground-based radars.
- 5 350-5 470 MHz is in-band to the ARNS frequency band and used by airborne weather radar, airborne ground mapping radars and associated airborne beacons.

**ICAO Position:**

To ensure that ITU-R studies appropriately account for the protection of systems used for the provision of aeronautical services, in particular those operating in the frequency ranges 2 700-2 900 MHz, 3 600-4 200 MHz, 5 350-5 470 MHz.

To ensure that the proposed methods to satisfy this agenda item would not create constraints on the aviation systems used to support the safe operation of international civil aviation.

**WRC-27 Agenda Item 1.16**

**Agenda Item Title**:

**To consider studies on the technical and regulatory provisions necessary to protect radio astronomy operating in specific Radio Quiet Zones (RQZs), 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)**.

**Discussion:**

Resolution **681** (**WRC-23**) asks for studies regarding the protection of radioastronomy from unwanted emissions from a single non-GSO satellite system or multiple non-GSO satellite systems operating the adjacent and nearby the adjacent frequency bands listed: 10.7-10.95 GHz, 42-42.5 GHz, 74-76 GHz, 95-100 GHz, 116-119.98 GHz, 123-130 GHz. The Resolution also asks for studies on new coexistence measures between non-GSO satellite systems and radio astronomy (RAS) stations in RQZs for the Square Kilometre Array Observatory in South Africa and the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile.

Civil aviation is a user of these non-GSO constellations when operated in the AMS(R)S and RNSS. This use is expected to grow in the coming years, with the development of non-GSO systems aiming to provide aeronautical services. These non-GSO constellation usually provide a global coverage.

In particular, the following aeronautical services rely on non-GSO constellations:

- AMS(R)S:
  - 117.975-137 MHz (Space-based VHF)
  - 1 087.7-1 092.3 MHz (Satellite-based ADS-B) Earth-to-Space
  - 1 610-1 626.5 MHz (satellite communications)
  - 5 000-5 150 MHz (Satellite-based C2 Link in the 5 030-5 091 MHz band)
- RNSS:
  - 1 164-1 215 MHz
  - 1 215-1 350 MHz
  - 1 559-1 610 MHz

Existing coordination, at the national level, between radio astronomy observatories with air traffic is adequate in addressing unwanted emissions from a single non-GSO satellite system or multiple non-GSO satellite systems operating the adjacent and

nearby the adjacent frequency bands, and an implementation of an international coordination framework for air traffic would be unnecessary.

Resolution **681** (WRC-23) also asks for studies on how the aggregate interference from unwanted emissions from multiple non-GSO satellite systems operating in the adjacent and nearby frequency bands to those in Table 1 of Resolution **681** (WRC-23) affect RAS. Notably, "nearby frequency bands" are not defined.

**ICAO Position:**

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|---|
| To ensure that any measures as part of this agenda item related to RQZs would not impose operational and development constraints on non-GSO satellite systems operating in AMS(R)S and RNSS frequency bands. |

**WRC-27 Agenda Item 1.17**

**Agenda Item Title:**

**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 (WRC23).**

**Discussion:**

Space weather observations from ground-based networks of receive-only space weather sensor systems are becoming more and more important for the detection of solar activity that can harmfully affect the operation of international civil aviation. Solar events, such as large solar flares and coronal mass ejections, produce magnetic storms that can present serious aviation safety risks. These events can cause major disruptions to the communications, navigation and surveillance (CNS) systems that are critical for maintaining the safety of the airspace.

Data from receive-only space weather sensors are provided to space weather forecast and warning centres around the world for many applications. Space weather advisories that could impact international air navigation are provided to aircraft operators and used to plan mitigations for any relevant potential risks. In addition, there are experimental research activities and other users of space weather sensor data that are not used by aviation.

While receive-only space weather sensors systems may operate in a variety of frequency bands, these may not be the same between different countries as there is not a harmonized approach to the use of receive-only space weather sensors worldwide. Further, the scope of this agenda item only includes receive-only space weather sensors and, by definition, those cannot cause harmful interference. Active space weather sensors are not within the scope of this agenda item; however, care needs to be taken to ensure the scope doesn't change.

In conclusion, space weather contributes to sustainability of aviation CNS systems. Limited to receive-only sensors, the consideration would be focused on the protection of the meteorological aids service (MetAids) (space weather) receiver and thus should be supported by international civil aviation stakeholders.

**ICAO Position:**

To support the appropriate radio regulatory changes for receive-only space weather sensors (excluding active sensors) while ensuring, based on the ITU-R studies as called for by Resolution **682 (WRC-23),** any changes would not impose any technical or regulatory constraints on aviation safety systems.

## WRC-23 Agenda Item 1.18

**Agenda Item Title**:

**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)**.

**Discussion:**

This agenda item seeks to strengthen the regulatory measures regarding the protection of systems operating in the Earth exploration satellite and radio astronomy services in various frequency bands above 76 GHz from unwanted emissions of active services in those frequency bands.

Aviation operates a number of foreign object debris (FOD) detection (radar) systems in the frequency range 92-100 GHz, which is adjacent to one of the proposed Earth exploration satellite service (EESS) (passive) bands identified in Resolution **712** (**WRC-23**). These radars are used to detect debris on runways that could, if not removed, cause damage to an aircraft either during landing or potentially, more seriously, while taking off as in the case of the Concorde at Charles de Gaulle airport in 2000. It is important that these FOD detection systems are able to operate with optimal performance in order to help prevent runway accidents from FOD. Therefore, studies undertaken as part of this agenda item must consider the technical and operational characteristics of FOD detection systems that are contained in ITU-R Report M.2501-0 (12/2021) "*Technical and operational characteristics of the foreign object debris detection system operating in the frequency range 92-100 GHz*" and Recommendation M.2162 (12/2023) "*Technical and operational characteristics of radiolocation systems operating in the frequency range 92-100 GHz and radionavigation systems operating in the frequency range 95-100 GHz*".

**ICAO Position:**

To ensure that the studies undertaken in response to this agenda item take into account FOD detection systems operating in the radiolocation service (RLS) in frequency band 92-94 GHz.

To ensure any action taken because of this agenda item in the frequency band 86-92 GHz would not impose any technical or operational constraints on FOD detection systems in the frequency band 92-94 GHz.

## WRC-27 Agenda Item 1.19

**Agenda Item Title**:

**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).**

**Discussion**:

This agenda item seeks to study and consider 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. Sea surface temperature measurements systems provide data for weather models that help predict significant meteorological events such as hurricanes and storms.

The frequency band 4 200-4 400 MHz is allocated globally to both the AM(R)S and ARNS on a primary basis and used by the WAIC and radio altimeters respectively.

Pursuant to No. **5.438**, the ARNS in frequency band 4 200-4 400 MHz is reserved exclusively for radio altimeters installed on board aircraft and for the associated transponders on the ground. Radio altimeters provide an accurate, independent, and absolute measurement of the minimum distance to the Earth's surface below an aircraft. Radio altimeters are integrated into several safety critical aircraft functions. Such systems include, but are not limited to the:

- flight control system;
- automated landing;
- terrain awareness warning system;
- airborne collision avoidance systems; and
- the wind shear detection and recovery applications.

These systems combined enable and enhance several safety and navigation functions throughout all phases of flight on all commercial aircraft and a wide range of other civil aircraft. Further, as the radio altimeter is the only sensor onboard the aircraft capable of providing a direct measurement of the clearance height above the terrain and any obstacles which may protrude above the terrain, it is a crucial component to enable the flight crew to maintain situational awareness. Measurements from the radio altimeters are displayed on the flight deck instrumentation to the flight crew

and, at lower altitudes, a separate aircraft system uses radio altimeter outputs to provide aural callouts to the flight crew of the height above terrain.

Pursuant to No. **5.436**, the AM(R)S usage in the frequency band 4 200-4 400 MHz is reserved exclusively for WAIC systems. WAIC systems provide safety related wireless communication between two points onboard a single aircraft. WAIC systems do not provide air-to-ground, air-to-satellite or air-to-air communications and are only used for aircraft communications involving safety and regularity of flight, allowing greater flexibility and redundancy to the existing internal aircraft wiring. One example of WAIC systems is to provide sensor information used to monitor the health of an aircraft structure and critical systems, and to communicate this information to a central onboard entity.

ICAO recognizes the benefits for weather forecasting that are provided by sea surface temperature measurements. Such information allows better predictions for hurricanes and other weather patterns that civil aviation uses for safe and efficient flight.

**ICAO Position:**

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|---|
| To ensure any changes would not impose any technical, regulatory, or operational constraints, on radio altimeters or WAIC in the frequency band 4 200-4 400 MHz, while recognizing the benefit for civil aviation by providing sea surface temperature measurements for weather forecasting. |

## WRC-27 Agenda Item 4

**Agenda Item Title:**

**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.**

**ICAO Position:**
**Resolutions:**

| ***Resolution No.*** | ***Title*** | ***Action recommended*** |
|---|---|---|
| **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. | No change |
| **20** *(Rev. WRC-03)* | Technical cooperation with developing countries in the field of aeronautical telecommunications. | No change |
| **26** *(Rev. WRC-23)* | Footnotes to the Table of Frequency Allocations in Article **5** of the Radio Regulations. | No change |
| **27** *(Rev. WRC-19)* | Use of incorporation by reference in the Radio Regulations. | No change |
| **63** *(Rev. WRC-12)* | Protection of radiocommunication services against interference caused by radiation from industrial, scientific and medical (ISM) equipment. | No change |
| **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. | No change |
| **95** *(Rev. WRC-19)* | General review of the resolutions and recommendations of world administrative radio conferences and world radiocommunication conferences. | No change |

| ***Resolution No.*** | ***Title*** | ***Action recommended*** |
|---|---|---|
| **114** *(Rev. WRC-15)* | Studies on compatibility between new systems of 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. | No change |
| **140** *(Rev. WRC-23)* | Measures and studies associated with the equivalent power flux-density (EPFD) limits in the band 19.720.2 GHz. | No change |
| **154** *(WRC-15)* | Consideration of technical and regulatory actions in order to support existing and future operation of fixed-satellite service Earth stations within the 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. | No change |
| **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. | No change |
| **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. | No change |
| **165** *(WRC-23)* | Use of the frequency band 21.4-22 GHz by high-altitude platform stations in the fixed service in Region 2. | No change |
| **166** *(WRC-23)* | Use of the frequency band 24.25-27.5 GHz by high-altitude platform stations in the fixed service in Region 2. | No change |
| **167** *(WRC-23)* | Use of the frequency band 31-31.3 GHz by high-altitude platform stations in the fixed service. | No change |
| **168***(WRC-23)* | Use of the frequency band 38-39.5 GHz by high-altitude platform stations in the fixed service. | No change |
| **205** *(Rev. WRC-19)* | Protection of the systems operating in the mobile satellite service in the band 406-406.1 MHz. | No change |
| **207** *(Rev. WRC-15)* | Measures to address unauthorized use of and interference to frequencies in the bands allocated to the maritime mobile service and to the aeronautical mobile (R) service. | No change |
| **217** *(WRC-97)* | Implementation of wind profiler radars. | No change |

| ***Resolution No.*** | ***Title*** | ***Action recommended*** |
|---|---|---|
| **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. | No change |
| **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. | No change |
| **225** *(Rev. WRC-12)* | Use of additional frequency bands for the satellite component of IMT. | No change |
| **229** *(Rev. WRC-19)* | 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. | No change |
| **249** *(Rev WRC-23)* | Study of technical and operational issues and regulatory provisions for space-to-space transmissions in the Earth-to-space direction 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. | Subject to WRC-27 Agenda Item 1.11 |
| **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. | Modify or suppress as necessary based on the results of studies at preliminary WRC-31 Agenda Item 2.5 |
| **339** *(Rev. WRC-07)* | Coordination of NAVTEX services. | No change |
| **354** *(Rev. WRC-23)* | Distress and safety radiotelephony procedures for 2 182 kHz. | No change |
| **356** *(WRC-07)* | ITU maritime service information registration. | No change |
| **405** *(Geneva 1979)* | Relating to the use of frequencies of the aeronautical mobile (R) service. | Subject to WRC-23 Agenda Item 1.9. |
| **413** *(Rev. WRC-23)* | Use of the band 108-117.975 MHz by aeronautical service. | No change |
| **417** *(Rev. WRC-12)* | Use of the frequency band 960-1 164 MHz by the aeronautical mobile (R) service. | No change |

| ***Resolution No.*** | ***Title*** | ***Action recommended*** |
|---|---|---|
| **418** (*Rev. WRC-15*) | Use of the band 5 091-5 250 MHz by the aeronautical mobile service for telemetry applications. | No change |
| **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). | Suppress as a result of the approval of Recommendation ITU-R M.2091. |
| **424** *(Rev. WRC-23)* | Use of wireless avionics intra-communications in the frequency band 4 200-4 400 MHz. | No change |
| **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. | No change |
| **608** *(Rev. WRC-19)* | Use of the frequency band 1 215-1 300 MHz by systems of the radionavigation satellite service. | No change |
| **609** *(Rev. WRC-07)* | Protection of aeronautical radionavigation systems from the equivalent power flux-density produced by radionavigation satellite service networks and systems in the 1 164-1 215 MHz band. | No change |
| **610** *(Rev. WRC-19)* | Coordination and bilateral resolution of technical compatibility issues for radionavigation satellite networks and systems in the band 1 164-1 300 MHz, 1 559-1 610 MHz and 5 0105 030 MHz. | No change |
| **612** (*Rev. WRC-12*) | Use of the radiolocation service between 3 and 50 MHz to support oceanographic radar operations. | No change |
| **660** (*WRC-19*) | Use of the frequency band 137-138 MHz by non-geostationary satellites with short-duration missions in the space operation service. | No change |
| **705** *(Rev. WRC-15)* | Mutual protection of radio services operating in the band 70-130 kHz. | No change |
| **729** *(Rev. WRC-07)* | Use of frequency adaptive systems in the MF and HF bands. | No change |
| **748** (*Rev. WRC-19*) | Compatibility between the aeronautical mobile (R) service and the fixed satellite service (Earth-to-space) in the band 5 091-5 150 MHz. | No change |

| ***Resolution No.*** | ***Title*** | ***Action recommended*** |
|---|---|---|
| **762** *(WRC-15)* | Application of power flux density criteria to assess the potential for harmful interference under 11.32A for fixed-satellite and broadcasting-satellite service networks in the 6 GHz and 10/11/12/14 GHz bands not subject to a plan. | No change |
| **406 (WRC-23)** | Use of the frequency band 117.975-137 MHz by the aeronautical mobile-satellite (R) service. | No change |
| **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. | No change |
| **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. | TBD |
| **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. | Subject to WRC-27 Agenda Item 1.19 |
| **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. | TBD |
| **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. | Modify to remove formal recognition that Administrations can deny access to RNSS. |
| **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. | Subject to WRC-27 Agenda Item 1.9 |
| **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. | Subject to WRC-27 Agenda Item 1.15 |

| ***Resolution No.*** | ***Title*** | ***Action recommended*** |
|---|---|---|
| **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. | Subject to WRC-27 Agenda Item 1.13 |
| **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] | Modify or suppress as necessary based on the results of studies at preliminary WRC-31 Agenda Item 2.2 |
| **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. | Modify or suppress as necessary based on the results of studies at preliminary WRC-31 Agenda Item 2.4 |
| **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. | Modify or suppress as necessary based on the results of studies at preliminary WRC-31 Agenda Item 2.9 |
| **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]. | Modify or suppress as necessary based on the results of studies at preliminary WRC-31 Agenda Item 2.12 |
| **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]. | Modify or suppress as necessary based on the results of studies at preliminary WRC-31 Agenda Item 2.13 |

| ***Resolution No.*** | ***Title*** | ***Action recommended*** |
|---|---|---|
| **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. | Subject to WRC-27 Agenda Item 1.7 |

**Recommendations:**

| ***Recommendation No.*** | ***Title*** | ***Action recommended*** |
|---|---|---|
| **7** *(Rev. WRC-97)* | Adoption of standard forms for ship station and ship Earth station licences and aircraft station and aircraft Earth station licences. | No change |
| **9** | Relating to the measures to be taken to prevent the operation of broadcasting stations on board ships or aircraft outside national territories. | No change |
| **71** | Relating to the standardization of the technical and operational characteristics of radio equipment. | No change |
| **75** *(Rev. WRC-15)* | Study on the boundary between the out-of-band and spurious domains of primary radars using magnetrons. | No change |
| **401** | Relating to the efficient use of aeronautical mobile (R) worldwide frequencies. | No change |
| **608** *(Rev. WRC-07)* | Guidelines for consultation meetings established in Resolution **609 (WRC-07)**. | No change |

## WRC-27 Agenda Item 8

**Agenda Item Title**:

**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-19).**

**Discussion:**

Allocations to the aeronautical services are generally made for all ITU regions and normally on an exclusive basis. These principles reflect the global process of standardization within ICAO for the promotion of safety and to support the global interoperability of radiocommunication and radionavigation equipment used in civil aircraft. In some instances, however, footnotes to the ITU Table of Frequency Allocations allocate spectrum in one or more countries to other radio services in addition or alternatively to the aeronautical service to which the same spectrum is allocated in the body of the table.

The use of country footnote allocations to non-aeronautical services in aeronautical bands is generally not recommended by ICAO, on safety grounds, as such use may result in harmful interference to safety services. Furthermore, this practice generally leads to an inefficient use of available spectrum to aeronautical services, particularly when the radio systems sharing the band have differing technical characteristics. It also may result in undesirable (sub-) regional variations with respect to the technical conditions under which the aeronautical allocations can be used. This can have a serious impact on the safety of aviation.

The following footnotes in aeronautical bands should be carefully reviewed by administrations in order to preserve the safety and efficiency of aeronautical services for the reasons as discussed below:

a) In the frequency bands used for the ICAO instrument landing system (ILS), (marker beacons 74.8-75.2 MHz; localizer 108-112 MHz and glide path 328.6-335.4 MHz) and the VHF omnidirectional radio range system (VOR); 108-117.975 MHz, Nos. **5.181**, **5.197** and **5.259** allow for the introduction of the mobile service on a secondary basis and subject to agreement obtained under No. 9.21 of the RR when these bands are no longer required for the aeronautical radionavigation service. The use of both ILS and VOR is expected to

continue. In addition, WRC-03, as amended by WRC-07, has introduced No. **5.197A** stipulating that the band 108-117.975 MHz is also allocated on a primary basis to the aeronautical mobile (R) service (AM(R)S), limited to systems operating in accordance with recognized international aeronautical standards. Such use shall be in accordance with Resolution **413 (Rev. WRC-12)**. The use of the band 108-112 MHz by the AM(R)S 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. ICAO encourages administrations listed in Nos. **5.181**, **5.197** and **5.259** to review their use and if no longer required, to remove their country's name from these footnotes.

b) Nos. **5.201** and **5.202** allocate the frequency bands 132-136 MHz and 136-137 MHz in some States to the aeronautical mobile (off-route) service (AM(OR)S). Since these frequency bands are heavily utilized for ICAO-standard VHF voice and data communications, ICAO encourages those concerned administrations to review their use and if no longer required, to remove their country's name from these footnotes.

c) In the frequency band 1 215-1 300 MHz, which is used by civil aviation for the provision of radionavigation services through No. **5.331**. Footnote No. **5.330** allocates the band in a number of countries to the fixed and mobile service. Given the receiver sensitivity of aeronautical uses of the frequency band, ICAO does not support the continued inclusion of an additional service through country footnotes. ICAO would therefore encourage administrations to review their use and if no longer required, to remove their country's name from No. **5.330**.

d) In the frequency band 1 525-1 530 MHz, which is used by civil aviation for the provision of satellite services No. **5.352A** specifies that 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 a number of countries that were notified prior to 1 April 1998. As of August 2020, the ITU Master International Frequency Register shows out of 20 administrations listed in this footnote, only 4 Administrations have fixed stations notified prior to 1 April 1998. ICAO would therefore encourage Administrations listed in the footnote to review their use of fixed service assignments in 1 525-1

530 MHz, and if no longer required, to remove their country's name from No. **5.352A**.

e) In the frequency bands 1 540-1 559 MHz, 1 610.6-1 613.8 MHz and 1 613.8-1 626.5 MHz, within which some portions are assigned to or used by the aeronautical mobile-satellite (R) service, No. **5.355** also allocates the band on a secondary basis to the fixed service in a number of countries. Given that portions of these bands are utilized by a safety-of-life service, ICAO does not support the continued use of No **5.355** country footnote. ICAO encourages those concerned administrations to review their use and if no longer required, to remove their country's name from No. **5.355**.

f) In the frequency bands 1 550-1 559 MHz, 1 610-1 645.5 MHz and 1 646.5-1 660 MHz which are assigned to mobile-satellite services, including in some portions assignment to or use by the aeronautical mobile-satellite (R) service, No. **5.359** also allocates the bands to the fixed service on a primary basis in a number of countries. Given that portions of these bands are utilized by a safety-of-life service, ICAO does not support the continued use of No. **5.359** country footnote. ICAO would therefore encourage those concerned administrations to review their use and if no longer required, to remove their country's name from No. **5.359**.

g) In the frequency band 4 200-4 400 MHz, which is reserved for use by airborne radio altimeters and wireless avionics intra-communications (WAIC), No. **5.439** allows the operation of the fixed service on a secondary basis in some countries. Radio altimeters are a critical element in aircraft automatic landing systems and serve as a sensor in terrain awareness warning systems. WAIC provides aircraft safety communications between points on an airframe. Interference from the fixed service has the potential to affect the safety of both of these systems. ICAO would therefore encourage those concerned administrations to review their use and if no longer required, to remove their country's name from No. **5.439**.

**ICAO Position:**

To encourage administrations listed in the footnotes to review Nos. **5.181, 5.197** and **5.259**, as access to the frequency bands 74.8-75.2, 108-112 and 328.6-335.4 MHz by the mobile service is difficult and could create the potential for harmful interference to important radionavigation systems used by aircraft at final approach and landing as well as systems operating in the aeronautical mobile service in the frequency band 108-112 MHz.

To encourage administrations listed in the footnotes to review Nos. **5.201 and 5.202**, as use by the AM(OR)S of the frequency bands 132-136 MHz and 136-137 MHz in some States may cause harmful interference to current and future aeronautical safety communications.

To encourage administrations listed in the footnote to review No. **5.330** as access to the frequency band 1 215-1 300 MHz by the fixed and mobile services could potentially cause harmful interference to services used to support aircraft operations.

To encourage administrations listed the footnote to review No. **5.352A** as access to the frequency bands 1 525-1 530 MHz by the fixed services could potentially constrain aeronautical use of this frequency band.

To encourage administrations listed in the footnote to review No. **5.355** as access to the frequency bands 1 540-1 559, 1 610.6-1 613.8 and 1 613.8-1 626.5 MHz by the fixed services could potentially constrain aeronautical use of these frequency bands.

To encourage administrations listed in the footnote to review No. **5.359** as access to the frequency bands 1 550-1 559 MHz, 1 610-1 645.5 MHz and 1 646.5-1 660 MHz by the fixed services could potentially jeopardize aeronautical use of those frequency bands.

To encourage administrations listed in the footnote to review No. **5.439** to ensure the protection of the safety critical operation of radio altimeters and WAIC systems in the frequency band 4 200-4 400 MHz.

ICAO would encourage administrations to take appropriate actions under this agenda item to remove their country’s name from these footnotes if no longer required.

*Note.— Administrations indicated in the footnotes mentioned in the ICAO Position above which are urged to remove their country names from these footnotes are as follows:*

*No.* ***5.181*** *Egypt, Israel and the Syrian Arab Republic*

*No.* ***5.197*** *The Syrian Arab Republic*

*No.* ***5.201*** *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*

*No.* ***5.202*** *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*

*No.* ***5.259*** *Egypt and the Syrian Arab Republic*

*No.* ***5.330*** *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*

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

*No.* ***5.355*** *Bahrain, Bangladesh, Congo (Rep. of the), Djibouti, Egypt, Eritrea, Iraq, Israel, Kuwait, Qatar, Syrian Arab Republic, Somalia, Sudan, South Sudan, Chad, Togo and Yemen*

*No. **5.352A*** *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*

*No. **5.359*** *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*

*No. **5.439*** *Iran (Islamic Republic of)*

## WRC-27 Agenda Item 9.1

**Agenda Item Title**:

**Activities of the ITU Radiocommunications sector since WRC-23**;

**Discussion:**

This agenda item seeks to identify any issue with or use of the RR that requires urgent action.

On agenda item 1.8[8] WRC-23 "*decided to suspend any further action on Resolution 155 (Rev.WRC-19) until decided by a future competent WRC. To this effect, a new item has been agreed by this conference to study, as a matter of urgency, necessary measures to facilitate the operation of Earth stations on board unmanned aircraft used for control and non-payload communication operated in non-segregated airspace using satellite links by the aeronautical mobile satellite (route) service (AMS(R)S) in suitable frequency bands in order to decide on the appropriate course of action to be taken for WRC-31*".

This agenda item is one of the vehicles by which a WRC-31 agenda item could be established to determine whether sufficient AMS(R)S spectrum had been identified for the provision of unmanned aircraft beyond line-of-sight command and control links (C2 Links). Given that the ICAO Standards and Recommended Practices for Annex 10, Volume VI, Part I, were published in July 2021, and further amendment to this Volume of the Annex is expected in the near future, then this can be used as the rationale for urgency.

**ICAO Position:**

To support ITU-R studies, as a matter of urgency, on necessary measures to facilitate the operation of Earth stations on board unmanned aircraft used for control and non-payload communication operated in non-segregated airspace using satellite links by the aeronautical mobile satellite (route) service (AMS(R)S) in suitable frequency bands in order to decide on the appropriate course of action to be taken for WRC-31.

[8] WRC-23 Agenda Item 1.8: to consider, on the basis of ITU R studies in accordance with Resolution 171 (WRC 19), appropriate regulatory actions, with a view to reviewing and, if necessary, revising Resolution 155 (Rev.WRC 19) and No. 5.484B to accommodate the use of fixed-satellite service networks by control and non-payload communications of unmanned aircraft systems.

## WRC-27 Agenda Item 9.2

*Note.— If coordination under Resolution **365** (WRC-23) has been successfully completed, then ICAO has the following position.*

**Resolution Title:**

Provisional application of the Radio Regulations for the introduction of new geostationary satellite networks into the global maritime distress and safety system under **Resolution 365 (WRC-23)**.

**Discussion:**

WRC-23 has provisionally identified specific frequency band options for the use of geostationary satellite networks within the Global Maritime Distress and Safety System (GMDSS). Some frequency bands under consideration are 1 614.4225-1 618.725 MHz or 1 616.3-1 620.38 MHz.

These frequency bands are in a portion of the 1 610-1 626.5 MHz AMS(R)S frequency band, subject to agreement under No **9.21** under RR **5.367**. WRC-23 decided to have a conditional allocation to MSS in order to provide GMDSS service. This allocation will not be made permanent until the ITU Radiocommunication Bureau (BR) confirms that the notifying Administration of the system proposed for GMDSS has successfully completed the requisite ITU satellite coordination procedures. If this confirmation is received in time, WRC-27 will have the opportunity to evaluate and potentially finalize the provisional measures taken at WRC-23.

**ICAO Position:**

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|---|
| To ensure that any decision at WRC-27 following report from the Director of the BR requested by Resolution **365** (WRC-23), would not have negative impact on AMS(R)S in the frequency band 1 610-1 626.5 MHz. |

## WRC-27 Agenda Item 10

The table below lists provisional WRC-31 Agenda Items that ICAO may have an interest in dependent on the decisions made at WRC-27. These have been identified as they have a potential concern for changes to aviation systems and/or the regulatory conditions they may operate under.

| ***Provisional WRC-31 Agenda No.*** | ***Title*** | ***Resolution No.*** |
|---|---|---|
| 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)**] | Resolution **910 (WRC-23)** |
| 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)** | 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)** | Resolution **251 (Rev.WRC-23)** |
| 2.9 | to consider possible 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)** | Resolution **684 (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)** | Resolution **722 (WRC-23)** |

In particular, Agenda Item 2.9 considers possible 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)** and it is critical to note that the frequency band 5 000-5 150 MHz has a strong importance for ICAO as follows.

- The frequency band 5 000-5 150 MHz is allocated to AMS(R)S. This frequency band is for RPAS C2 Links, supporting communication, navigation and surveillance functionalities of RPAS.
- The frequency band 5 030-5 091 MHz is allocated to AM(R)S. This frequency band is for terrestrial C2 Link systems for RPAS, supporting the core communication, navigation and surveillance functionalities of RPAS.
- The frequency band 5 091-5 150 MHz is allocated to aeronautical mobile service. In this frequency band, the AM(R)S is limited to airport surface application and is used for AeroMACS system which facilitates ground communications in airport areas. The frequency band is also allocated to the aeronautical mobile service and is used for aeronautical mobile telemetry.

In addition, it should be noted that the experience on other RNSS frequency bands has highlighted increasing intentional interference to RNSS receivers caused by jammers and spoofers as discussed in ICAO State letter 3/4-24/54. As a consequence, the sharing of this frequency range between RNSS and aeronautical systems is unsuitable since interference targeting RNSS would have consequential impact on aeronautical systems.

**ICAO Position:**

To ensure that any new agenda item approved for WRC-31 will provide sufficient guarantees that civil aviation systems will be protected.

To oppose the inclusion of preliminary Agenda Item 2.9 into the WRC-31 Agenda, because of the inherent interference risk that intentional jammers to the RNSS would cause to aviation safety systems operating in the same frequency band used by civil aviation systems.

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**APPENDIX TO ATTACHMENT F** *

# 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

* The text of the resolution included in this Annex has been copied from the ITU Radio Regulations, Edition of 2024, Volume III.

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

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,

[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.

*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.

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# Attachment G

# TECHNICAL INFORMATION AND FREQUENCY-SHARING CRITERIA

## 1. INTRODUCTION

This attachment contains a repository of technical information for the various frequency bands relevant to aviation. This includes relevant references to other technical documentation, interference scenarios and frequency-sharing criteria.

**Band:** 130–535 kHz (selected bands)

**Technical Information:**

**Service:** Aeronautical radionavigation
**Aviation use:** Non-directional beacons, locator beacons
**Annex 10:**

SARPs: Annex 10, Volume I, Chapter 3, paragraphs 3.4 and 3.9
Frequency plan: Regional Plan
Channelization: 1 kHz spacing; in EUR region 0.5 kHz spacing may also be used
Planning criteria:

Annex 10, Volume V, Chapter 3, paragraph 3.2
Annex 10, Volume I, Attachment C, paragraph 6
Annex 10, Volume V, Attachment B
Air Navigation Plan: European Frequency Management Manual (EUR Doc. 11), Part 3, Chapter 1 (download from https://www.icao.int/EURNAT/Pages/EUR-and-NAT-Document.aspx

*Note.— Reference to planning criteria for other regions to be added.*

**RTCA:** DO-179, MOPS for ADF equipment (1982)
**Eurocae:** ED-51, MPS for Airborne ADF Equipment (1983), Amendment #1 (1987)
**ARINC characteristic:** 712-7, Airborne ADF System (1992)
**ITU Res./Rec.:**
**ITU-R:** Rec. P.368: Ground wave propagation curves for frequencies between 10 kHz and 30 MHz
**Other material:**

- CCIR Report No. 910-1 – Sharing between the maritime mobile service and the aeronautical radionavigation service in the band 415–526.5 kHz.

*Note.— This report is published in Annex 3 to Volume VIII of the* Report of the XVII Plenary Assembly of the International Radio Consultative Committee (CCIR) *(Düsseldorf, 1990).*

- *Final Acts of the Regional Administrative Radio Conference for the planning of the MF Maritime Mobile and Aeronautical Radionavigation Services (Region 1)*, Geneva, 1985

## INTERFERENCE FROM NON-AERONAUTICAL SOURCES AND FREQUENCY SHARING BETWEEN NDB AND MARITIME MOBILE SERVICES IN BANDS BETWEEN 415 KHZ AND 435 KHZ

The medium frequency bands allocated to aeronautical radionavigation service between 415 kHz and 495 kHz are used for NDBs in all three ITU regions and shared with the maritime mobile service. In Region 1, in the band 415–435 kHz, the sharing is on a joint primary basis. In Regions 2 and 3, in the band 415–495 kHz (and in Region 1, in the band 435–495 kHz), the aeronautical radionavigation service is on a secondary basis although in some countries the aeronautical radionavigation service has a primary status (RR Nos. **5.77** and **5.78**). With careful planning and coordination, acceptable sharing arrangements can be achieved, facilitated by the geographically different areas of operation of the two services.

The protection of aeronautical beacons from transmissions of coast and ship stations of the maritime mobile service can be assured by the application of the criteria contained in Appendix **12** to the Radio Regulations. Additional guidance material is contained in Annex 10. Some ICAO regions, notably the European region, have also agreed to apply supplementary criteria to NDB frequency assignments in their areas. An overview of the relevant provisions is given below.

### ITU Radio Regulations

**Appendix 12**

**Special Rules Applicable to Radiobeacons**
**Section 1 — 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 microvolts per metre for radiobeacons north of 30° N;

— 120 microvolts per metre for radiobeacons between 30° N and 30° S;

— 70 microvolts per metre for radiobeacons south of 30° S.

5) *Region 3*

— 70 microvolts per metre for radiobeacons north of 40° N;

— 120 microvolts per metre for radiobeacons between 40° N and 50° S;

— 70 microvolts per metre for radiobeacons south of 50° S.

The above provisions have the status of Regulations through the linked reference at Article **28** (**28.23** and **28.24**), which specifies the above as special rules which must be complied with.

**Annex 10**

Frequency planning material relevant for NDB assignments is also contained in:

i) Annex 10, Volume I, 3.4 – Specification for non-directional radio beacon (NDB);

ii) Annex 10, Volume I, Attachment C – Information and material for guidance in the application of Standards and Recommended Practices for ILS, VOR, PAR, 75 MHz marker beacons (en route), NDB and DME; and

iii) Annex 10, Volume V, Attachment A – Considerations affecting the deployment of LF/MF frequencies and the avoidance of harmful interference.

The planning guidance in Attachment A of Annex 10, Volume V, is related to the RF-filtering characteristics of ADF receivers used in aircraft. These characteristics are used for developing adjacent channel NDB planning parameters for establishing the required separation distance in the case where the NDB and maritime service frequencies operate on adjacent channels.

**Propagation model**

Daytime propagation at low frequency and medium frequency are greatly affected by the conductivity and permittivity characteristics of the ground. Night-time transmissions from NDBs are prone to ionospheric reflection. This condition does not generally provide a reliable service and such use is not recommended. The appropriate ground wave transmission model used for frequency assignment planning is contained in ITU-R Recommendation P.368. This recommendation provides ground wave propagation data for frequencies from 10 kHz up to 30 MHz. In the frequency range of interest for NDB, there are separate curves for the frequencies of 200, 300, 400 and 500 kHz. Separate propagation curves are provided for sea and for eight different values of ground conductivity and permittivity, which must be ascertained from local knowledge to enable accurate application.

**CCIR Report 910-1 – Sharing between the maritime mobile service and the aeronautical radionavigation service in the band 415–526.5 kHz**

Parts of the frequency band 415–526.5 kHz are allocated to both the maritime mobile service and the aeronautical radionavigation service. As a result of differences in operational use, i.e. frequency planning characteristics, radiated power, etc., the coexistence of these two radio services in the same bands may present problems. Particular attention is required with respect to the problems which have their origin in the power levels used. In general, the coast stations of the maritime mobile service operate at power levels in the order of 20 to 30 dB higher than short- and medium-range NDBs. For example, coast station operation at e.r.p. of 10 to 50 Watts is typical as is ship station operation at 40 Watts e.r.p., whereas an NDB with a range of 50 NM would have an e.r.p. of less than 1 Watt (taking into account the relative antenna efficiencies which may be as low as 10 to 30 per cent).

This highly important report examines in detail some of the important parameters to be addressed in any analysis of these situations. The required protection to both maritime (NAVTEX services on 518 kHz) and NDB is examined for the full range of conditions of propagation. Two annexes provide detailed analysis for particular cases: Annex I for protection of NAVTEX services and Annex II for protection of NDB services.

**Band:** 2 850–22 000 kHz (selected bands)

**Technical Information:**

**Service:** AM(R)S
**Aviation use:** Air-ground communications (HF voice and data)
**Annex 10:**
SARPs: Annex 10, Volume III, Part II, Chapter 2, 2.4
Frequency plan: Appendix 27 (see ITU below)
Channelization: 3 kHz spacing SSB
Planning criteria: see ITU below
**RTCA:**
- DO-163, Minimum Performance Standards-Airborne HF Radio Communications Transmitting and Receiving Equipment Operating within the Radio-Frequency Range of 1.5 to 30 Megahertz (1976)
- DO-265, Minimum Operational Performance Standards for Aeronautical Mobile High Frequency Data Link (HFDL) (2000)
- DO-277, Minimum Aviation System Performance Standards (MASPS) for the High Frequency Data Link Operating in the Aeronautical Mobile (Route) Service (AM(R)S) (2002)

**Eurocae:**
**ARINC characteristic:**
622-4, ATS Data Link Applications Over ACARS Air-Ground Network
634, HF Data Link System Design Guidance Material
635-4, HF Data Link Protocols
714-6, Mark 3 Airborne SELCAL System
719-5, Airborne HF/SSB System
753-3, HF Data Link System
**ITU:** Appendix 27 to Radio Regulations (Frequency Allotment Plan, Planning Criteria)
**ITU Res./Rec.:**
- Res. 207: 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 (Rev. WRC-15)
- Res. 405: Relating to the use of frequencies of the aeronautical mobile (R) service
- Rec. 401: Relating to the efficient use of aeronautical mobile (R) worldwide frequencies
- Rec. 402: Relating to cooperation in the efficient use of worldwide frequencies in the aeronautical mobile (R) service

**ITU-R:** Rec. M.1458: Use of the frequency bands between 2.8 and 22 MHz by the AM(R)S for data transmission using class of emission J2D

**Other material:**

- The reports of AMCP/3, AMCP/4, AMCP/5 and ADSP/3 contain ICAO material relevant to the development of SARPs for HF data link.
- DO-258A, Interoperability Requirements for ATS Applications Using ARINC 622 Data Communications (2005)

**Bands:** 3 023 kHz and 5 680 kHz

**Technical Information:**

**Service:** AM(R)S
**Aviation use:** Search and rescue frequencies in HF
**Annex 10:**
SARPs:
Frequency plan: Annex 10, Volume V, Chapter 2, 2.2
Channelization:
Planning criteria:
**RTCA:** DO-163, Minimum Performance Standards-Airborne HF Radio Communications Transmitting and Receiving Equipment Operating within the Radio-Frequency Range of 1.5 to 30 Megahertz (1976), Errata
**Eurocae:**
**ARINC characteristic:**
**ITU Res./Rec.:**

- Rec. 401: Relating to the efficient use of aeronautical mobile (R) worldwide frequencies
- Res. 405: Relating to the use of frequencies of the aeronautical mobile (R) service

**ITU-R:**
**Other material:**

- Radio Regulations, Chapter VII
- Radio Regulations, Appendix 27

**Band:** 74.8–75.2 MHz

**Technical Information:**

**Service:** Aeronautical radionavigation
**Aviation use:** Marker beacon
**Annex 10:**
SARPs: Annex 10, Volume I, Chapter 3, 3.1.7 and 3.6
Frequency plan: Fixed frequency of 75 MHz
Channelization: Mono Signal freqnency or Monochannel
Planning criteria: Annex 10, Volume I, Attachment C, Section 5
**RTCA:** DO-143, MOPS for Airborne Radio Marker Receiving Equipment Operating on 75 MHz (1970)
**Eurocae:** 1/WG7/70, MPS for 75 MHz marker beacon receiving equipment (1970)
**ARINC characteristic:**
**ITU Res./Rec.:**
**ITU-R:**

**Band:** 108–117.975 MHz

**Technical Information:**

**Service:** Aeronautical radionavigation, Aeronautical Mobile

**Aviation use:**

VOR (108–117.975 MHz)
ILS localizer (108–111.975 MHz)
GBAS (112.050–117.900 MHz)
VDL Mode 4 (112.000 MHz to 117.975 MHz)

**Annex 10:**

SARPs: Annex 10, Volume I, Chapter 3, 3.1 (ILS), 3.3 (VOR), 3.7 (GBAS) and Volume III, Chapter 6 (VDL Mode 4)

Frequency plan: Annex 10, Volume I, Chapter 3, 3.1.6 (ILS), 3.7.3.5.4.1 (GBAS)

Channelization: 100 kHz/50 kHz spacing for ILS, VOR and 25 kHz for GBAS, 25 kHz for VDL Mode 4

Planning criteria:

Annex 10, Volume V, Chapter 4, 4.2
Annex 10, Volume I, Attachment C, 2.6 (ILS)
Annex 10, Volume I, Attachment C, 3.5 (VOR/ILS)
Annex 10, Volume I, Appendix B, 3.6.8.2.2 and Attachment D, 7.2.1 (GBAS)

**RTCA:**

ILS:

- DO-195, MOPS for Airborne ILS Localizer Receiving Equipment Operating within the Radio Frequency Range of 108–112 MHz (1986)

VOR:

- DO-180A, MOPS for Airborne Area Navigation Equipment Using a Single Collocated VOR/DME Sensor Input (1990)
- DO-187, MOPS for Airborne Area Navigation Equipment Using Multi-Sensor Inputs (1984)
- DO-196, MOPS for Airborne VOR Receiving Equipment Operating within the Radio Frequency Range of 108–117.95 MHz (1986)

GBAS:

- DO-246C, GNSS Based Precision Approach Local Area Augmentation System (LAAS) – Signal-in-Space Interface Control Document (ICD) (2005)

**Eurocae:**

ILS:

- ED-46B, MOPS for Airborne Localizer Receiving Equipment
- ED-74, MOPS for Combined ILS and MLS Airborne Receiving Equipment, Amend. 1 (1997)

- ED-88, MOPS for MMR including ILS, MLS, and GPS used for Supplemental Means of Navigation

VOR:

- ED-22B, MPS for Airborne VOR Receiving Equipment (1988)

VOR:

- ED-27, MOPR for Airborne Area Navigation Systems Based on VOR and DME as Sensors (1979)
- ED-28, MPS for Airborne Area Navigation Computing Equipment Based on VOR and DME as Sensors
- ED-52, MPS for Conventional and Doppler VOR Ground Equipment (1984)

GBAS:

- ED-95, MASPS for GBAS to Support CAT 1 Operations (1999)
- ED-114, MOPS for GBAS Ground Facility to Support CAT 1 Approach and Landing (2003)

VDL Mode 4:

- ED-108, MOPS for VHF VDL Mode 4 Aircraft Transceiver for ADS-B (2001)

**ARINC characteristic:**

ILS: 578-4, Airborne ILS Receiver
ILS: 710-10, Mark 2 Airborne ILS Receiver
VOR: 579-2, Airborne VOR Receiver
VOR/ILS: 711-10, Airborne VOR ILS Receiver

**ITU Res./Rec.:** Res. 413 (Rev. WRC-12): Use of the band 108–117.975 MHz by the aeronautical mobile (R) service

**ITU-R:**

- Rec. M.44-1: Signal-to-interference ratios and minimum field strengths required in the aeronautical mobile (route) service above 30 MHz
- Rec. M.1841: Compatibility between FM sound-broadcasting in the band of about 87-108 MHz and the aeronautical ground-based augmentation system (GBAS) in the band about 108-117.975 MHz
- Rec. SM.1009-1: Compatibility between the Sound Broadcasting Service in the band 87–108 MHz and the Aeronautical Services in the band 108–137 MHz

**Other material:**

- Receiver susceptibility to FM broadcast:
  - DO-176, FM Broadcast Interference related to Airborne ILS, VOR and VHF Communications (1981)
  - Annex 10, Volume I, Chapter 3, 3.1.4 (ILS)
  - Annex 10, Volume I, Attachment C, 2.2.2 (ILS)
  - Annex 10, Volume I, Chapter 3, 3.3.8 (VOR)
  - Annex 10, Volume I, Attachment C, 3.6.5 (VOR)

  - Annex 10, Volume I, Appendix B, 3.6.8.2.2 (GBAS)
  - Annex 10, Volume III, Part I, 6.3.5.4 (VDL)
- RTCA DO-117, Standard Adjustment Criteria for Airborne Localizer and Glide Slope Receivers (1963), Errata
- RTCA DO-217, MASPS for DGNSS Instrument Approach System: Special Category 1 (SCAT-1) (1993), Change 1 to DO-217 (1994), Change 2 to DO-217 (1996)

## INTERFERENCE FROM NON-AERONAUTICAL SOURCES AND COMPATIBILITY BETWEEN ILS/VOR AND FM BROADCASTING

### General

The ITU WARC in 1979 allocated the band at 100–108 MHz to broadcasting services in Region 1. This band was previously allocated in that way only in Regions 2 and 3. The band is adjacent to the VOR/ILS band at 108–117.975 MHz, and interference effects have been experienced due to transmissions of broadcast stations, particularly those operating on frequencies close to the band edge and in areas where there is a high density of both FM stations and ILS or VOR. In many countries, FM sound broadcasting services of both low and high power are operated in this band. In some countries, the broadcast services also include analogue television transmissions. Compatibility problems due to intermodulation products, generated by both FM transmitter stations and in ILS/VOR receivers, as well as overloading of the front end of aircraft ILS/VOR receivers, became apparent when broadcast stations commenced use of the frequencies in the band 100–108 MHz in the mid-1970s in Region 2. Studies on a suitable planning methodology initiated by the CCIR (now ITU-R) in a joint aeronautical/ broadcasting group have documented a viable methodology for broadcast and aeronautical frequency assignment planning with a view to ensuring a safe situation for air operations.

Any resolution of this problem through planning and coordination automatically restricts both services. In high-density areas, such as Western Europe and North America, the full potential of the frequency band for either service cannot be realized. Both services tend to be at their greatest density in areas of high population, which places a severe constraint on the full utilization of the potential of the 40 channels available for use by ILS (see Annex 10, Volume I, 3.1.6). VOR services are also affected but not to the same critical degree. VHF communications, because of their greater frequency separation, are also affected, but to a lesser degree than ILS/VOR.

### ITU-R studies

After many studies on the compatibility between ILS/VOR and FM broadcasting were initiated in ITU, ITU-R approved Recommendation SM.1009-1: *Compatibility between the Sound Broadcasting Service in the band 87–108 MHz and the Aeronautical Services in the band 108–137 MHz* in 1995.

The three annexes of Recommendation SM.1009-1 deal comprehensively with the subject and are:

Annex 1: Interference mechanism, system parameters and compatibility assessment criteria;

Annex 2: General assessment method; and

Annex 3: Detailed compatibility assessment and practical verification.

The Recommendation comprehensively covers the treatment of conflict situations for the four interference modes:

Type A: FM broadcasting-transmitter-generated interference products falling within the ILS/VOR bands. The two sub-types are:

Type A1: spurious or harmonic intermodulation products generated by one or more FM transmitters within the aeronautical band; and

Type A2: non-negligible components of the FM broadcasting signal, operating near the band edge 108 MHz, within the aeronautical band (affecting only aeronautical frequencies near the 108 MHz band edge).

Type B: ILS/VOR-receiver-generated interference caused by high-level broadcast signals operating outside the ILS/VOR band. The two sub-types are:

Type B1: interference that may be generated in the aeronautical receiver being driven into non-linearity due to high-power broadcasting signals outside the aeronautical band. The effect on the receiver resulting in the generation of intermodulation products in the receiver; and

Type B2: performance degradation due to high-power overload and desensitization without any frequency relationship.

This Recommendation, with its three detailed annexes, provides the essential requirements for the identification and analysis of interference situations and for the coordination between broadcasting and aeronautical interests within a country or between countries. The criteria and methods have been developed and reviewed by a group of experts and represent the best available information on the subject. Furthermore, the Recommendation is recognized by aeronautical and telecommunication authorities as the definitive guidance for planning and coordination purposes.

**SARPs on FM-immunity for ILS, VOR, GBAS, VDL and VHF communications**

Since 1984, Annex 10 has incorporated provisions covering the FM-immunity performance of airborne receivers. These performance requirements are a considerable improvement compared to those of unmodified receivers. In many cases, compliance with these SARPs will require equipment replacement. These SARPs were incorporated to standardize the FM-immunity performance of ILS, VOR and VHF communication receivers to FM broadcast signals. While the SARPs were incorporated in the Annex with Amendment No. 65 in 1984, implementation was not required until 1998, allowing fourteen years for modification or refit. In some areas of the world, implementation is not necessary due to the lower level of implementation of both ILS/VOR and FM broadcasting stations. Implementation of these SARPs took place in Europe by 2001 and is foreseen in other regions.

The FM-immunity SARPs are contained in:

for ILS: Annex 10, Volume I, Chapter 3, 3.1.4, Interference immunity performance for ILS localizer receiving systems and Annex 10, Volume I, Attachment C, 2.2.2, providing guidance material;

for VOR: Annex 10, Volume I, Chapter 3, 3.3.8, Interference immunity performance for VOR receiving systems;

for GBAS: Annex 10, Volume I, Appendix B, 3.6.8.2.2;

for VDL: Annex 10, Volume III, Part I, 6.3.5.4 (VDL); and

for VHF Com: Annex 10, Volume III, Part II, 2.3.3, Interference immunity performance and Annex 10, Volume III, Part II, Attachment, 1.3.

**LEGBAC consultative arrangements**

In Europe, the Limited European Group on Broadcasting Aeronautical Compatibility (LEGBAC) has developed a methodology, including software tools, to assess compatibility of assignments to FM broadcasting stations and ILS/VOR assignments. This methodology has been accepted as the European-wide assessment method. It is compliant with the provisions of the Final Acts of the 1984 ITU Broadcasting Conference, ITU-R Recommendation SM.1009-1 and the relevant SARPs.

**Band:** 117.975–137 MHz

**Technical Information:**

**Service:** AM(R)S, AMS(R)S
**Aviation use:** Air-ground and air-air communication (VHF voice and data)
**Annex 10:**
SARPs: Annex 10, Volume III, Part II, Chapter 2, 2.1, 2.2 and 2.3
Frequency plan: Annex 10, Volume V, Chapter 4, 4.1
Channelization: 25 kHz/8.33 kHz
Planning criteria: Doc 9718, Volume II
**RTCA:**

- DO-186A, MOPS for airborne radio communications equipment operating within the radio frequency range 117.975–137 MHz (1995), Change 1 (1998), Change 2 (2002)
- DO-207, MOPS for Devices that Prevent Blocked Channels Used in Two-Way Radio Communications Due to Unintentional Transmissions (1991)
- DO-209, MOPS for Devices that Prevent Blocked Channels Used in Two-Way Radio Communications Due to Simultaneous Transmissions (1992), Errata (1992)
- DO-219, MOPS for ATC Two-Way Data Link Communications (1993)
- DO-267A, MASPS for Flight Information Services Broadcast (FIS-B) Data Link (2004)
- DO-271B, Minimum Operational Performance Standards for Aircraft VDL Mode 3 Transceiver Operating in the Frequency Range 117.975–137.000 MHz (2003)
- DO-281, Minimum Operational Performance Standards for Aircraft VDL Mode 2 Physical, Link and Network Layer (2002)

**Eurocae:**

- ED-23B, MOPS for Airborne VHF Rx-Tx Operating in 117.975–136.975 (1995), Amendment #3 (1997)
- ED-67, MOPS for Devices That Prevent Unintentional or Continuous Transmissions
- ED-92A, MOPS for Airborne VDL Mode 2 Transceiver Operating in the Frequency Range 118–136.975 MHz (2003)

**ARINC characteristic:**
566A-9, Mark 3 VHF Communications Transceiver
622-4, ATS Data Link Applications Over ACARS Air-Ground Network
631-3, VHF Digital Link Implementation Provisions Functional Description
716-11, Airborne VHF Communications Transceiver

724-9, Mark 2 Aircraft Communications Addressing and Reporting System (ACARS)

750-4, VHF Data Radio

**ITU Res./Rec.:**

**ITU-R:** Rec. SM.1009-1: Compatibility between the sound broadcasting service in the band 87–108 MHz and the aeronautical services in the band 108–137 MHz

**Other material:**

- RTCA DO-165, Initial Report on Civil Aviation Frequency Spectrum Requirements 1980–2000 (1976)
- RTCA DO-169, VHF Air-Ground Communication Technology and Spectrum Utilization (1979)
- RTCA DO-176, FM Broadcast Interference Related to Airborne ILS, VOR and VHF Communications (1981)
- RTCA DO-224B, Signal-in-space MASPS for Advanced VHF Digital Data Communications Including Compatibility with Digital Voice Techniques (2000), Change 1 (2001), Change 2 (2002)
- RTCA DO-225, VHF Air-Ground Communications System Improvements Alternatives Study and Selection of Proposals for Future Action (1994)
- RTCA DO-264, Guidelines for Approval of the Provision and Use of Air Traffic Services Supported by Data Communications (2000)
- RTCA DO-284, Next Generation Air/Ground Communication (NEXCOM) Safety and Performance Requirements (2003)
- RTCA DO-285, Next Generation Air/Ground Communication (NEXCOM) VDL Mode 3 Interoperability (2003)
- Eurocae ED-78A, Guidelines for the Approval of the Provision and Use of ATS Supported by Data Communications
- Eurocae ED-85A, Data Link Application System Document (DLASD) for the “Departure Clearance” Data Link Service
- Eurocae ED-89A, DLASD for the “ATIS” Data-link Service
- Eurocae ED-100A, Interoperability Requirements for ATS Applications Using ARINC 622 Data Communications
- Eurocae ED-106A, Data Link Application System Document for “Oceanic Clearance” (OCL) Datalink Service
- Eurocae ED-110A, Interoperability Requirements Standard for ATN Baseline 1 (Interop ATN B1)
- Eurocae ED-120, Safety and Performance Requirements Standard for Initial Air Traffic DLS in Continental Airspace

**Frequency:** 121.5 MHz, 123.1 MHz and 243 MHz

**Technical Information:**

**Service**: AM(R)S, AMS(R)S

**Aviation use**: Emergency position-indicating radiobeacon (EPIRB) and Aircraft Emergency Locator (ELT) [Search and rescue]

**Annex 10:**

SARPs: Annex 10, Volume III, Part II, Chapter 5

Frequency plan: Annex 10, Volume V, Chapter 4

Channelization:

Planning criteria:

**RTCA:** DO-183, MOPS for Emergency Locator Transmitters-Automatic Fixed-ELT (AF), Automatic Portable-ELT (AP), Automatic Deployable-ELT (AD), Survival-ELT (S) Operating on 121.5 and 243.0 MHz (1983)

**Eurocae:** ED-62, MOPS for Aircraft Emergency Locator Transmitters (121.5/243 MHz and 406 MHz)

**ARINC characteristic:**

**ITU Res./Rec.:** Res. 18 (WRC-15): Relating to the procedure for identifying and announcing the position of ships and aircraft of States not parties to an armed conflict

**ITU-R:** Rec. M.690-1: Technical characteristics of emergency position- indicating radio beacons (EPIRBs) operating on the carrier frequencies of 121.5 MHz and 243 MHz (This ITU-R Recommendation is incorporated by reference in the Radio Regulations as per Appendix 15 (Table 15-2)

**Other material:**

- ITU Radio Regulations, Chapter VII
- RTCA DO-154, Recommended Basic Characteristics for Airborne Radio Homing and Alerting Equipment for Use with ELTs (1973)
- RTCA DO-182, ELT Equipment Installation and Performance (1982)

**Band:** 328.6–335.4 MHz

**Technical Information:**

**Service:** Aeronautical radionavigation
**Aviation use:** ILS glide path
**Annex 10:**
SARPs: Annex 10, Volume I, Chapter 3, 3.1.5
Frequency plan: Annex 10, Volume I, Chapter 3, 3.1.6
Channelization: 300 kHz or 150 kHz spacing
Planning criteria: as for ILS localizer
**RTCA:** DO-192, MOPS for Airborne ILS Glide Slope Receiving Equipment Operating within the Radio Frequency Range of 328.6–335.4 MHz (1986)
**Eurocae:** ED-47B, MOPS for Airborne Glide Path Receiving Equipment
**ARINC characteristic:** 551, Airborne Glide Slope Receiver – Mark 2
**ITU Res./Rec.:**
**ITU-R:**
**Other material:** RTCA DO-117, Standard Adjustment Criteria for Airborne Localizer and Glide Slope Receivers (1963), Errata

**Band:** 406–406.1 MHz

**Technical Information:**

**Service:** Mobile-satellite (Earth-to-space)
**Aviation use:** Search and rescue
**Annex 10:**
SARPs: Annex 6; Annex 10, Volume III, Part II, Chapter 5 and Appendix to Chapter 5; and Annex 10, Volume V, Chapter 2.
**RTCA:** DO-204, MOPS for 406 MHz Emergency Locator Transmitters (ELT) (1989), Change 1 (1994), Change 2 (1997), Change 3 (2001)
**Eurocae:** ED-62, MOPS for Aircraft Emergency Locator Transmitters (121.5/ 243 MHz and 406 MHz)
**ARINC characteristic:**
**ITU Res./Rec.:** Res. 205 (Rev. WRC-15): Protection of the systems operating in the mobile-satellite service in the frequency band 406–406.1 MHz
**ITU-R:**
- Rec. M.633-4 Transmission characteristics of a satellite emergency position-indicating radio beacon (satellite EPIRB) system operating through a satellite system in the 406 MHz band
- Rec. M.1478 Protection criteria for COSPAS/SARSAT search and rescue instruments in the band 406–406.1 MHz
- Rep. M.2359 Protection of the 406–406.1 MHz band

**Other material:**
- COSPAS/SARSAT Doc. C/S T.001; Specifications for COSPAS/ SARSAT 406 MHz distress beacons
- COSPAS/SARSAT Doc. C/S T.012; 406 MHz frequency management plan

**Band:** 960–1 215 MHz

**Technical Information:**

**Service:** Aeronautical radionavigation, aeronautical mobile (R)
**Aviation use:** DME, LDACS
**Annex 10:**
SARPs: DME: Annex 10, Volume I, Chapter 3, 3.5
Frequency plan:
DME: Annex 10, Volume I, Chapter 3, Table A
DME: Annex 10, Volume V, Chapter 4, 4.3
Planning criteria:
DME, Annex 10, Volume I, Attachment C, Section 7
EUR ANP COM/3
**RTCA:**
- DO-152, Minimum Operational Characteristics – Vertical Guidance Equipment Used in Airborne Volumetric Navigational Systems (1972), Appendix D (1974)
- DO-180A, MOPS for Airborne Area Navigation Equipment Using a Single Collocated VOR/DME Sensor Input (1990)
- VOR: DO-187, MOPS for Airborne Area Navigation Equipment Using Multi-Sensor Inputs (1984)
- DO-189, MOPS for Airborne DME Operating within the Radio Frequency Range of 960–1 215 MHz (1985)

**Eurocae:**
- ED-27, MOPR for Airborne Area Navigation Systems Based on VOR and DME as Sensors (1979)
- ED-28, MPS for Airborne Area Navigation Computing Equipment Based on VOR and DME as Sensors
- ED-39, MOPR for Airborne Area Navigation Systems Based on Two DME as Sensors (1984)
- ED-40, MPS for Airborne Computing Equipment for Area Navigation Systems Using Two DME as Sensors (1984)
- ED-54, MPS for (DME/N and DME/P) Interrogators (airborne equipment) (1987)
- ED-57, MPS for distance measuring equipment (DME/N and DME/P) (ground equipment), (1986), Amendment #1 (1992)

**ARINC characteristic:** 709-8, Airborne DME Supplement 8, 709A-1, Precision Airborne DME
**ITU Res./Rec.:**
- Res. 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

- ITU Rec. 608 (Rew.WRC-07) : Guidelines for consultation meetings established in Resolution 609 (Rev.WRC-07)

**ITU-R:**

- Rec. M.1639: Protection criterion for the aeronautical radionavigation service with respect to aggregate emissions from space stations in the radio-navigation-satellite service in the band 1 164–1 215 MHz
- Rec. M.1642: 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
- Rep. M.2121: Guidelines for AM(R)S sharing studies in the 960–1 164 MHz band
- Rep. M.2205: Results of studies of the AM(R)S allocation in the band 960–1 164 MHz and of the AMS(R)S allocation in the band 5 030–5 091 MHz to support control and non-payload communications links for unmanned aircraft systems
- Rep. M.2235: Aeronautical mobile (route) service sharing studies in the frequency band 960–1 164 MHz

**Band:** 978 MHz

**Technical Information (UAT):**

**Service:** Aeronautical radionavigation
**Aviation use:** ADS-B, TIS-B, FIS-B, Universal Access Transceiver (UAT)
**Annex 10:**
SARPS: Annex 10, Volume III, Chapter 12
Frequency plan: Single frequency
Channelization: Single frequency
Planning criteria:
**RTCA:**

- DO-239, MOPS for Traffic Information Service (TIS) Data Link Communications (1997)
- DO-267A, MASPS for Flight Information Services Broadcast (FIS-B) Data Link (2004)
- DO-282A, MOPS for Universal Access Transceiver (UAT) Automated Dependent Surveillance-Broadcast (2004)
- DO-286A, MASPS for Traffic Information Services-Broadcast (TIS-B) (2005)

**Eurocae:**
**ARINC characteristic:**
**ITU Res./Rec.:**
**ITU-R:** Rep. M.2205: Results of studies of the AM(R)S allocation in the band 960–1 164 MHz and of the AMS(R)S allocation in the band 5 030–5 091 MHz to support control and non-payload communications links for unmanned aircraft systems
**Other material:** RTCA DO-232, Operations Concepts for Data Link Applications of Flight Information Services (1996)

**Bands:** 1 030 MHz and 1 090 MHz

**Technical Information (SSR):**

**Service:** Aeronautical radionavigation, aeronautical mobile (R)
**Aviation use:** SSR/ACAS
**Annex 10:**

SARPs: Annex 10, Volume IV, Chapters 3 and 4
Frequency plan: Two frequencies: 1 030 MHz for ground-to-air interrogations and 1 090 MHz for air-to-ground reply
Channelization: N/A
Planning criteria: Coordination of the pulse repetition frequency (PRF) on a national basis is required for overlapping coverage areas of SSR

**RTCA:**

- DO-144, Minimum Operational Characteristics-Airborne ATC Transponder Systems (1970), Change 1
- DO-181C, MOPS for ATCRBS/Mode S Airborne Equipment (2001), Change 1 (2002)
- DO-185A, Minimum Operational Performance Standards for Traffic Alert and Collision Avoidance System II (TCAS II) Airborne Equipment (1997)
- DO-197A, Minimum Operational Performance Standards for an Active Traffic Alert and Collision Avoidance System I (Active TCAS I) (1994), Change 1 (1997)
- DO-218B, MOPS for the Mode S Airborne Data Link Processor (2001)

**Eurocae:**

Mode S:

- MOPS for the Airborne Data Links Processor
- ED-86, Equipment Characteristics for Mode S Transponders with Extended Interface Functions
- ED-101, MOPS for Mode S Specific Service Applications
- ED-117, MOPS for Mode S Multilateration Systems for Use in A-SMGCS (2003) [Rx or Tx/Rx]

SSR:

- 1/WG7/71, MPS for Airborne Secondary Surveillance Radar Transponder Apparatus
- ED-43, MOPR for SSR Transponder and Alticoder
- ED-73B, MOPS for SSR Mode S Transponders (2003)
- ED-115, MOPS for Light Aviation SSR Transponders (2002)

**ARINC characteristic:**

718-4, Mark 3 ATC Transponder (ATCRBS/Mode S)
718A-1, Mark 4 ATC Transponder (ATCRBS/Mode S)
735-2, TCAS; 735A-1 Mark 2 TCAS

**ITU Res./Rec.:** Res. 18 (Rev. WRC-15): Relating to the procedure for identifying

and announcing the position of ships and aircraft of States not parties to an armed conflict

**ITU-R:** Rep. M.2205: Results of studies of the AM(R)S allocation in the band 960–1 164 MHz and of the AMS(R)S allocation in the band 5 030–5 091 MHz to support control and non-payload communications links for unmanned aircraft systems

**Other material:** RTCA DO-184, Traffic Alert and Collision Avoidance System (TCAS) I Functional Guidelines (1983)

**Band:** 1 090 MHz

**Technical Information (1090ES):**

**Service:** Aeronautical radionavigation, aeronautical mobile (R), aeronautical mobile-satellite (R)(E-s)
**Aviation use:** ADS-B, Mode S Extended Squitter
**Annex 10:**
SARPS:
Annex 10, Volume III, Part II, Appendix to Chapter 5
Annex 10, Volume IV, Chapter 3
Frequency plan: Single frequency
Channelization: Single frequency
Planning criteria:
**RTCA:**
- DO-242A, Minimum Aviation System Performance Standards for Automatic Dependent Surveillance Broadcast (ADS-B) (2002)
- DO-260 Change 1, MOPS for 1 090 MHz Extended Squitter Automatic Dependent Surveillance-Broadcast (ADS-B)
- DO-260A, MOPS for 1 090 MHz Extended Squitter Automatic Dependent Surveillance-Broadcast (ADS-B) and Traffic Information Services (TIS-B) (2003)
- DO-260B with Corrigendum 1, MOPS for 1 090 MHz Extended Squitter Automatic Dependent Surveillance-Broadcast (ADS-B) and Traffic Information Services (TIS-B)

**Eurocae:** ED-102, MOPS for 1 090 MHz ADS-B (2000)
**ARINC characteristic:** 745-2, Automatic Dependent Surveillance
**ITU Res./Rec.:** Res. 425 (WRC-15): 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
**ITU-R:** Rep. M.2205: Results of studies of the AM(R)S allocation in the band 960–1 164 MHz and of the AMS(R)S allocation in the band 5 030–5 091 MHz to support control and non-payload communications links for unmanned aircraft systems

**Band:** 1 164–1 215 MHz

**Technical Information:**

**Service:** Radionavigation-satellite
**Aviation use:** GNSS
**Annex 10:**
SARPs: Annex 10, Volume I, Chapters 3
Frequency plan:
Channelization: N/A
Planning criteria: N/A
**ITU Res./Rec.:**

- Res. 223 (Rev. WRC-15): Additional frequency bands identified for International Mobile Telecommunications
- Res. 224 (Rev. WRC-15): Frequency bands for the terrestrial component of International Mobile Telecommunications below 1 GHz
- Res. 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
- Res. 610 (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

**ITU-R:**

- Rec. M.1318: Evaluation model for continuous interference from radio sources other than in the radionavigation-satellite service to the radionavigation-satellite service systems and networks operating in the 1 164–1 215 MHz, 1 215–1 300 MHz, 1 559–1 610 MHz and 5 010–5 030 MHz bands
- Rec. M.1787: Description of systems and networks in the radionavigation-satellite service (space-to-Earth and space-to-space) and technical characteristics of transmitting space stations operating in the bands 1 164–1 215 MHz, 1 215–1 300 MHz and 1 559–1 610 MHz
- Rec. M.1831: A coordination methodology for radionavigation-satellite service inter-system interference estimation
- Rec. M.1901: Guidance on ITU-R Recommendations related to systems and networks in the radionavigation-satellite service operating in the frequency bands 1 164–1 215 MHz, 1 215–1 300 MHz, 1 559–1 610 MHz, 5 00–5 010 MHz and 5 010–5 030 MHz
- Rec. M.1904: Characteristics, performance requirements and protection criteria for receiving stations of the radionavigation-satellite service (space-to-space) operating in the frequency bands 1 164–1 215 MHz,

1 215–1 300 MHz and 1 559–1 610 MHz

- Rec. M.1905: Characteristics and protection criteria for receiving earth stations in the radionavigation-satellite service (space-to-Earth) operating in the band 1 164–1 215 MHz
- Rec. M.2030: Evaluation method for pulsed interference from relevant radio sources other than in the radionavigation-satellite service to the radionavigation-satellite service systems and networks operating in the 1 164–1 215 MHz, 1 215–1 300 MHz and 1 559–1 610 MHz frequency bands
- Rep. M.2220: Calculation method to determine aggregate interference parameters of pulsed RF systems operating in and near the bands 1 164–1 215 MHz and 1 215–1 300 MHz that may impact radionavigation-satellite service airborne and ground-based receivers operating in those frequency bands

**RTCA:**

- DO-292: Assessment of Radio Frequency Interference Relevant to the GNSS L5/E5A Frequency Band
- DO-373: MOPS for GNSS Airborne Active Antenna Equipment for the L1/E1 and L5/E5a Frequency Bands (2018)

**Eurocae:**

- ED-259A: Minimum Operational Performance Standard For Dual-Frequency Multi-Constellation Satellite-Based Augmentation System Airborne Equipment

## PROTECTION OF GNSS IN BAND AND OUT OF BAND

### Sharing and protection from other radio services

*Potential interference from AM(R)S unwanted emissions*

Resolution **417 (Rev. WRC-15)** provides the criteria in order to ensure that AM(R)S systems do not cause harmful interference to RNSS in the frequency band 1 164–1 215 MHz.

*Protection of GNSS signals from potential interference of IMT unwanted emissions*

Current results of theoretical and experimental estimations indicate that the levels of unwanted emissions of IMT stations that are defined in ITU-R Recommendations M.2070 and ITU-R M.2071 are not low enough to provide required protection level for RNSS receiving earth stations that operate in 1 164–1 300 MHz. Required separation distances are from 42 m to 2 446 m depending on the type of RNSS

receiver, which makes impossible simultaneous application of these devices in one local spot without additional compatibility measures.

**Band:** 1 215–1 400 MHz

**Technical Information:**

**Service:** Radiolocation/aeronautical radionavigation/radionavigation-satellite
**Aviation use:** Medium- and long-range surveillance radar
**Annex 10:**
SARPs:
Frequency plan: Nationally produced
Channelization: Nationally produced
Planning criteria: Nationally produced
**RTCA:**

- DO-206, MASPS for Radiodetermination Satellite Service (RDSS) (1990)
- DO-381A, MOPS for GBSS for Traffic Surveillance

**Eurocae:**
**ARINC characteristic:**
**ITU Res./Rec.:**

- Res. 608 (Rev. WRC-15): Use of the frequency band 1 215–1 300 MHz by systems of the radionavigation-satellite service (space-to-Earth)
- Res. 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

**ITU-R:**

- Rec. M.1318: Evaluation model for continuous interference from radio sources other than in the radionavigation-satellite service to the radionavigation-satellite service systems and networks operating in the 1 164–1 215 MHz, 1 215–1 300 MHz and 1 559–1 610 MHz and 5 010–5 030 MHz bands
- Rec. M.1463: Characteristics of and protection criteria for radars operating in the radiodetermination service in the frequency band 1 215–1 400 MHz
- Rec. M.1584: Methodology for computation of separation distances between Earth stations of the radionavigation-satellite service (Earth-to-space) and radars of the radiolocation service and the aeronautical radionavigation service in the frequency band 1 300–1 350 MHz
- Rec. M.1787: Description of systems and networks in the radionavigation-satellite service (space-to-Earth and space-to-space) and technical characteristics of transmitting space stations operating in the bands 1 164–1 215 MHz, 1 215–1 300 MHz and 1 559–1 610 MHz
- Rec. M.1831: A coordination methodology for radionavigation-satellite service inter-system interference estimation
- Rec. M.1901: Guidance on ITU-R Recommendations related to systems

and networks in the radionavigation-satellite service operating in the frequency bands 1 164–1 215 MHz, 1 215–1 300 MHz and 1 559–1 610 MHz, 5 000–5 010 MHz and 5 010–5 030 MHz

- Rec. M.1902: Characteristics and protection criteria for receiving earth stations in the radionavigation-satellite service (space-to-Earth) operating in the band 1 215–1 300 MHz
- Rec. M.1904: Characteristics, performance requirements and protection criteria for receiving stations of the radionavigation-satellite service (space-to-space) operating in the frequency bands 1 164–1 215 MHz, 1 215–1 300 MHz and 1 559–1 610 MHz
- Rec. M.2030: Evaluation method for pulsed interference from relevant radio sources other than in the radionavigation-satellite service to the radionavigation-satellite service systems and networks operating in the 1 164–1 215 MHz, 1 215–1 300 MHz and 1 559–1 610 MHz frequency bands
- Rep. M.2220: Calculation method to determine aggregate interference parameters of pulsed RF systems operating in and near the bands 1 164–1 215 MHz and 1 215–1 300 MHz that may impact radionavigation-satellite service airborne and ground-based receivers operating in those frequency bands
- Rep. M.2305: Consideration of aggregate radio frequency interference event potentials from multiple Earth exploration-satellite service systems on radionavigation-satellite service receivers operating in the 1 215–1 300 MHz frequency band

**Bands:** 1 544–1 545 MHz and 1 645.5–1 646.5 MHz

**Technical Information:**

**Service:** Mobile-satellite
**Aviation use:** Distress and safety communications (satellite EPIRBs)
**Annex 10:**
SARPs:
Frequency plan:
Planning criteria:
**RTCA:**
**Eurocae:**
**ARINC characteristic:** 761-2, Second Generation Aviation Satellite Communications System, Aircraft Installation Provisions
**ITU Res./Rec.:** Radio Regulations: Article N38/Appendix 15
**ITU-R:** Rec. M.1731: Protection criteria for COSPAS/SARSAT local user terminals in the band 1 544–1 545 MHz

**Bands:** 1 525–1 559 MHz and 1 626.5–1 660.5 MHz

**Technical Information:**

**Service:** AMS(R)S
**Aviation use:** Satellite communications
**Annex 10:**
SARPs: Annex 10, Volume III, Part I, Chapter 4
Frequency plan: Prepared by space segment provider
Channelization:
Planning criteria:
**RTCA:**

- DO-215A, Guidance on Aeronautical Mobile Satellite Service (AMSS) End-to-End System Performance (1995), Change 1 (1998)
- DO-210D, MOPS for Geosynchronous Orbit Aeronautical Mobile Satellite Services (AMSS) Avionics (2000), Change 1 (2000), Change 2 (2001)
- RTCA DO-231, Design Guidelines and Recommended Standards for the Implementation and Use of AMS(R)S Voice Services in a Data Link Environment (1996)
- RTCA DO-262, MOPS for Avionics Supporting Next Generation Satellite Systems (NGSS) (2000), Change 1 (2001)
- DO-270, MASPS for the Aeronautical Mobile-Satellite (R) Service (AMS(R)S) as Used in Aeronautical Data Links (2001)
- DO-343, MOPS for AMS(R)S data and voice communications supporting required communications performance (RCP) and required procedure performance (RSP) in procedural airspace

**Eurocae:**
**ARINC characteristic:**
741 P1, Aviation Satellite Communications System: Part 1 – Aircraft Installation Provisions;
741 P2, ASCS: Part 2 – System Design and Equipment Functional Description;
741 P4, ASCL: Part 4 – Specification and Description Language
781 Mark 3 Aviation Satellite Communications Systems
**ITU Res./Rec.:** Res. 222 (Rev. WRC-12): 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
**ITU-R:**

- Rec. M.828-1: Definition of availability for communication circuits in the mobile-satellite service
- Rec. M.1037: Bit error performance objectives for the AMS(R)S radio links

- Rec. M.1089: Technical considerations for the coordination of mobile-satellite systems supporting the AMS(R)S
- Rec. M.1180: Availability of communication circuits in the AMS(R)S

- Rec. M.1233: Technical considerations for sharing satellite network resources between the MSS (other than AMS(R)S) and AMS(R)S
- Rec. M.1234: Permissible level of interference in a digital channel of a geostationary satellite network in the AMS(R)S in the bands 1 545–1 555 MHz and 1 646.5–1 656.5 MHz and its associated feeder links caused by other networks of this service and the FSS
- Rec. M.2091: Methodology 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 aeronautical mobile-satellite (R) service communications related to the priority categories 1 to 6 of Article 44 of the Radio Regulations
- Rep. M.2396: Use of mobile-satellite service systems for flight tracking

**Other material:**

- AMCP/5 Report
- ICAO Doc 9925, *Manual on the Aeronautical Mobile Satellite (Route) Service*

**Band:** 1 559–1 610 MHz

**Technical Information:**

**Service:** Radionavigation-satellite/aeronautical radionavigation
**Aviation use:** GNSS
**Annex 10:**
SARPs: Annex 10, Volume I, Chapters 2 and 3
Frequency plan:
Channelization: N/A
Planning criteria: N/A
**RTCA:**

- DO-208, MOPS for Airborne Supplemental Navigation Equipment using GPS (1991), Change 1 (1993) Errata (1995)
- DO-228, MOPS for GNSS Airborne Antenna Equipment (1999), Change 1 (2000)
- DO-229F, MOPS for Global Positioning System/Wide Area Augmentation System Airborne Equipment (2020)

  *Note.— DO-235A (not a Standard) is shown below under Other Material.*
- DO-245A, Minimum Aviation System Performance Standards for Local Area Augmentation System (LAAS) (2004)
- DO-246C, GNSS Based Precision Approach Local Area Augmentation System (LAAS) – Signal-in-Space Interface Control Document (ICD) (2005)
- DO-253A, MOPS for GPS Local Area Augmentation System Airborne Equipment (2001)
- DO-301, Minimum Operational Performance Standards for Global Navigation Satellite System (GNSS) Airborne Active Antenna Equipment for the L1 Frequency Band (2006)
- • DO-373, MOPS for GNSS Airborne Active Antenna Equipment for the L1/E1 and L5/E5a Frequency Bands (2018)DO-401, Minimum Operational Performance Standard For Dual-Frequency Multi-Constellation Satellite-Based Augmentation System Airborne Equipment

**Eurocae:**

- ED-72A, MOPS for Airborne GPS Receiving Equipment Used for Supplemental Means of Navigation (1997)
- ED-88, MOPS for MMR including ILS, MLS, and GPS Used for Supplemental Means of Navigation
- ED-97, Interim Technical Performance Statement for EGNOS/WAAS Airborne Equipment (2000)

- ED-259A, Minimum Operational Performance Standard For Dual-

Frequency Multi-Constellation Satellite-Based Augmentation System Airborne Equipment

**ARINC characteristic:**

743, Airborne GPS Receiver, 743A, GNSS Sensor;
756-3, GNSS Navigation & Landing Unit
760-1, GNSS Navigation Unit (GNU)

**ITU Res./Rec.:**

- Res. 212 (Rev. WRC-15): Implementation of International Mobile Telecommunications in the bands 1 885–2 025 MHz and 2 110–2 200 MHz
- Res. 223 (Rev. WRC-15): Additional frequency bands identified for International Mobile Telecommunications
- Res. 224 (Rev. WRC-15): Frequency bands for the terrestrial component of International Mobile Telecommunications below 1 GHz
- Res. 225 (Rev. WRC-12): Use of additional frequency bands for the satellite component of IMT
- Res. 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
- Res. 739 (Rev. WRC-15): Compatibility between the radio astronomy service and the active space services in certain adjacent and nearby frequency bands

**ITU-R:**

- Rec. M.823: Technical characteristics for differential transmissions for GNSS from maritime radio beacons in the frequency band 283.6–315 MHz in Region 1 and 285–325 MHz in Regions 2 and 3
- Rec. M.1318: Evaluation model for continuous interference from radio sources other than in the radionavigation-satellite service to the radionavigation-satellite service systems and networks operating in the 1 164–1 215 MHz, 1 215–1 300 MHz, 1 559–1 610 MHz and 5 010–5 030 MHz bands
- Rec. M.1343: Essential technical requirements of mobile Earth stations for global non-geostationary mobile-satellite service systems in the band 1–3 GHz
- Rec. M.1480: Essential technical requirements of mobile Earth stations of geostationary mobile-satellite systems that are implementing the Global mobile personal communications by satellite (GMPCS) – Memorandum of understanding arranagments in parts of the frequency band 1–3 GHz
- Rec. M.1787: Description of systems and networks in the radionavigation-satellite service (space-to-Earth and space-to-space) and technical characteristics of transmitting space stations operating in the bands 1 164–1 215 MHz, 1 215–1 300 MHz and 1 559–1 610 MHz
- Rec. M.1831: A coordination methodology for radionavigation-satellite service inter-system interference estimation
- Rec. M.1901: Guidance on ITU-R Recommendations related to systems and networks in the radionavigation-satellite service operating in the frequency bands 1 164–1 215 MHz, 1 215–1 300 MHz, 1 559–1 610 MHz, 5 000–5 010 MHz and 5 010–5 030 MHz

- Rec. M.1903: Characteristics and protection criteria for receiving earth stations in the radionavigation-satellite service (space-to-Earth) and receivers in the aeronautical radionavigation service operating in the band 1 559–1 610 MHz
- Rec. M.1904: Characteristics, performance requirements and protection criteria for receiving stations of the radionavigation-satellite service (space-to-space) operating in the frequency bands 1 164–1 215 MHz, 1 215–1 300 MHz and 1 559–1 610 MHz
- Rec. M.2030: Evaluation method for pulsed interference from relevant radio sources other than in the radionavigation-satellite service to the radionavigation-satellite service systems and networks operating in the 1 164–1 215 MHz, 1 215–1 300 MHz and 1 559–1 610 MHz frequency bands
- Rep. M.2396: Use of mobile-satellite service systems for flight tracking

**Other material:**

- GNSSP and NSP meeting reports
- RTCA DO-235C, Assessment of Radio Frequency Interference Relevant to the GNSS (2023)

## PROTECTION OF GNSS IN BAND 1 559–1 610 MHz

The radionavigation-satellite band at 1 559–1 610 MHz supports the operation of the GNSS which is expected to become the future all-purpose radionavigation system for aviation operations. GPS and GLONASS, presently in operation, have been identified as the initial components of the systems that will be used, possibly with ground augmentation. Both systems are also available for all purposes where a position fixing facility is required. This includes all mobile navigation needs for land, sea or air, survey, mineral exploitation, search and rescue, etc.

Very stringent integrity and reliability standards, and other performance characteristics have been developed by the ICAO NSP (see SARPs for GNSS in Annex 10, Volume I). Both GPS and GLONASS operate using multiple orbiting satellites (up to 24 in number) at around 20 000 km above the Earth's surface. Each satellite transmits exact orbital parameters (ephemeris data) with its corresponding highly accurate (atomic source) timing signal. Ground receivers solve four simultaneous equations for at least three sets of position data using the receivers' integral accurate time source to obtain a two-dimensional position. A minimum of four satellites is required to provide a three-dimensional position. The two systems use different methods of modulation and transmission, with GPS using pseudo-random coding transmitted on the same frequency and GLONASS using frequency division on a discrete frequency for individual satellites.

Brief spectrum details of the occupation of the 1 559–1 610 MHz frequency band,

present and expected, are shown in Figure 7-5. The details of the two systems presently in operation are:

**GPS.** The centre frequency is 1 575.42 MHz. The occupied bandwidth is dependent on the type of receiver, and its tracking process coarse acquisition (C/A) code requires plus or minus 4 MHz and precision (P) code plus or minus 12 MHz.

**GLONASS.** GLONASS operates on 14 frequencies spaced at 0.5625 MHz in the band between 1 598.0625 and 1 605.3750.

**GNSS augmentation.** Proposals have been made for augmentation systems to improve GNSS integrity, which may operate in the lower end of the 1 559–1 610 MHz band. Protection requirements are tentative but early indications are that they would be similar to the systems already in use.

***Aircraft receiving system protection***

The performance requirements for the aircraft receiving system in regard to the projection from interference are contained in:

– Annex 10, Volume I;

– RTCA DO-229C, *Minimum Operational Performance Standards for Global Positioning System/Wide Area Augmentation System (GPS/WAAS) Airborne Equipment* (2001), Errata (2002);

– RTCA DO-228, *Minimum Operational Performance Standards for Global Navigation Satellite Systems (GNSS) Airborne Antenna Equipment* (1999), Change 1 (2000).

The document RTCA DO-235A, *Assessment of Radio Frequency Interference Relevant to the GNSS* (2002), addresses the specifics of the interference situation. This document contains basic material for protection calculations.

The maximum tolerable aggregate interference power levels measured at the antenna port for aircraft receivers, as contained in Annex 10, Volume I, are:

| | **Tracking** | **Acquisition** |
|---|---|---|
| **GPS** | | |
| Narrow-band signals | –150.5 dBW | –156.5 dBW |
| Wide-band signals | –140.5 dBW per 1 MHz | –146.5 dBW per 1 MHz |
| **GLONASS** | | |
| Narrow-band signals | –149.0 dBW | –155.0 dBW |
| Wide-band signals | –140.0 dBW per 1 MHz | –146.0 dBW per 1 MHz |
| **GALILEO** | | |
| Narrow-band signals | -145 dBW | -151 dBW |
| Wide-band signals | -133 dBW per 1 MHz | -139 dBW per 1 MHz |
| **BEIDOU B1C** | | |
| Narrow-band signals | -150.5 dBW | -156.5 dBW |
| Wide-band signals | -140.5 dBW per 1 MHz | -146.5 dBW per 1 MHz |

Wide-band signals are 1 MHz and wider, and narrow-band are nominally less than 700 kHz.

**Sharing and protection from other radio services**

***Fixed links***

No published characteristics are available for the fixed links which used to be operated under Footnotes 5.362B and 5.362C which were suppressed by WRC-15. Information from other work in connection with these fixed links indicates typical systems with characteristics as follows:

| | |
|---|---|
| Frequency: | Anywhere in band 1 400–1 660 MHz at a bandwidth of 600 kHz |
| Output Power: | 1.2 W |
| Antenna Gain: | up to 22 dB |
| Front/Back: | 16 dB |
| Side Lobe Attenuation: | 9 dB min |

With these characteristics, unacceptable interference to GNSS services could exist at distances of 400 km and greater to an aircraft receiver in the main lobe of the fixed link transmitter. Ground station GNSS monitors used for augmentation may be

affected within 80 km. The numbers, locations and operating frequencies of the equipment are only known to the licensing national administrations. National coordination with authorities in the countries concerned is necessary to establish the sharing possibilities on an individual site basis.

These links have the potential to inhibit GNSS operations over a wide area. The problem has been recognized internationally. ICAO Policy (Section 1 559–1 626.5 MHz of this handbook) supports the removal of the GNSS band at 1 559–1 610 MHz from both footnotes.

***ICAO studies***

The ICAO NSP has prepared material on the protection of GNSS to be used as ICAO input documentation to ITU-R and other discussions on this subject. This material contains the protection requirements for all GNSS and support systems that are expected to be utilized for aviation purposes.

The protection requirements for GNSS systems as stated by the NSP are:

– minus 137 dBW/m$^2$/MHz (wide-band signals); and

– minus 148 dBW/m$^2$/MHz (narrow-band signals).

**Protection of GNSS from the spurious emissions of mobile Earth stations (MES)**

***Mobile-satellite terminals in the band 1–3 GHz***

The band 1 610–1 626.5 MHz is allocated for use by mobile-satellite terminals for transmissions in the Earth-to-space direction to satellites in non-geostationary orbits (NGSO). The mobile terminals may either be fixed to a vehicle or other mobile unit, or be hand-held. The systems presently proposed may be either of CDMA (wide-band) or of FDMA (narrow-band) type. These systems generate unwanted emissions which can interfere with GNSS services in the band 1 559–1 610 MHz.

GSO mobile-satellite systems operating in other bands between 1 GHz and 3 GHz and particularly the Earth-to-space band at 1 660–1 660.5 MHz also have the potential to cause interference. The latter band is also used by AMS(R)S for transmissions from the aircraft (i.e. from an aeronautical Earth station) to the satellite. For this situation, special measures have to be applied by aircraft systems designers to maintain the AMS(R)S signal level at the GNSS antenna below the agreed protection value.

Any of these mobile terminals may be used in the vicinity of airports, which creates the need for an international agreement to control the manufacture and use of, and the cross-border controls relating to, such terminals. The Global Mobile Personal Communications by Satellite MOU, which was developed jointly by ITU and the World Telecommunications Policy Forum (held in 1996), has been raised for signature by all participating countries as an agreement addressing the import and control of mobile-satellite equipment.

***NGSO MES terminals***

Protection of GNSS from NGSO MES is addressed by ITU-R Recommendation M.1343 (*Essential technical requirements of mobile Earth stations for global non-geostationary mobile-satellite systems in the band 1–3 GHz*).

The purpose of this recommendation, approved in 1997, is to provide a common technical basis to:

a) establish type approval requirements for MES terminals;

b) facilitate the licensing of MES terminal operations;

c) facilitate the development of mutual recognition arrangements of type approvals of MES terminals; and

d) facilitate the development of mutual recognition arrangements to facilitate the circulation and the use of MES terminals.

***GSO MES terminals***

Protection of GNSS from GSO MES is addressed by ITU-R Recommendation M.1480 (*Essential technical requirements of mobile Earth stations of geostationary mobile-satellite systems that are implementing the Global mobile personal communications by satellite (GMPCS) – Memorandum of understanding arranagments in parts of the frequency band 1–3 GHz*).

The data for the “carrier-on” condition only have been extracted. For the “carrier-off” condition and all other relevant data, reference should be made to the Recommendation. The subject is complex and the information presented here is for general guidance only.

The limits relate to the level of unwanted emissions at the output of the MES in the

frequency bands quoted. The first column is for terminals with antenna gain less than 8 dBi and e.i.r.p. less than 15 dBW. The measurement bandwidth is 1 MHz unless indicated otherwise.

***Protection of GNSS signals from potential harmful interference of IMT***

Current results of theoretical and experimental estimations indicate that the levels of unwanted emissions of IMT stations that are defined in ITU-R Recommendations M.2070 and ITU-R M.2071 are not low enough to provide required protection level for RNSS receiving Earth stations that operate in 1 559–1 610 MHz. Required separation distances are from 42 m to 2 446 m depending on the type of RNSS receiver, which makes impossible simultaneous application of these devices in one local spot without additional compatibility measures.

**Band:** 1 616 -1 626.5MHz

**Technical Information:**

**Service:** AMS(R)S
**Aviation use:** Satellite communications
**Annex 10:**

SARPs: Annex 10, Volume III, Part I, Chapter 4
Frequency plan: Prepared by space segment provider
Channelization:

- 1616-1626.5MHz for Iridium Legacy
- 1618-1626.5MHz for Iridium Certus

Planning criteria:

**RTCA:**

- DO-343D, MASPS for AMS(R)S Data and Voice Communications Supporting Required Communications Performance (RCP) and Required Surveillance Performance (RSP) in Procedural Airspace
- DO-262F, MOPS for Avionics Supporting Next Generation Satellite Systems (NGSS).

**Eurocae:**

- ED-242C, MASPS for AMS(R)S Data and Voice Communications Supporting Required Communications Performance (RCP) and Required Surveillance Performance (RSP) in Procedural Airspace
- ED-243B MOPS for Avionics Supporting Next Generation Satellite Systems (NGSS)

**ARINC characteristic:**

- ARINC 771

**ITU-R:**

- ITU-R M.1184-3: Technical characteristics of mobile satellite systems in the frequency bands below 3 GHz for use in developing criteria for sharing between the mobile-satellite service (MSS) and other services
- ITU-R M.1188-1: Impact of propagation on the design of non-GSO mobile-satellite systems not employing satellite diversity which provide service to handheld equipment
- ITU-R M.1854-1: Use of mobile-satellite service in disaster response and relief

**Other material:**

- ICAO Doc 9925: Manual on the Aeronautical Mobile Satellite (Route) Service, 1st Edition, 2010
- ICAO Doc 9869: Performance-based Communication and Surveillance (PBCS) Manual. Second Edition 2017
- ICAO Doc 10037: Global Operational Datalink (GOLD) Manual, First Edition 2017
- ICAO Doc 10038: Satellite Voice Operations Manual (SVGM), First Edition 24 July 2012

**Band:** 2 700–3 300 MHz

**Technical Information:**

**Service:** Aeronautical radionavigation/radionavigation

**Aviation use:** Primary surveillance radar, surveillance radar element of precision approach radar (PAR) medium-range systems, ground-based weather radar

**Annex 10:**

SARPs: Annex 10, Volume I, Chapter 3, 3.2.4

Frequency plan:

Planning criteria:

**RTCA:**

- DO-381A, MOPS for GBSS for Traffic Surveillance

**Eurocae:**

**ARINC characteristic:**

**ITU Res./Rec.:**

**ITU-R:**

- Rec. M.629: Use for the RN service of the frequency bands 2 900–3 100 MHz, 5 470–5 650 MHz, 9 200–9 300 MHz, 9 300– 9 500 MHz and 9 500–9 800 MHz
- Rec. M.1460: Technical and operational characteristics and protection criteria of radiodetermination and meteorological radars in the 2 900–3 100 MHz band
- Rec. M.1461: Procedures for determining the potential for interference between radars operating in the radiodetermination service and systems in other services
- Rec. M.1464: Characteristics of and protection criteria for radionavigation and meteorological radars operating in the frequency band 2 700–2 900 MHz
- Rec. M.1465: Characteristics of and protection criteria for radars operating in the radiodetermination service in the frequency band 3 100–3 700 MHz

**Band:** 4 200–4 400 MHz

**Technical Information:**

**Service:** Aeronautical radionavigation and Aeronautical Mobile (R) Service
**Aviation use:** Radio altimeters and WAICs
**Annex 10**
SARPs:
Frequency plan:
Planning criteria:
**RTCA:**
- DO-155, Minimum Performance Standards – Airborne Low-range Radar Altimeters (1974)
- DO-161A, Minimum Performance Standards – Airborne Ground Proximity Warning Equipment (1976)

**Eurocae:**
- ED-30, MPS for Airborne Low-Range Radio (Radar) Altimeter Equipment (1980), Amend. 1 (1980)
- ED-83, Recommendations on Ground Collision Avoidance Systems

**ARINC characteristic:**
594-4, Ground Proximity Warning System (GPWS)
723-3, Ground Proximity Warning System
707-6, Radar Altimeter (RALT) Supplement 6
**ITU Res./Rec.:**
- Rec. M.2059: Operational and technical characteristics and protection criteria of radio altimeters utilizing the band 4 200 – 4 400 MHz (2014)
- Rec. M.2067-0: Technical characteristics and protection criteria for Wireless Avionics Intra-Communication systems (2015)
- Rec. M.2085-0: Technical conditions for the use of wireless avionics intra-communication systems operation in the aeronautical mobile (R) service in the frequency band 4 200 – 4 400 MHz
- Res. 424 (WRC-15): Use of Wireless Avionics Intra-Communications in the frequency band 4 200 – 4 400 MHz

**ITU-R:**
- Rep. 1186 (Question 94/8):Use of frequency band 4 200 – 4 400 MHz by radio altimeters (1990)
- Rep. M.2197: Technical characteristics and operational objectives for wireless avionics intra communications (WAIC) (2010)
- Rep M.2319-0: Compatibility analysis between wireless avionic intra-communication systems and systems in the existing services in the frequency band 4 200 – 4 400 MHz (2014)

## PROTECTION ASPECTS OF RADIO ALTIMETERS IN BAND 4 200–4 400 MHz

### General

The frequency band at 4 200–4 400 MHz has been allocated to the aeronautical radionavigation service (ARNS) and is reserved exclusively for radio altimeters by RR No. **5.438**. The radio altimeter, in one of its main applications, performs the highly important task of providing flare guidance in the last stages of automated approach to land. Equally critical is its use as an input to ground proximity warning systems (GPWS) in aircraft, which give a "pull up" warning at a predetermined altitude and closure rate.

For these applications, a good interference rejection performance is essential. Integrity standards of the order of one failure in $10^{19}$ operations are not uncommon. The use of a wide frequency band is an essential feature in effective designs to achieve high orders of interference rejection and freedom from disruptive effects due to the high levels of pollution of the radio environment which exist in densely populated areas.

Studies have determined the necessity for the retention of the existing 200 MHz of spectrum to meet the exacting requirements of high accuracy with good all-round performance.

### ITU-R studies

CCIR Report 1186 discusses the technical background to meeting the operational performance required for modern conditions. It concludes that:

"The whole of the band 4 200 to 4 400 MHz currently allocated is required up to at least the year 2015."

In coming to this conclusion, Report 1186 reviews the accuracy requirements and the design features to meet those requirements as laid down in MOPS and MASPS. The relationship between frequency excursion and accuracy is particularly noted. Typical performance requirements are contained in ARINC Doc 707-1, Section 3.7 as follows:

– accuracy: within 1.5 ft., or 2 per cent if greater, in the range 20 to 2 500 ft;

– output noise: 0.25 ft;

– output Resolution: 0.125 ft.

**Band:** 5 000–5 250 MHz

**Technical Information:**

**Service:** Aeronautical radionavigation, aeronautical mobile (R), aeronautical mobile-satellite (R), aeronautical mobile (for aeronautical mobile telemetry), radionavigation-satellite
**Aviation use:** MLS, RPAS C2, AeroMACS, aeronautical mobile telemetry
**Annex 10:**
SARPs: Annex 10, Volume I, Chapter 3, 3.11
Frequency plan: Annex 10, Volume I, Table A
Planning criteria:
Annex 10, Volume V, Chapter 4, 4.4
Annex 10, Volume I, Attachment G, Section 9
**RTCA:**
- DO-177, MOPS for MLS airborne receiving equipment (1981), Change 1 & 2 (1986)
- DO-362A, Command and Control (C2) Data Link Minimum Operational Performance Standards (MOPS) (Terrestrial), 2020**Eurocae:**
- ED-36B, MOPS for MLS Airborne Receiving Equipment
- ED-53A, MOPS for MLS Ground Based Equipment
- ED-74, MOPS for Combined ILS and MLS Airborne Receiving Equipment, Amend. 1 (1997)
- ED-88, MOPS for MMR including ILS, MLS, and GPS used for Supplemental Means of Navigation
- ED-227, Minimum Aviation System Performance (MASPS) AeroMACS (2016)

**ARINC characteristic:** 727-1, Airborne Microwave Landing System
**ITU Res./Rec.:**
- Res. 418 (Rev. WRC-15): Use of the frequency band 5 091–5 250 MHz by the aeronautical mobile service for telemetry applications
- Res. 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
- Res. 748 (Rev. WRC-15): Compatibility between the aeronautical mobile (R) service and the fixed-satellite service (Earth-to-space) in the frequency band 5 091–5 150 MHz

**ITU-R:**
- Rec. M.1318: Evaluation model for continuous interference from radio sources other than in the radionavigation-satellite service to the radionavigation-satellite service systems and networks operating in the

1 164–1 215 MHz, 1 215–1 300 MHz, 1 559–1 610 MHz and 5 010–5 030 MHz bands

- Rep. M.2171: Characteristics of unmanned aircraft systems and spectrum requirements to support their safe operation in non-segregated airspace (2009)
- Rep. M.2205: Results of studies of the AM(R)S allocation in the band 960 – 1 164 MHz and of the AM(R)S allocation in the band 5 030 – 5 091 MHz to support control and non-payload communications links for unmanned aircraft systems (2010)
- Rep. M.2237: Compatibility study to support the line-of-sight control and non-payload communications link(s) for unmanned aircraft systems proposed in the frequency band 5 030 – 5 091 MHz (2011)

- Rec. M.1582: Method for determining coordination distances, in the 5 GHz band, between the international standard microwave landing system stations operating in the aeronautical radionavigation service and stations of the radionavigation-satellite service (Earth-to-space)
- Rec. M.1831: A coordination methodology for radionavigation-satellite service inter-system interference estimation
- Rec. M.1901: Guidance on ITU-R Recommendations related to systems and networks in the radionavigation-satellite service operating in the frequency bands 1 164–1 215 MHz, 1 215–1 300 MHz, 1 559–1 610 MHz, 5 000–5 010 MHz and 5 010–5 030 MHz
- Rec. M.1906: Characteristics and protection criteria of receiving space stations and characteristics of transmitting earth stations in the radionavigation-satellite service (Earth-to-space) operating in the band 5 000–5 010 MHz
- Rec. M.2031: Characteristics and protection criteria of receiving earth stations and characteristics of transmitting space stations in the radionavigation-satellite service (space-to-Earth) operating in the band 5 010–5 030 MHz
- Rec. S.1342: Method for determining coordination distances, in the 5 GHz band, between the international standard microwave landing system (MLS) in the aeronautical radionavigation service (ARNS) and non-geostationary mobile-satellite service stations providing feeder uplink services
- Rep. M.2219: Radionavigation-satellite service applications for the 5 000–5 010 MHz and 5 010–5 030 MHz bands
- Rep. M.2262: Potential interference between the ICAO standard microwave landing system (MLS) operating above 5 030 MHz and radionavigation-satellite service (RNSS) systems in the band 5 000–5 030 MHz

**Other material:**

- RTCA DO-226, Guidance Material for Evolving Airborne Precision Area Navigation Equipment with Emphasis on MLS (1995)
- RTCA DO-377, MASPS — Minimum Aviation System Performance Standards (MASPS) for C2 Link Systems Supporting Operations of Uncrewed Aircraft Systems in U.S. Airspace
- ICAO Doc. 10044, Manual on the Aeronautical Mobile Airport Communications System (AeroMACS) (2017)

## MLS COORDINATION WITH FSS IN BAND 5 090–5 150 MHz

### Protection requirements for MLS (coordination with FSS Earth stations)

The band 5 000–5 250 MHz is allocated to the aeronautical radionavigation service (ARNS). RR No. **5.444** gives precedence in the band 5 030–5 150 MHz to the international standard system (microwave landing system) for precision approach and landing. RR No. **5.444A** allocates on a joint primary basis the band 5 091–5 150 MHz to the FSS (for mobile-satellite feeder links) in the Earth-to-space direction. This allocation was made by WRC-95. Resolution **114**, calling for studies of the compatibility between these two services, was approved.

The compatibility studies under Resolution **114** were carried out by ITU-R WP4A, which primarily deals with fixed-satellite systems, and it was found appropriate for the results of the work obtained in WP4A to be examined by the ICAO AWOP/16 held in 1997. AWOP/16 proposed numerous amendments, most of which were later adopted at the ITU Radiocommunication Assembly in 1997.

### ITU-R Recommendations

The method for the determination of coordination distances between Earth stations in the mobile-satellite service (feeder links) in the band 5 091–5 150 MHz and MLS in the band 5 030–5 090 MHz which was agreed in ITU-R is contained in ITU-R Rec. S.1342 (Method for determining coordination distances, in the 5 GHz band, between the international standard microwave landing system (MLS) in the aeronautical radionavigation service (ARNS) and non-geostationary mobile-satellite service stations providing feeder uplink services).

This Recommendation addresses only the protection of MLS in the band 5 030–5 090 MHz. This band is displayed at Table A of Annex 10, Volume I, which specifies 200 channels for MLS installations. The Recommendation recognizes that the sharing between MLS in the band 5 091–5 150 MHz and the FSS in the band 5 091–5 250 MHz, and other new ARNS in the band 5 030–5 250 MHz and FSS in the band 5 091–5 250 MHz remains to be studied. (It should also be noted that AWOP/16 concluded that co-frequency sharing between the FSS and MLS is not feasible.) The band 5 091–5 150 MHz is required to satisfy future long-term requirements.

**Band:** 5 350–5 470 MHz

**Technical Information:**

**Service:** Aeronautical radionavigation
**Aviation use:** Airborne weather radar
**Annex 10:**
SARPs: Annex 6, Part I, Chapter 6, 6.11
Frequency plan:
Channelization:
Planning criteria:
**RTCA:**

- DO-173, Minimum Operational Performance Standards for Airborne Weather and Ground Mapping Pulsed Radars (1980), Corrigendum/ Errata/Change 1
- DO-220, Minimum Operational Performance Standards for Airborne Weather Radar with Forward-Looking Windshear Detection Capability (1993), Change 1 (1995)
- DO-366A, Minimum Operational Performance Standards for Minimum Operational Performance Standards (MOPS) for Air-to-Air Radar for Traffic Surveillance

**Eurocae:**
**ARINC characteristic:** No. 708A-3, Airborne Weather Radar with Forward Looking Windshear Detection Capability
**ITU Res./Rec.:**

- Rec. M.1638: Characteristics of and protection criteria for sharing studies for radiolocation, aeronautical radionavigation and meteorological radars operating in the frequency bands between 5 250 and 5 850 MHz.

**ITU-R:**

**Band:** 8 750–8 850 MHz

**Technical Information:**

**Service:** Aeronautical radionavigation/radiolocation
**Aviation use:** Airborne Doppler radar
**Annex 10:**
SARPs:
Frequency plan:
Channelization:
Planning criteria:
**RTCA:**

- DO-158, Minimum Performance Standards-Airborne Doppler Radar Navigation Equipment (1975)
- DO-173, Minimum Operational Performance Standards for Airborne Weather and Ground Mapping Pulsed Radars (1980), Corrigendum/ Errata/Change 1
- DO-220, Minimum Operational Performance Standards (MOPS) for Airborne Weather Radar with Forward-Looking Windshear Detection Capability (1993)

**Eurocae:**
**ARINC characteristic:**
**ITU Res./Rec.:**

- Rec. M1796-2: Characteristics of and protection criteria for terrestrial radars operating in the radiodetermination service in the frequency band 8 500-10 680 MHz

**ITU-R:**

**Band:** 9 000–9 500 MHz

**Technical Information:**

**Service:** Aeronautical radionavigation/radionavigation

**Aviation use:** Primary radar 3 cm short-range applications including precision approach. Airport surface detection equipment (ASDE)

**Annex 10:**

SARPs: Annex 10, Volume I, Chapter 3, 3.2

Frequency plan:

Channelization:

Planning criteria:

**RTCA:**

- DO-173, Minimum Operational Performance Standards for Airborne Weather and Ground Mapping Pulsed Radars (1980), Corrigendum/ Errata/Change 1
- DO-381A, MOPS for GBSS for Traffic Surveillance

**Eurocae:** ED-116, MOPS for Surface Movement Radar Sensor Systems for Use in A-SMGCS

**ARINC characteristic:** 708A-3, Airborne Weather Radar with Forward Looking Windshear Detection Capability

**ITU Res./Rec.:**

- Rec. M1796-2: Characteristics of and protection criteria for terrestrial radars operating in the radiodetermination service in the frequency band 8 500-10 680 MHz

**ITU-R:**

- Rec. M.629: Use for the radionavigation service of the radio frequency bands 2 900–3 100 MHz, 5 470–5 650 MHz, 9 200–9 300 MHz, 9 300–9 500 MHz and 9 500–9 800 MHz

**Band:** 13.25–13.4 GHz

**Technical Information:**

**Service:** Aeronautical radionavigation
**Aviation use:** Airborne Doppler radar
**Annex 10:**
SARPs:
Frequency plan:
Channelization:
Planning criteria:
**RTCA:**

- DO-158, Minimum Performance Standards-Airborne Doppler Radar Navigation Equipment (1975)
- DO-173, Minimum Operational Performance Standards for Airborne Weather and Ground Mapping Pulsed Radars (1980), Corrigendum/ Errata/Change 1
- DO-220, Minimum Operational Performance Standards (MOPS) for Airborne Weather Radar with Forward-Looking Windshear Detection Capability (1993), Change 1 (1995)

**Eurocae:**
**ARINC characteristic:**
**ITU Res./Rec.:**

- M2208-1: Characteristics and protection criteria for radars operating in the aeronautical radionavigation service in the frequency band 13.25-13.40 GHz

**ITU-R:**

- Rec. M.496.3: Limits of power flux-density of radionavigation transmitters to protect space station receivers in the fixed-satellite service in the 14 GHz band

**Band:** 15.4–15.7 GHz

**Technical Information:**

**Service:** Aeronautical radionavigation/radiolocation

**Aviation use:** Primary radar, particularly airport surface detection equipment (ASDE)

**Annex 10:**

SARPs:

Frequency plan:

Channelization:

Planning criteria:

**RTCA:**

- DO-173, Minimum Operational Performance Standards for Airborne Weather and Ground Mapping Pulsed Radars (1980), Corrigendum/Errata/ Change 1

**Eurocae:** ED-116, MOPS for Surface Movement Radar Sensor Systems for use in A-SMGCS (2004)

**ARINC characteristic:**

**ITU Res./Rec.:**

**ITU-R:**

- Rec. S.1340: 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
- Rec. S.1341: Sharing between feeder links for the mobile-satellite service and the aeronautical radionavigation service in the space-to-Earth direction in the band 15.4–15.7 GHz and the protection of the radio astronomy service in the band 15.35–15.4 GHz

## SHARING IN THE BAND 15.4–15.7 GHz

### General

The part of the band at 15.43–15.63 GHz of the aeronautical radionavigation band 15.4–15.7 GHz is shared with the fixed-satellite service (FSS), an allocation which was made by WRC-95 and later amended by WRC-97 (RR No. **5.511A**). The sharing of the band is addressed in ITU-R Recommendation S.1340. The FSS use is restricted to feeder links for non-geostationary satellites in the mobile-satellite service. The conditions of use are covered by RR Nos. **5.511A** and **5.511C**, which place restrictions on both services as part of the protection requirements.

### ITU-R studies

#### *Aeronautical utilization of band*

The band is utilized by the ARNS for a variety of systems:

– airport surface detection equipment (ASDE): radar systems used at civil airports for the control of surface movement;

– Radar sensing and measurement system (RSMS): sensing systems used in small aircraft and helicopters for height and other low-range measurement;

– aircraft landing system(s) (ALS): a transportable landing system used for temporary airfields;

– multi-purpose radar (MPR): an airborne surveillance radar.

Descriptions of these systems are given in Annex A of ITU-R Recommendations S.1340 and S.1341 (see below). This frequency band is also targeted for RPAS Air to Air Detect and Avoid System.

### ITU-R Recommendations

Rec. S.1340: 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

This Recommendation contains the following limitations:

– limits the emissions from ALS and MPR at low angles (paragraph 2.1);

– limits horizontal emission by Earth stations to 54 dB (W/MHz);

– restricts RSMS to band 15.43 to 15.63 GHz;

– establishes coordination distances for the protection of ALS and MPR; and

– urges the limit of 42 dBW on all ARNS stations.

Rec. S.1341: Sharing between feeder links for the mobile-satellite service and the aeronautical radionavigation service in the space-to-Earth direction in the band 15.4–15.7 GHz and the protection of the radio astronomy service in the band 15.35–15.4 GHz

This Recommendation contains the following limitations:

– limits the power flux-density of the FSS at the Earth's surface for various angles of arrival (paragraph 2.1);

– establishes coordination distances for ALS and MPR (paragraph 5);

– limits Earth stations to operate above 5 degrees; and

– makes provision for the protection of the radio astronomy service in the band 15.35–15.4 GHz.

**Band:** 24.25–24.65 GHz

**Technical Information:**

**Service:** Radionavigation
**Aviation use:** Primary radar: airport surface detection equipment (ASDE)
**Annex 10:**
SARPs:
Frequency plan:
Channelization:
Planning criteria:
**RTCA:**
**Eurocae:** ED-116, MOPS for Surface Movement Radar Sensor Systems for use in A-SMGCS (2004)
**ARINC characteristic:**
**ITU Res./Rec.:**
**ITU-R:**
**Other material:**

- ICAO Doc 9830, *Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual*
- ICAO Doc 9924, *Aeronautical Surveillance Manual*

**Band:** 31.8–33.4 GHz

**Technical Information:**

**Service:** Radionavigation

**Aviation use:** Airport surface detection equipment (ASDE), enhanced flight vision systems (EFVS)

**Annex 10:**

SARPs:

Frequency plan:

Channelization:

Planning criteria:

**RTCA:**

**Eurocae:**

**ARINC characteristic:**

**ITU Res./Rec.:** Rec. No. 707 (WARC-79): Relating to the use of the frequency band 32–33 GHz shared between the inter-satellite service and the radionavigation service

**ITU-R:** Rec. M.1466: Characteristics of and protection criteria for radars operating in the radionavigation service in the frequency band 31.8–33.4 GHz

**Band:** 92-95 GHz

**Technical Information:**

**Service:** Radiolocation
**Aviation use:** Foreign object debris detection system (FOD)
**Annex 10:**
SARPs:
Frequency plan:
Channelization:
Planning criteria:
**RTCA:**
**Eurocae:**
**ARINC characteristic:**
**ITU Res./Rec.:**

- Recommendation ITU-R M.2162-0 Technical and operational characteristics of radiolocation systems operating in the frequency range 92-100 GHz and radionavigation systems operating in the frequency range 95-100 GHz.

**ITU-R:**

- ITU Report M.2501-0, Technical and operational characteristics of the foreign object debris detection system operating in the frequency range 92-100 GHz

**Band:** 95-100 GHz

**Technical Information:**

**Service:** Radiolocation, Radionavigation
**Aviation use:** Airport surface detection equipment (ASDE), Enhanced flight vision systems (EFVS), foreign object debris detection system (FOD)
**Annex 10:**
SARPs:
Frequency plan:
Channelization:
Planning criteria:
**RTCA:**
**Eurocae:**
**ARINC characteristic:**
**ITU Res./Rec.:**

- Recommendation ITU-R M.2162-0 Technical and operational characteristics of radiolocation systems operating in the frequency range 92-100 GHz and radionavigation systems operating in the frequency range 95-100 GHz.

**ITU-R:**

- ITU Report M.2501-0 Technical and operational characteristics of the foreign object debris detection system operating in the frequency range 92-100 GHz

# Attachment H

# ITU RESOLUTIONS AND RECOMMENDATIONS

(as contained in the Radio Regulations)

## 1. INTRODUCTION

The ITU Resolutions and Recommendations contained in the Radio Regulations and referenced below are relevant to specific frequency bands used by aviation, specific aviation safety systems or certain WRC agenda items referenced in the ICAO Position.

| Resolution | Footnotes/WRC-27 agenda item | Band description |
|---|---|---|
| 18 (Rev. WRC-23) | – | Procedure for identifying and announcing the position of ships and aircraft of States not parties to an armed conflict |
| 114 (Rev. WRC-15) | 5.444; 5.444A | 5 091–5 150 MHz |
| 154 (Rev. WRC-15) | – | 3 400–4 200 MHz; VSAT |
| 155 (Rev. WRC-19) | 5.484B | FSS bands; regulatory provisions for RPAS C2 links (UAS CNPC links) |
| 205 (Rev. WRC-19) | – | 406–406.1 MHz |
| 207 (Rev. WRC-15) | – | Aeronautical HF bands |
| 215 (Rev. WRC-12) | – | L-band mobile-satellite/ AMS(R)S spectrum |
| 222 (Rev. WRC-23) | 5.353A; 5.357A | L-band mobile-satellite/ AMS(R)S spectrum |
| 225 (Rev. WRC-23) | 5.351A | L-band mobile-satellite; GNSS, 2 700–2 900 MHz |
| 229 (Rev. WRC-32) | 5.446A | 5 150–5 250 MHz |
| 249 (Rev. WRC-23) | **WRC-27 AI 1.11** | L band SATCOM |
| 253 (WRC-23) | **WRC-27 AI 1.13** | 694 – 2700 MHz |
| 256 (WRC-23) | **WRC-27 AI 1.7** | 4.2 – 4.4 GHz |

| Resolution | Footnotes/WRC-27 agenda item | Band description |
|---|---|---|
| 405 | – | Aeronautical HF bands |
| 406 (WRC-23) | 5.198A | VHF band 117.975 – 137 MHz |
| 411 (WRC-23) | **WRC-27 AI 1.9** | Aeronautical HF bands |
| 413 (Rev. WRC-23) | 5.197A | 108–117.975 MHz; AM(R)S |
| 417 (Rev. WRC-15) | 5.327A | 960–1 164 MHz; AM(R)S |
| 418 (Rev. WRC-19) | 5.444B, 5.446C | 5 091–5 150 MHz (AMS) |
| 422 (WRC-12) | – | L-band mobile-satellite/ AMS(R)S spectrum |
| 608 (Rev. WRC-19) | 5.329 | 1 215–1 300 MHz |
| 609 (Rev. WRC-07) | 5.328A | 1 164–1 215 MHz |
| 610 (WRC-19) | 5.328B | 1 164–1 300 MHz; 1 559–1 610 MHz; 5 010–5 030 MHz |
| 674 (WRC-23) | **WRC-27 AI 1.19** | 4.2 – 4.4 GHz |
| 680 (WRC-23) | **WRC-27 AI 1.15** | Portions between 390 MHz and 28.35 GHz |
| 682 (WRC-23) | **WRC-27 AI 1.17** | All band |
| 712 (WRC-23) | **WRC-27 AI 1.18** | Above 76 GHz |
| 739 (Rev. WRC-19) | 5.208B | 1 525–1 559 MHz; 1 559–1 610 MHz |
| 748 (Rev. WRC-19) | 5.444B | 5 091–5 150 MHz (AMS, FSS) |
| 750 (Rev. WRC-19) | 5.338A | 1 350–1 400 MHz |
| 804 (Rev. WRC-23) | – | Establishment of WRC Agendas |
| **Recommendation** | **Footnotes** | **Band** |
| 206 (Rev. WRC-32) | – | L-band mobile-satellite/ AMS(R)S spectrum |
| 401 | – | Aeronautical HF bands |
| 608 (Rev. WRC-07) | – | 1 164–1 215 MHz |
| 707 (Rev. WRC-23) | 5.548 | 31.8–33 GHz |
| 724 (WRC-07) | – | Use of VSAT stations |

**– END –**