



**Journal Title:** Telecommunication Journal

**Journal Issue:** vol. 38 (no. 10), 1971

**Article Title:** The World Administrative Radio Conference for Space Telecommunications: Geneva, 7 June – 17 July 1971: summary record by the International Frequency Registration Board (IFRB)

**Page number(s):** pp. 673-682

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# the world administrative radio conference for space telecommunications

geneva, 7 june - 17 july 1971

summary record by the international frequency  
registration board (ifrb)

## Introduction

THE World Administrative Radio Conference for Space Telecommunications opened at the Palais des Expositions in Geneva on 7th June 1971. About 800 delegates from the administrations of 101 Member countries of the Union took part, together with observers from the United Nations, specialized agencies and other international organizations.

A conference of this nature was envisaged by the Extraordinary Administrative Radio Conference to allocate frequency bands for space radiocommunication purposes (Geneva, 1963) on the understanding that it would be convened when the Administrative Council, with the approval of the majority of Members of the Union, thought fit.

The agenda of the Conference, given in Administrative Council Resolution No. 653, is annexed hereto and consisted basically of a revision of various provisions of the Radio Regulations, with a view to enabling space communications, which have already made prodigious advances,

to continue to develop harmoniously, as techniques are perfected, for some years to come.

At its first meeting, the Conference unanimously elected:

— Chairman: Mr. Gunnar Pedersen (Denmark)

— Vice-Chairmen: Mr. A. Badalov (USSR)  
Mr. Robert C. Tyson (United States)

Mr. C. Stead was nominated Secretary of the Conference, and Mr. K. Ćomic Technical Secretary of the Conference.

The Conference also set up the following seven committees to prepare its decisions:

## Committee 1

### *Steering Committee*

Chairman: Mr. Gunnar Pedersen, Chairman of the Conference (Denmark)

Vice-Chairmen: Mr. A. Badalov (USSR)  
Mr. Robert C. Tyson (United States)  
Vice-Chairmen of the Conference

Secretary: Mr. C. Stead

## Committee 2

### *Credentials*

Chairman: Mr. C. J. Martínez (Venezuela)

Vice-Chairman: Mr. N. P. Kamga (Cameroon)

Secretary: Mr. W. Scott

## Committee 3

### *Budget Control Committee*

Chairman: Mr. L. Constantinescu (Roumania)

Vice-Chairman: Mr. A. Zaidan (Saudi Arabia)

Secretary: Mr. R. Prélaz

## Committee 4

### *Technical*

Chairman: Mr. E. Sandbach (Australia)

Vice-Chairman: Mr. J. Hernández (Mexico)

Secretary: Mr. I. Dolezel

#### Committee 5

##### *Allocations*

Chairman: Mr. H. A. Kieffer  
(Switzerland)  
Vice-Chairman: Mr. J. Maršiček  
(Czechoslovakia)  
Secretary: Mr. A. Matthey

#### Committee 6

##### *Regulations*

Chairman: Mr. M. K. Basu  
(India)  
Vice-Chairman: Mr. A. A. Bodede  
(Nigeria)  
Secretary: Mr. W. García-Ríos

#### Committee 7

##### *Editorial*

Chairman: Mr. F. Job (France)  
Vice-Chairmen: Mr. D. Baptiste (United Kingdom)  
Mr. B. A. Durán (Spain)  
Secretary: Mr. R. Macheret

The Committees then split into Working Groups, often into Sub-Groups, and finally into very small drafting groups in which the most laborious and detailed work was done. The International Frequency Registration Board (IFRB), which had been making technical preparations for the Conference for a considerable time, under the terms of No. 482 of the Radio Regulations, provided the Technical Secretariat, and the members of the Board and officials of the Specialized Secretariat took an active part in all phases of the work associated with the revision of the Radio Regulations and its appendices. After six weeks of discussion, the Conference ended on 17th July, at 06.00 hours, with the signature of the Final Acts, containing more than 300 pages. About 250 of these were revised texts of the Radio Regulations, the remainder being 8 Resolutions and 14 Recommendations adopted by the Conference on various subjects. It would doubtless be premature and even presumptuous—only a few days after so many-sided a Conference with such voluminous Final Acts—to attempt any detailed analysis of its decisions or fully weigh up the repercussions. The Board will be in a position to make this analysis

in the coming months and, as with preceding Conferences, it will communicate the full results to administrations in one of its circular-letters.

It is possible at this stage, however, to provide a glimpse of the work of the Conference and its overall results by reviewing briefly the action of the three Committees whose fundamental task was to prepare the decisions of the Conference on the revision of the Radio Regulations, in other words Committees 4, 5 and 6.

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#### Committee 4

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In accordance with its terms of reference, Committee 4 examined, revised and completed the existing provisions of the Radio Regulations pertaining to the technical criteria applicable for frequency sharing between space and terrestrial services and between space systems, taking into account, *inter alia*, the results of the technical studies made by the CCIR (see the Report of the CCIR Special Joint Meeting, Geneva, 1971).

With respect to the terms and definitions of Article 1 of the Radio Regulations, Committee 4 prepared a new definition of "equivalent satellite-link noise temperature", a term which is used in the texts of Article 9A and the new Appendix 29. It also defined the terms of "coordination distance", "coordination contour" and "coordination area", all of which are used in the new Appendix 28 and in the texts of Articles 9 and 9A.

As for the technical criteria themselves, which constitute the majority of the provisions in Article 7 of the Radio Regulations, Committee 4 drafted new provisions or amended existing provisions incorporating new data so as to provide for better sharing between the space and terrestrial radiocommunication services in the frequency bands allocated for these purposes which now extend from 1 to 40 GHz.

In the first place, a maximum value of equivalent isotropically radiated power was determined for the transmitting stations of the fixed and mobile services which share frequency bands with the space radiocommunication services. Such stations shall be located in such a way that, in certain frequency bands, the direction of

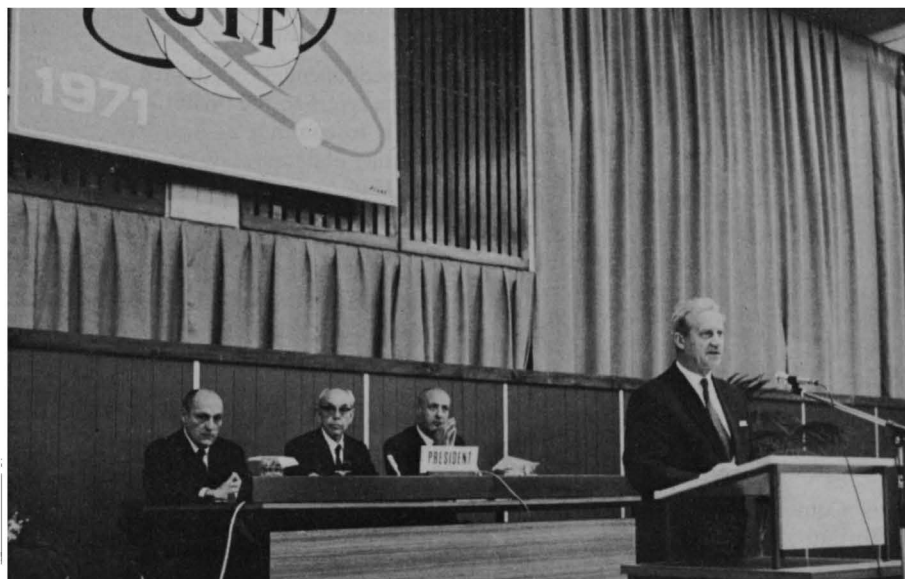
maximum radiation of their antennae is at least 1.5° to 2° away from the geostationary satellite orbit. When this condition cannot be met, the maximum equivalent isotropically radiated power shall be limited to a given level. These limits and restrictions apply in the frequency bands allocated to the fixed satellite service and to the meteorological satellite service for reception by space stations when they are shared, with equal rights, with the fixed and mobile services.

With regard to the location and limits for earth stations operating in frequency bands shared, with equal rights, between terrestrial and space radiocommunication services, restrictions were also stipulated for the equivalent isotropically radiated power transmitted by an earth station in any direction towards the horizon, and these limits vary depending on the angle of elevation of the horizon viewed from the centre of radiation of the earth station antenna. It should be noted that for angles of elevation of the horizon exceeding 5°, there are no restrictions on the equivalent isotropically radiated power transmitted by an earth station towards the horizon.

The limits set for earth stations may on occasion be exceeded by 10 dB at most. Nevertheless, when the coordination area resulting from this increase extends into the territory of another country, the increase must be the subject of agreement with the administration of that country.

The angle of elevation of transmitting earth station antennae may not be less than 3°, measured from the horizontal plane to the direction of maximum radiation, except when agreed to by administrations concerned or those whose services may be affected. In case of reception by an earth station, the above value shall be used for coordination purposes if the operating angle of elevation is less than that value. As an exception to the above, however, earth station antennae in the space research service (near-earth) shall not be used for transmission at elevation angles of less than 5° and those in the space research service (deep-space) at not less than 10°, the angles in both cases being measured from the horizontal plane to the direction of maximum radiation.

Limits were also determined for the power-flux density produced by space stations



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*Mr. R. Bonvin, Swiss Federal Councillor, speaking at the opening session of the Conference; in the background, from left to right: Messrs. M. G. Candau, Director-General of WHO, representing U Thant; G. Pedersen, Chairman of the Conference and M. Mili, Secretary-General of the ITU*

on the earth's surface, depending on either the frequency bands or the services sharing the bands with the space stations. These power-flux density limits apply to all conditions and methods of modulation and also depend on the angles of arrival above the horizontal plane. It should be emphasized that these power-flux density limits vary according to the bands shared and the services sharing them with the space radiocommunication service. Allowance has also been made, in the case of the fixed service, for whether it operates on the line-of-sight or tropospheric scatter method. The limits of power-flux density may be exceeded in those territories whose administrations have given prior agreement.

As frequency bands have been allocated with equal rights to the broadcasting-satellite service and the fixed or mobile service, limits have also been fixed for the power-flux density produced on the earth's surface by transmissions from a space station of this service for all conditions and methods of modulation; the limits vary here also according to the angle of arrival above the earth's surface.

Other technical provisions refer to the station-keeping of space stations that must be able to maintain their positions to within  $1^\circ$  of the longitude of their nominal positions, but efforts will be made to reduce this tolerance to  $\pm 0.5^\circ$  or less. However,

this provision does not apply or need to be respected so long as the satellite network to which the station belongs does not produce an unacceptable level of interference to another satellite network whose space station is meeting the limits specified. The pointing accuracy of geostationary satellite antennae was also determined and this accuracy should be maintained within certain limits to avoid unacceptable interference to other systems.

The maximum power-flux density produced at the earth's surface by a broadcasting satellite within the service area of a terrestrial broadcasting station, in the frequency band 620-790 MHz, was also fixed provisionally in the form of a Recommendation.

One of the major factors which will permit space and terrestrial radiocommunication services to share frequency bands between 1 and 40 GHz is the procedure for determining the coordination area around an earth station, which forms part of the new Appendix 28. The procedure in this new appendix replaces that given in the annex to Recommendation No. Spa 1.

Firstly, it is emphasized in Appendix 28 that with this procedure the presence or installation of a terrestrial station within the coordination area of an earth station (determined by this procedure) would not necessarily preclude the successful operation of either the earth station or the

terrestrial station, since the procedure is based on the most unfavourable case assumptions as regards interference.

In determining the coordination area, two cases are considered: first, when the earth station is receiving and hence capable of being interfered with by terrestrial stations, and second, when the earth station is transmitting and hence may cause interference to terrestrial stations. The permissible values of interference level are given by a general formula based on the permissible level of interference power, to be exceeded for no more than a percentage of the time at the receiver input of a station suffering interference.

The procedure described in Appendix 28 for determining the coordination area is fairly complex but, for practical application, an annex is attached to the appendix giving a simplified version of the procedure in the form of a flow diagram to help the user follow the necessary steps for obtaining the coordination contours.

Determination of the coordination distance implies the study of three modes of propagation. Modes *a*) and *b*) are based on near great circle propagation: mode *a*) is used when the main beam of the earth station antenna is elevated more than  $12^\circ$ , and mode *b*) when it is elevated less than  $12^\circ$  for long periods of time. The third mode of propagation, *c*), takes account of scattering from hydrometeors (rain scatter).

When the calculations for each azimuth of the three propagation modes have been made, the greatest of the coordination distances for each of the three modes represents the coordination distance to be used for the coordination procedure. Further, in the process of determining the coordination distance for any of the propagation modes, if values result which would require the coordination distance curves to be extended to distances of less than 100 km, the coordination distance for the mode under consideration shall be 100 km.

The parameters required for determining the coordination contour appear in Tables I and II of Appendix 28. Table I gives the interference data for a transmitting earth station, and Table II for a receiving earth station.

New Appendix 29, also prepared by Committee 4, shows a method of calculation to evaluate the degree of interference between geostationary satellite networks sharing the same frequency bands.

The method of calculating interference is based on the concept that the noise temperature of the system receiving interference increases as the level of interference increases, and it can therefore be applied irrespective of the modulation characteristics of the networks and of the precise frequencies used.

In this method, the apparent increase in the equivalent satellite-link noise temperature resulting from interference caused by a given system is calculated and this value is compared with a predetermined increase in the noise temperature.

The increase in the receiver noise temperature caused by interference in the receivers of the satellite and the earth station is calculated by a series of equations involving the maximum power density per Hz delivered to the transmitting antennae of the satellite and the earth station, the transmitting and receiving antenna gains of the satellite and earth station, the free-space transmission losses on the up- and down-paths and the geocentric angular separation in degrees between two satellites. The values thus calculated are then compared with the predetermined values which are taken as 2% of the appropriate equivalent satellite-link noise temperatures. If the calculated value is less than the predetermined value, the level of interference

of a link with respect to another satellite link is permissible. It may be seen, as an illustration of this method, that in the case of a satellite link operating in conformity with current CCIR Recommendations, using FM telephony and having a total noise of 10 000 pWOp in a telephone channel including 1000 pWOp interference noise from terrestrial radio-relay systems and 1000 pWOp interference noise from other satellite links, a 2% increase in equivalent noise temperature would correspond to a level of interference noise of 160 pWOp.

The annex to Appendix 29 gives an example of an interference calculation between two geostationary satellite links.

This Committee also prepared a fairly important Resolution relating to the technical criteria recommended by the CCIR for sharing frequency bands between space radiocommunication and terrestrial radiocommunication services or between space radiocommunication services. The Resolution states that, in frequency bands shared, with equal rights, by space radiocommunication and terrestrial radiocommunication services, it is necessary for the Radio Regulations to impose certain technical limitations and coordination procedures on each of the sharing services in the interest of controlling mutual interference. The continuing improvement in space techniques is recognized, as is the successful sharing of frequency bands by space and terrestrial radiocommunication services, and every Plenary Assembly of the CCIR since the Xth Plenary Assembly held in Geneva in 1963 has improved some of the technical criteria recommended by the preceding Assembly. Nevertheless, as World Administrative Radio Conferences empowered to amend the Radio Regulations are held less often and at less regular intervals than the CCIR Plenary Assemblies, it was decided that after every Plenary Assembly of the CCIR, administrations should be consulted to find out whether they wish to apply the most recent CCIR Recommendations and technical criteria relating to sharing between space and terrestrial radiocommunication services and between space radiocommunication services instead of those appearing in the Radio Regulations. In the case of administrations which wish to continue applying the provisions of the Radio Regulations or which do not reply to the enquiry, the provisions of the Radio

Regulations will therefore apply whenever they are involved in cases of sharing.

A Recommendation adopted by the Committee refers to the invitation made to the CCIR to continue as a matter of urgency its study of data not yet included in Tables I and II of Appendix 28 relating to the space and terrestrial radiocommunication services sharing frequency bands, with equal rights, and to formulate calculation methods for determining the coordination areas of earth stations at frequencies below 1 GHz and above 40 GHz.

Finally, the Committee also adopted a Recommendation relating to technical standards for the assessment of harmful interference in the frequency bands above 28 MHz. In this Recommendation, it stated that the term "harmful interference", as it was defined in No. 93 of the Radio Regulations, was of a qualitative nature and led to a purely subjective estimation of the nuisance of an interference. As harmful interference implies a considerable degree, or probability, of interference, it is desirable to determine the level of interference by which any emission, radiation or induction affects a radiocommunication service beyond specific limits established to ensure the quality and reliability of performance required by the nature of the service. The assessment of these levels is related to various factors such as the nature of the service concerned, the number of interference sources, percentages of time during which the interfering signal affects the wanted signal. It also notes that although the maximum allowable values of interference are given in certain Recommendations of the CCIR, the IFRB does not possess data on the extent to which these recommended values and the associated percentages of time may be exceeded without affecting a service beyond the specific limits established to ensure the quality and reliability of performance required by the nature of the service. The CCIR is therefore invited to study this subject and recommend the technical performance criteria for the frequency bands above 28 MHz allocated to space radiocommunication, radio astronomy and the terrestrial radiocommunication services, in order to enable the IFRB and administrations to apply such criteria for these bands. In addition, the IFRB is invited to publish, for the information of administrations, its Technical Standards based upon the relevant provisions of the



*General view of the Conference*

(ITU)

Radio Regulations and appendices thereto, decisions of the Administrative Conferences of the Union as appropriate, the CCIR Recommendations, the state of the radio art and the development of transmission techniques.

#### **Committee 5**

The terms of reference of Committee 5 were as follows:

"To consider, revise and supplement, as necessary, the existing Table of Frequency Allocations in the Radio Regulations for radiocommunication services, in so far as they may use space radio techniques and the radio astronomy service."

The Conference also instructed Committee 5 to consider the proposals pertaining to the definitions of services contained in Sections II and IIA of Article I of the Radio Regulations.

The Committee decided to deal with the allocation proposals service by service and to draw up the resultant revisions of the Table in numerical order of frequencies.

In order to complete its task in the allotted time, the Committee created six Working Groups, which themselves set up no less than eleven Sub-Groups. The volume of work performed was very considerable, as the proposals submitted by administrations concerning the Table of Frequency Allocations alone filled over 350 pages of conference documents.

In short, it may be said that the results achieved constituted a full revision of the Table of Frequency Allocations and of the related service definitions. Frequency allocations were added to those which were made in 1963, thereby multiplying by about 35 the portion of the radio frequency spectrum usable for space radiocommunications. Some of these allocations were made to ten new services, namely: the aeronautical mobile-satellite service, the maritime mobile-satellite service, the mobile-satellite service, the aeronautical radionavigation-satellite service, the maritime radionavigation-satellite service, the broadcasting-satellite service, the standard frequency-satellite service, the time signal-satellite service, the earth exploration-satellite service and the amateur-satellite service. Addi-

tional spectrum space was allocated to the fixed-satellite service, the meteorological-satellite service, the radionavigation-satellite service, the space research service and the radio astronomy service. Provisions were adopted to enable research into, and development of, space techniques to be pursued.

It is interesting to review the principal changes made to the service definitions. They resulted from the adoption of a philosophy which, simply stated, rested on the accepted notion that the basic radio services remain and it is only the technique allowing the establishment of links that evolves. Consequently, the terms adopted were constituted by retaining the name of the existing terrestrial radio-communication service and adding the word "satellite", instead of choosing a new name which would suggest that a different basic radio service was involved: for example, "fixed-satellite service" instead of "communication-satellite service". In other words, the term "satellite" was added to indicate the use of space techniques by the existing radio service concerned.

In connection with the newly-adopted service names, it may be noted that:

- a) when referring to more than one service using space radiocommunication techniques, the present term "space services" has been replaced by "space radiocommunication services";
- b) likewise, "terrestrial services" has been replaced by "terrestrial radiocommunication services";
- c) the definition of the earth exploration-satellite service includes the meteorological-satellite service; allocations to the earth exploration-satellite service therefore may be used for meteorological-satellite service purposes, whereas the reverse is not the case, i.e. allocations to the meteorological-satellite service are restricted to the purposes of that service;
- d) the "space operation service" replaces the term "space" appearing in the Table where followed by "telemetry", "telecommand" or "tracking", and these functions are normally provided within the service in which the space station is operating;
- e) the "inter-satellite service" covers the existing term "space-to-space";
- f) the "broadcasting-satellite service" definition has been supplemented by two new definitions, namely: "individual reception" and "community reception".

With respect to frequency allocations, the principal revisions of the Table of Frequency Allocations may be summarized as follows. This summary is intended to give an overall impression of the revisions of the Table and is not a complete list of all detailed changes introduced\*. Generally speaking, the allocations made in 1963 to the service which became the *fixed satellite service* were maintained. Additional allocations were made in the following frequency bands:

2500-2535 MHz and 2655-2690 MHz in Regions 2 and 3; 10.95-11.2 GHz; 11.45-12.75 GHz; 14-14.5 GHz; 17.7-21.2 GHz; 27.5-31 GHz and, above 40 GHz, 40-41 GHz; 50-51 GHz; 92-95 GHz; 102-

105 GHz; 140-142 GHz; 150-152 GHz; 220-230 GHz and 265-275 GHz. The allocations between 10 GHz and 40 GHz are generally to be shared, with equal rights, by this service and one or more terrestrial radiocommunication services; it should be noted that in Region 2, the band 11.7-12.2 GHz is also shared with the broadcasting-satellite service and its use is limited to domestic systems. Furthermore, in some of these shared bands, the use of the frequencies is subject to previous agreement among the administrations concerned and those having services, operating or planned to operate in accordance with the Table, which may be affected.

The allocations to the *aeronautical mobile-satellite* and *maritime mobile-satellite services* and associated *radionavigation-satellite services* were largely consequential to preparatory provisions adopted in 1963. For example, frequency bands 149.9-150.05 MHz and foot-notes MOD 285B and ADD 285C; 399.9-400.05 MHz and foot-notes ADD 285C and MOD 311A; 1535-1660 MHz where allocations to these services are either exclusive or, where shared, limited to sharing between two services for common use; 4200-4400 MHz, 5000-5250 MHz, 14.3-14.4 GHz and 15.4-15.7 GHz and foot-notes MOD 352A, MOD 352B, ADD 383B and ADD 408A. New provisions were adopted for the bands 240-328.6 MHz and 335.4-399.9 MHz in foot-note ADD 308A to encourage the use and development of space techniques in the mobile-satellite service, on specified conditions. The Conference adopted a Resolution relating to the use of the band 156-174 MHz by the *maritime mobile-satellite service* and a Recommendation relating to future frequency allocation requirements for the *maritime mobile-satellite service*. A world-wide allocation of the band 406-406.1 MHz was made and foot-note ADD 317A was adopted to encourage the use and development of low-power emergency position-indicating radiobeacon (EPIRB) systems using space techniques. Above 40 GHz, allocations were made at 43-48 GHz, 66-71 GHz, 95-101 GHz, 142-150 GHz, 190-200 GHz and 250-265 GHz (see in this connection a Recommendation relating to the future use of certain frequency bands between 40 GHz and 275 GHz).

With respect to the application of space techniques for safety and distress purposes

in the *maritime mobile service*, foot-note ADD 287A was adopted, providing for the possible use, on an exclusive basis, from 1 January 1976 at the earliest, of narrow channels in the bands 157.3125-157.4125 MHz (ships to satellites) and 161.9125-162.0125 MHz (satellites to ships).

The allocations to the *broadcasting-satellite service* may be summarized as follows:

- in the band 620-790 MHz, assignments may be made in all Regions to television stations using frequency modulation in the broadcasting-satellite service on specified conditions and subject to prior agreement among the administrations concerned and those having services which may be affected (see foot-note ADD 332A). Also with reference to this band, the Conference adopted a Recommendation relating to the criteria to be applied for sharing between the broadcasting-satellite service and the terrestrial broadcasting service;
- in the band 2500-2690 MHz, world-wide allocations were adopted with varying sharing arrangements; the use of this band is limited to domestic and regional systems for community reception and is subject to prior agreement (see foot-note ADD 361B);
- in the band 11.7-12.5 GHz in Region 1 and band 11.7-12.2 GHz in Regions 2 and 3, allocations were made with varying degrees of protection or limitation according to the Region (see foot-note ADD 405BA for Regions 1 and 3, and foot-notes ADD 405BB and ADD 405BC for Region 2);
- in the band 22.5-23 GHz, an allocation was made for Region 3 (see foot-note ADD 410B);
- in the bands 41-43 GHz and 84-86 GHz, allocations were made on a world-wide basis.

Allocations to the *amateur-satellite service* were made at 7000-7100 kHz, 14 000-14 250 kHz, 21 000-21 450 kHz, 28-29.7 MHz, 144-146 MHz, and 24-24.05 GHz. Foot-note ADD 320A provides authorization for the amateur-satellite service to use the band 435-438 MHz on condition that harmful interference shall not be caused to other services operating in accordance with the Table,

\* In connection with references to the foot-notes to the Table, the symbol "MOD" means that the text is the revised version of an existing foot-note and the symbol "ADD" indicates new provisions adopted at the Space Conference, Geneva, 1971.

and requires administrations authorizing such use to ensure immediate elimination of any harmful interference in accordance with the provisions of No. 1567A of the Radio Regulations.

Allocations were made to the *earth exploration-satellite service* and, in some cases, explicitly to the *meteorological-satellite service* which, according to the revised definition, is also part of the *earth exploration-satellite service*. The allocations with varying degrees of sharing and limitation may be found in the following frequency bands:

- for the *earth exploration-satellite service*, 460-470 MHz (foot-note ADD 324B); 1525-1535 MHz; 1690-1700 MHz (foot-note ADD 324B); 2096-2120 MHz for Region 1, and 2025-2120 MHz for Regions 2 and 3 and Spain (foot-notes ADD 356AC and ADD 356AB, respectively); 8025-8400 MHz and 21.2-22 GHz. Above 40 GHz, the bands 51-52 GHz and 65-66 GHz have been allocated on a shared basis with the *space research service*;
- for the *meteorological-satellite service* explicitly, allocations were made at 460-470 MHz, 1670-1700 MHz, 1770-1790 MHz, 7450-7550 MHz and 8175-8215 MHz.

An allocation to the *standard frequency-satellite service* was made in the band 400.05-400.15 MHz and foot-note ADD 312B provides that the standard frequency is 400.1 MHz and that emissions shall be confined in a band  $\pm 25$  kHz about this frequency.

By foot-note ADD 379A, the *standard frequency-satellite service* and the *time signal-satellite service* may be authorized to use the frequencies 4202 MHz and 6427 MHz, provided that such transmissions are confined within the limits of  $\pm 2$  MHz of these frequencies and subject to prior agreement with administrations having services operating in accordance with the Table, which may be affected.

Committee 5 adopted a Recommendation relating to the future use of bands allocated to the *inter-satellite service* (namely 54.25-58.2 GHz, 59-64 GHz, 105-130 GHz, 170-182 GHz and 185-190 GHz).

With respect to *search and rescue operations concerning manned space vehicles*, the Committee adopted foot-note ADD

201A providing that frequencies 2182 kHz, 3023.5 kHz, 5680 kHz, 8364 kHz, 10 003 kHz, 14 993 kHz, 19 993 kHz, 121.5 MHz, 156.8 MHz and 243 MHz may be used for such purposes in accordance with the procedures in force for terrestrial radiocommunication services.

Most of the allocations to the *space research service* made in 1963 were retained and new provisions were adopted. When they are in shared bands, the additional allocations are generally for use on a secondary basis.

Provisions designed progressively to improve conditions for the *radio astronomy service* were also introduced, in particular with respect to the frequencies mentioned in this connection in the Report of the CCIR Special Joint Meeting.

In adopting these provisions, Committee 5 established different levels of obligation to take measures to protect radio astronomy observations. These levels ranged from exclusive world-wide or regional allocations (e.g. 1400-1427 MHz) to a series of foot-notes exhorting administrations "to bear in mind the needs of the radio astronomy service" in certain countries where observations were authorized under national arrangements (e.g. foot-notes MOD 310, ADD 364G and ADD 412K). Between these two extremes, Committee 5 adopted foot-notes affording varying degrees of protection according to the present and possible future usage of the frequency band in question.

Provisions, in one form or another, were made or confirmed with reference to the following rest frequencies or their immediate neighbourhood: 327.4 MHz (see foot-note MOD 310); 1420.405 MHz; 1612.231 MHz (ADD 352K); 1665.401 MHz and 1667.358 MHz (MOD 353A); 1720.530 MHz (ADD 352K); 4829.649 MHz (ADD 382A); 5763 MHz (ADD 391A); 14.489 GHz (ADD 408C); 22.235 GHz (ADD 410A); 23.694 GHz, 23.723 GHz and 23.870 GHz (world-wide allocation 23.6-24 GHz); 36.466 GHz (ADD 391A) and 115.271 GHz (ADD 412K). Allocations were also made or retained in the bands 21.850-21.870 kHz (see foot-note ADD 221B); 2670-2690 MHz (foot-note ADD 364G); 2690-2700 MHz; 10.68-10.7 GHz; 15.35-15.4 GHz; 31.2-31.3 GHz (foot-note ADD 412I) and 31.3-31.5 GHz.

Two recommendations of interest to the radio astronomy service were adopted,

one relating to the protection of radio astronomy observations on the shielded area of the moon, and the other to the future provision of a band near 10 MHz for the said service.

Before adopting frequency allocations in bands between 40 GHz and 275 GHz, Committee 5 gave special consideration to the possible consequences of extending the upper limit of the Table above 40 GHz for space radiocommunication services only. The Committee took note that, at this order of frequency, the sharing problems with terrestrial radiocommunication services experienced in the lower portion of the spectrum and up to about 25 GHz were virtually non-existent. Consequently, future competent World Administrative Radio Conferences would probably not be hindered in making allocations to terrestrial radiocommunication services by the presence of allocations to space radiocommunication services. Two recommendations reflecting the conclusions of the Committee on this subject were adopted with reference to specific services: one of them relates to the future use of the 41-43 GHz band by the fixed and mobile services, and the other to the future use of certain frequency bands between 40 and 275 GHz.

With respect to *experimental operations* outside the *space research service*, a very large majority expressed the opinion that it would be inappropriate to allocate a frequency band for this purpose. In fact, it seems that it was considered that, however useful and meritorious an experimentation project might be, from a frequency management point of view, the existing provisions of the Radio Regulations were adequate to enable such experiments to be pursued.

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#### Committee 6

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The terms of reference of Committee 6 were the following:

"To consider, revise and supplement, as necessary, the existing administrative provisions of the Radio Regulations pertaining to the coordination, notification and registration procedures as well as the other related provisions."

In other words, the main task of Committee 6 was to revise the administrative regulations and international management

of frequency usage for space applications. It accordingly revised Articles 8, 9 and 9A of the Radio Regulations, the technical bases for the applications of the provisions they contain (Appendices 1, 1A, 1B, 28 and 29) having been formulated or revised by Committee 4. In so doing, Committee 6 naturally took into account the experience gained both by administrations and by the IFRB in the application of the regulations drawn up in 1963.

According to the decisions taken in Committee 6, the measures preceding the use of a frequency by a satellite network (or by a group of networks forming a satellite system) generally comprise the following steps:

- advance publication of the relevant information in the IFRB weekly Circular;
- coordination between geostationary satellite networks or systems;
- coordination between space radio-communication services and terrestrial radiocommunication services;
- notification of frequency assignments to the IFRB;
- examination of the frequency notices by the IFRB;
- recording of assignments in the Master Register.

These various stages are designed to enable all countries without distinction to have access to the use of space radio techniques (this principle was stated in a Resolution), while taking in advance the action required to avoid interference. It should be noted in this respect that limits have been fixed by Committee 4 in Article 7 of the Radio Regulations for the protection of reception on board satellites against terrestrial station emissions, and for the protection of reception in terrestrial stations against satellite emissions. The other possible sources of interference are the subject of coordination procedures, of which some were introduced by the 1963 Conference and which have the advantage of bringing administrations into direct contact with each other and enabling them, when necessary, to agree on acceptable levels of interference.

One of the innovations of the 1971 Conference was the establishment of a procedure for coordination between geostationary satellite systems which did

not exist in the 1963 Regulations. The new steps in the procedure were discussed at great length and Committee 6 finally adopted the following six principles, which it then did its utmost to reflect in the provisions of the revised Article 9A:

- “1) the data related to the “Advance Publication Procedure” must be published world-wide by means of the IFRB weekly Circular whether or not geostationary satellites are involved;
- 2) all administrations have the right to make comments;
- 3) the publication of data must contain a specified minimum of data to permit the calculation of the increase in noise temperature;
- 4) when the coordination procedure is commenced, it will be directed to the administrations whose interests may be affected and to those which have made comments;
- 5) the administration initiating coordination will inform the IFRB who will publish this information in its weekly Circular;
- 6) an administration believing that its notified or coordinated system was not taken into account shall have the right to require that it will be brought into the coordination procedures provided that this administration will provide the necessary information.”

Each of the steps in this procedure follows a strict time-schedule and merits a brief examination to bring out the innovations with respect to the 1963 Regulations.

- a) The purpose of advance publication is to inform all other administrations that an administration intends within a time limit not exceeding five years to carry out a project for a satellite system or for adding a satellite network to an existing system, irrespective of whether geostationary satellites are involved. This administration has to send to the IFRB, for publication in a special section of the weekly Circular, the technical data listed in Appendix 1B, from which can be calculated the increase in noise temperature which will be provoked in the other satellite systems by the bringing into use of the new system or new network and from which it

can be seen whether the increase exceeds or not the permissible limit fixed in Appendix 29. The other administrations have ninety days in which to make their comments. All the administrations concerned are therefore led to discuss the characteristics of their systems and their compatibility and an administration which has an existing system under its jurisdiction may, as a last resort, consider modifying the characteristics of that system, the position of its satellites in the geostationary satellite orbit, for example. This advance publication and the publication of comments in the IFRB weekly Circular make this procedure a public one. Administrations may request the assistance of the Board in overcoming their difficulties. In principle, it is only when any problems are solved that an administration can move on to the following stage, but in the event of persistent disagreement with another administration, it may, subject to certain reservations, pursue the procedure one hundred and fifty days after the date of the relevant IFRB weekly Circular. It should be noted that this procedure is much more elaborate and will certainly be much more productive than that deriving from Resolution No. Spa 1 of the 1963 Conference.

- b) Coordination between geostationary satellite space systems is on a frequency assignment by frequency assignment basis. It must be conducted with the administrations which have earth station or space station frequency assignments, whether they are already recorded in the Master Register in the same band or are or have been the subject of coordination between space systems. The coordination is based on the technical data listed in Appendix 1A and is required when the increase that will be caused in the noise temperature of the system concerned exceeds the permissible increase fixed in Appendix 29. All the information concerning coordination between space systems is published in the IFRB weekly Circular and the Board may be asked to endeavour to effect coordination in certain cases in which the administrations concerned have not answered or where they do not

reach an agreement on the acceptable level of interference. Any administration which considers it should have been included in the coordination procedure is entitled to ask to participate.

- c) Coordination between space radiocommunication earth stations and terrestrial radiocommunication stations operating above 1 GHz is required in the frequency bands which are designated for space applications in this portion of the spectrum and which are also allocated, with equal rights, to terrestrial radiocommunication services. It is done frequency assignment by frequency assignment. By and large Committee 6 retained the principles laid down in this regard by the 1963 Conference but the basis of the definition of "coordination distance" has changed. Whereas in 1963 it had been founded on the concept of "harmful interference", in 1971, it was based on that of "permissible level of interference", on the understanding that, during coordination, if interference exceeds the permissible level fixed by the Regulations or recommended by the CCIR, the administrations concerned may be led to agree on a higher level known as "the acceptable level of interference". The technical method of determining the coordination area of an earth station is defined in Appendix 28, which is far more elaborate and complex than Recommendation No. Spa 1 of the 1963 Conference. The Board may be asked by the administrations concerned to endeavour to effect coordination and, in so doing, to determine the coordination area.
- d) Frequency assignments to earth stations and space stations should be notified to the IFRB within three years before being put into use and this notification can take place, in principle, only after the two coordination procedures, if appropriate, have been carried out successfully. The data to be provided in the notice are those listed in Appendix 1A. In the event of persistent disagreement between administrations, an administration may, subject to certain reservations, send its notice to the Board one hundred and fifty days after the unsuccessful request for coordination.

- e) The procedures established in 1963 for the examination of frequency notices by the IFRB were amplified to take account of the new coordination procedure between satellite systems or satellite networks, but they were not fundamentally changed. The findings the Board has to reach in certain cases are still based on the concept of "harmful interference". Provision is made for an administration which, after an unfavourable finding in this respect, insists on a new examination of its notice, to have its earth station or space station frequency assignment recorded in the Master Register if the administration states that the assignment has been in use for at least one hundred and twenty days without any complaint of harmful interference having been received. But if this use causes harmful interference to another assignment previously recorded in the Master Register following a favourable finding, the administration responsible must have the interference eliminated. It may be said therefore that in the frequency bands designated for space applications, the Board's findings impose an obligation on the notifying administration which the dates entered in Column 2d, being of no significance, do not impose in other bands. The juridical status of the Board's findings is thus considerably enhanced and the significance of the dates recorded in Column 2d becomes almost equivalent to that of the dates in Column 2a.

Frequency assignments to broadcasting-satellite stations, however, are excluded from Article 9A. Committee 6 decided in a Resolution that stations in the broadcasting-satellite service shall be established and operated in accordance with agreements and associated plans adopted by world or regional administrative conferences, as the case may be, and that the Administrative Council shall examine as soon as possible the question of convening one or more competent conferences.

Pending the entry into force of such plans, Committee 6 defined in another Resolution an interim procedure for the treatment of frequency assignment notices concerning broadcasting-satellite stations. It is based on coordination and is similar to the Article 9A procedure, reference being made to the latter in several instances.

It should be noted that unfavourable findings by the IFRB have an obligatory character, this time not only vis-à-vis other satellite systems (as in Article 9A) but also vis-à-vis terrestrial stations.

In any case, the Radio Regulations stipulate that all available means shall be used to reduce to the maximum extent practicable radiation from space broadcasting stations over the territory of other countries, unless an agreement has been previously reached with them.

In revising Article 9A of the Radio Regulations, Committee 6 was very preoccupied by frequency assignments entered in the Master Register but not used, which it has long been customary to refer to as "dead wood". A special provision in Article 9A deals with this question and it is also the subject of a Recommendation that, if a difficult situation arises because of this "dead wood", the Administrative Council should place the question on the agenda of the next competent world administrative conference.

Article 9 of the Radio Regulations was also adjusted to take account of the new procedures concerning relations between space radiocommunication services and terrestrial radiocommunication services inserted in Article 9A. Committee 6 recognized the difficulties to which the "collective notification" of frequency assignments under No. 490 of the Radio Regulations gives rise and decided that such collective notification would no longer apply to terrestrial stations located in the coordination areas of earth stations or to terrestrial stations whose radiated power exceeds the level adopted for the calculation of the coordination distance. In other words, it decided that, for stations in these categories, individual notices are to be required containing all the technical data needed to ascertain whether they respect the technical limitations fixed in the Radio Regulations, including those on interference.

Committee 6 also decided that, from now on, terrestrial stations would only be coordinated when they are transmitting stations located in the coordination area of earth receiving stations, regardless of their frequency separation from the latter. It felt in fact that in the coordination area of earth transmitting stations which had already been coordinated, administrations setting up terrestrial sta-

tions would be sufficiently well informed of the possibility of interference to their receiving stations for co-ordination to be superfluous. On the other hand, Committee 6 considered that, from now on, the frequency separation of 6 MHz which had been fixed in the 1963 Regulations was insufficient.

Committee 6 also considered that the long-term IFRB studies provided for in Article 8 of the Radio Regulations (No. 477) should be extended to the whole of the frequency spectrum: it thus recognized the current evolution of radio technique by withdrawing the emphasis which had been placed on high frequencies in 1969 when those frequencies offered practically the only means of establishing long-distance telephone communications.

#### Conclusions

What conclusions may be drawn from this brief description of the work of the various Conference Committees, in which all delegations demonstrated an unreserved spirit of collaboration? In the main, the Conference may be said to have:

- 1) extended from 40 GHz to 275 GHz (i.e. practically multiplied by 7) the portion of the frequency spectrum whose use is regulated;
- 2) raised from 6076.462 MHz to 209 568.190 MHz (i.e. practically multiplied by 35) the portion of the spectrum usable for space applications, thus opening the way to considerable development of space radiocommunications of all kinds in the years to come; the greater part of this increase is due to allocations in the bands above 10 GHz;
- 3) decided that stations in the broadcasting satellite service shall be established and operated in accordance with agreements and associated plans adopted by world or regional administrative conferences, as the case may be;
- 4) established, and given regulatory force to, detailed technical procedures, based on technical criteria recommended by the CCIR, for calculating levels of interference;
- 5) established, and given regulatory force to, detailed technical procedures, based on technical criteria recommended by

the CCIR, for determining coordination areas and the sharing of the geostationary satellite orbit;

- 6) taken the necessary measures for cases where, in future, administrations agree to the use, so far as they are concerned, of the most recent technical criteria recommended by the CCIR in place of those laid down in the Radio Regulations;
- 7) considerably extended, supplemented and improved coordination procedures, on the basis of experience;
- 8) considerably extended and supplemented, again on the basis of experience, the procedures for notifying the IFRB and for the Board's examination of notices, such procedures thus becoming more complex;
- 9) given to certain findings of the IFRB a meaning which practically amounts to a right to international protection against harmful interference.

There is no doubt that the development of space communications in coming years will place a considerable workload on administrations; this will be accompanied, in both the technical and administrative sphere, by markedly more complex and detailed work in the management of the frequency spectrum by the IFRB at Union Headquarters. The IFRB's work will also increase in detail and complexity owing to the more extensive and elaborate regulatory procedures it will have to follow.

Furthermore, according to the 1971 revision of the Radio Regulations, administrations are entitled to ask for the Board's help at all stages of the procedures they have to go through and it seems likely that many administrations, particularly those of new and developing countries not yet equipped with the required technical and administrative facilities, will appeal for this assistance. It is to be expected, therefore, that in addition to the extra responsibilities resulting from the increased complexity of the new procedures and new tasks decided upon by the Conference, the Board will have to carry out studies for quite a number of individual administrations, in addition to the long-term studies it now has to make on the use of the whole frequency spectrum (including the preparation of the necessary technical standards) and the preparatory studies for future radio conferences.

#### Annex

##### Agenda for the Conference

In accordance with Resolution No. 653 adopted by the Administrative Council at its 24th Session (May 1969) the Agenda for the World Administrative Radio Conference for Space Telecommunications was as follows:

- to consider, revise and supplement as necessary, existing administrative and technical provisions of the Radio Regulations and adopt, as necessary, new provisions for radiocommunication services, in so far as they use space radio techniques, including those for manned space vehicles, and for the radioastronomy service, so as to ensure the efficient use of the spectrum;
- to consider, revise and supplement as necessary, the Radio Regulations to provide for the use of space radio techniques by the aeronautical mobile and maritime mobile services, for communication as well as for radio-determination purposes;
- to consider, revise and supplement as necessary, the existing Table of Radio Frequency Allocations in the Radio Regulations for radiocommunication services, in so far as they may use space radio techniques and the radio astronomy service;
- to consider, revise and supplement as necessary, the existing provisions pertaining to the technical criteria and the procedures for frequency sharing between space and terrestrial services, and to establish technical criteria and procedures for frequency sharing between space systems;
- to consider the feasibility at this time of coordinated frequency planning for radiocommunication satellites, including those placed on the geostationary orbit, and to take such action as is deemed appropriate;
- to make only such consequential changes to the Radio Regulations as are essential for the effective implementation of the decisions of the Conference;
- to adopt such Resolutions and such Recommendations related to the foregoing, as may be necessary.